

PROJECT MANUAL

GILES COUNTY PUBLIC SCHOOLS

MACY MCCLAUGHERTY ELEMENTARY/MIDDLE SCHOOL RENOVATIONS

STATE PROJECT NO.: 035-39-00-102

Architect's Project No. 2022088

July 7, 2023

Bidding/Construction Documents



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JULY 7, 2023

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GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS

STATE PROJECT NUMBER: 035-39-00-102

ZMM
ARCHITECTS ENGINEERS
1116 SOUTH MAIN STREET
BLACKSBURG, VIRGINIA 24060

COMMISSION NO. 2022088

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

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NOT USED

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NOT USED

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

SHEET NO. TITLE

GENERAL
G000

COVER SHEET

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M111C FIRST FLOOR PLAN AREA "C" - HVAC DUCT DEMOLITION
M111D FIRST FLOOR PLAN AREA "D" - HVAC DUCT DEMOLITION
M112 SECOND FLOOR PLAN - HVAC DUCT DEMOLITION
M113 ROOF PLAN - HVAC DEMOLITION
M121A FIRST FLOOR PLAN AREA "A" - HVAC PIPING DEMOLITION
M121B FIRST FLOOR PLAN AREA "B" - HVAC PIPING DEMOLITION
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M131C FIRST FLOOR PLAN AREA "C" - HVAC DUCTWORK
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M132 SECOND FLOOR PLAN - HVAC DUCTWORK
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M141C FIRST FLOOR PLAN AREA "C" - HVAC PIPING
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M310	ENLARGED MECHANICAL VIEWS
M510	DETAILS
M511	HVAC DETAILS
M520	SCHEDULES
M620	HVAC CONTROLS DIAGRAMS

ELECTRICAL

E101	GENERAL NOTES & LEGEND
E201	NEW LIGHTING 1ST FL AREA A, 2ND FL
E202	NEW LIGHTING 1ST FL AREA B
E203	NEW LIGHTING 1ST FL AREA C, AREA D
E301	NEW MECH POWER 1ST FL AREA A, 2ND FL
E302	NEW MECH POWER 1ST FL AREA B
E303	NEW MECH POWER 1ST FL AREA C, AREA D
E304	NEW MECH POWER PLAN ROOF
ED101	ELECTRICAL DEMO 1ST FL AREA A, 2ND FL
ED102	ELECTRICAL DEMO 1ST FL AREA B
ED103	ELECTRICAL DEMO 1ST FL AREA C, AREA D
ED104	ELECTRICAL DEMO PLAN ROOF

INVITATION TO BID

ARCHITECT:

ZMM

ARCHITECTS ENGINEERS

1116 South Main Street

Blacksburg, Virginia 24060

(540) 552-2151

GILES COUNTY PUBLIC SCHOOLS

MACY MCCLAUGHERTY

ELEMENTARY/MIDDLE SCHOOL RENOVATIONS

PEARISBURG, VIRGINIA

You are invited to bid on a general contract for Giles County Public Schools, Macy McClagherty Elementary/Middle School renovations for the Giles County School Board. This project consists of renovations to Macy McClagherty Elementary/Middle School that includes the following: Roof Replacement, Window Replacement, HVAC Replacement, Limited Interior Painting and Ceiling Replacement, etc. All bids shall be on a lump sum basis. Bids shall be received until 2:00 P.M. local prevailing time on October 26th, 2023, in the Board Room of the Giles County Public Schools, 151 School Road, Pearisburg, VA 24134, at which time they will be opened publicly and read aloud. Bids received after this time will not be accepted. All interested parties are invited to attend. Plans and specifications can be obtained via download from ShareFile **at no cost**. Contact ggoetz@zmm.com for ShareFile access. Upon receipt of valid email address, ZMM will provide a password with instructions on accessing and downloading plans and specifications. Hard copies of plans and specifications can be obtained from ZMM upon receipt of a nonrefundable check in the amount of \$150.00. Plans and specifications can be shipped for additional charge. A mandatory pre-bid conference will be held on October 17, 2023 beginning at 10:00 A.M. at Macy McClagherty Elementary/Middle School, 1001 Henson Ave., Pearisburg, VA 24134. This will provide an opportunity to answer questions and explain any items requiring further clarification.

Giles County School Board

Dr. Terry Arbogast

Superintendent of Schools

ZMM
ARCHITECTS ENGINEERS
1116 South Main Street
Blacksburg, Virginia 24060
(540) 552-2151

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
PEARISBURG, VIRGINIA

1. You are invited to bid on a general contract for Giles County Public Schools, Macy McClaugherty Elementary/Middle School renovations for the Giles County School Board. This project consists of renovations to Macy McClaugherty Elementary/Middle School that includes the following: Roof Replacement, Window Replacement, HVAC Replacement, Limited Interior Painting and Ceiling Replacement, etc. All bids shall be on a lump sum basis.

2. Bids shall be received until 2:00 P.M. local prevailing time on October 26th, 2023, in the Board Room of the Giles County Public Schools, 151 School Road, Pearisburg, VA 24134, at which time they will be opened publicly and read aloud. Bids received after this time will not be accepted. All interested parties are invited to attend.

3. Drawings and specifications may be examined at the Office of the Architect/Engineer, the Giles County School Board, and at the following locations:

Valley Construction News
426 Campbell Avenue SW
Roanoke, VA 24016

Jeanette Giordano
The Blue Book Bldg. & Construction Network
800 E. Main Street
Jefferson Valley, NY 10535

Builders Exchange of Tennessee
300 Clark Street
Knoxville, TN 37921

DODGE Data & Analytics
3315 Central Avenue
Hot Springs, AR 71913

ConstructConnect
30 Technology Parkway South
Suite 100
Norcross, GA 30092-2912

Construction Journal
400 SW 7th Street
Stuart, FL 34994

4. Plans and specifications can be obtained via download from ShareFile **at no cost**. Contact ggoetz@zmm.com for ShareFile access. Upon receipt of valid email address, ZMM will provide a password with instructions on accessing and downloading plans and specifications. Hard copies of plans and specifications can be obtained from ZMM upon receipt of a nonrefundable check in the amount of \$150.00. Plans and specifications can be shipped for additional charge. Contact ZMM for further details.

5. Bids shall be accompanied by a bid guarantee of not less than 5% of the amount of the bid, which may be a bid bond of 5% of the amount of the bid, made payable to Giles County School Board. A performance bond, payment bond and a material and labor bond will be required and the cost shall be included in the bid price.

6. Bidders are required under Title 54.1, Chapter 11, Code of Virginia (1950), as amended, to be licensed as a "Class A Contractor" before submitting a bid of one hundred twenty thousand (\$120,000) dollars or more; or to be licensed as a "Class B Contractor" before submitting a bid of ten thousand (\$10,000) dollars or more but less than one hundred twenty thousand (\$120,000) dollars; or be licensed as a "Class C Contractor" before submitting a bid of no more than ten thousand dollars (\$10,000). Each Bidder will be required to give their State Registration Number on their proposal. All non-resident contractors and

subcontractors bidding the work described herein shall register with the Department of Labor and Industry under the provisions of Section 40.1-30 of the Code of Virginia.

7. The Owner reserves the right to waive irregularities and to reject any or all bids.

a. A mandatory pre-bid conference will be held on October 17, 2023 beginning at 10:00 A.M. at Macy McClaugherty Elementary/Middle School, 1001 Henson Ave., Pearisburg, VA 24134. This will provide an opportunity to answer questions and explain any items requiring further clarification.

8. Bids shall be binding for a period of sixty (60) days from the date on which bids are opened.

Giles County School Board
Dr. Terry Arbogast
Superintendent of Schools

ZMM
ARCHITECTS ENGINEERS
1116 South Main Street
Blacksburg, Virginia 24060
(540) 552-2151

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NUMBER: 035-39-00-102

To be considered, bids must be made in accordance with these Instructions to Bidders.

A. Documents

1. Plans and specifications can be obtained via download from ShareFile **at no cost**. Contact ggoetz@zmm.com for ShareFile access. Upon receipt of valid email address, ZMM will provide a password with instructions on accessing and downloading plans and specifications. Hard copies of plans and specifications can be obtained from ZMM upon receipt of a nonrefundable check in the amount of \$150.00. Plans and specifications can be shipped for additional charge.

2. No partial sets will be issued.

B. Obligation of Bidder

1. By submitting a bid, the bidder covenants and agrees that they are satisfied from their own investigation of the conditions to be met, that they fully understand their obligation and that they will not make any claim for, or have right to cancellation or relief from the contract because of any misunderstanding or lack of information.

C. Questions

1. Submit all questions and comments about the drawings and specifications to the Architect/Engineer in writing to 1116 South Main Street, Blacksburg, VA 24060 or via e-mail to ggoetz@zmm.com. Replies will be issued as addenda to the drawings and specifications and will become part of the contract. Addenda will be posted on the ZMM **ShareFile** website. Planholders who have obtained authorization to download drawings and specifications from the ZMM **ShareFile** website will also have access to the AAddenda@ folder where all addenda will be posted. Immediately report any technical problems with the ZMM **ShareFile** website by calling the office of ZMM at (540) 552-2151. The ZMM **ShareFile** website will send notifications to the authorized Contractors when addenda are posted on the website. Planholders shall submit a valid email address to the office of ZMM when requesting plans and specifications. This email address shall have open security settings to allow receipt of addenda notifications generated from the ZMM **ShareFile** website (example: mail@sf-notifications.com). It is the Planholders responsibility to visit the ZMM **ShareFile** website and download the addenda. ZMM shall not be held responsible for email notifications not received by Planholders. Addenda posted on the ZMM **ShareFile** website may be accessed by any party, at any time. New addenda may be posted, and new addendum notification emails sent to Planholders up to 24 hours prior to bid opening.

D. Substitutions

1. Approvals and/or Submittals Prior to Bidding: The Bid Documents shall not require samples, shop drawings, or similar materials to be submitted for approval prior to receipt of bids. Bids shall be based upon the materials and equipment as indicated in the Contract Documents. No substitutions will be approved prior to bidding.

2. Approvals of Submittals: The specifications contain sufficient information to describe to the Contractor and bidders the performance and quality standards that will be used to evaluate the submittals.

3. Brand Names: Brand names may be utilized in the contract documents.

4. Equal Materials, Equipment or Assemblies: **Unless otherwise stated in the specifications**, other brand, make or manufacturer of a product, assembly or equipment which in the opinion of the Architect/Engineer is the equal of that specified, considering quality, capabilities, workmanship, configuration, economy of operation, useful life, compatibility with design of the work, and suitability for the intended purpose, may be accepted. The Contractor may submit to the Architect/Engineer a request for substitution during the shop drawing submittal phase. All such requests shall be submitted in writing and shall be accompanied by a Substitute Request Cover Sheet, itemized list of deviations from specified product, complete manufacturer's literature, specifications, and cutsheets covering the proposed substitute materials and the manufacturer's recommendations for installation. It shall be understood that the burden of proof for a substitute or an "or equal" material shall be on the Contractor.

E. Basis of Bid

1. The bidder must include the base bid, all alternate bid items, all unit prices, and all other items shown on the bid forms; failure to comply may be cause for rejection.

F. Preparation of Bids

1. Bids shall be made on unaltered bid forms as furnished in Section 00300 - FORM OF PROPOSAL. Fill in all blank spaces. Bids shall be signed with name typed below signature. Where bidder is a corporation, bids must be signed with the legal name of the corporation, followed by the name of the state of incorporation and the legal signature of an officer authorized to bind the corporation to a contract.

2. No bids shall be withdrawn for a period of sixty (60) days after the scheduled bid opening time.

G. Bid Security

1. Bid security shall be made payable to Giles County School Board in the amount of 5% of the total bid sum. Security shall be either certified check or bid bond issued by a surety licensed to conduct business in the State of Virginia. The successful bidder's security will be retained until he has signed the contract and furnished the required performance and payment bonds. The owner reserves the right to retain the security of the next two lowest bidders until the lowest bidder enters into contract or until sixty (60) days after the bid opening, whichever is shorter. All other bid securities will be returned as soon as practicable. If any bidder refuses to enter in a contract, the Owner will retain his bid security as liquidated damages, but not as a penalty. The amount of bid security retained shall be the difference between the bid for which the bond was written and the next low bid in accordance with Title 2.2, Chapter 43, Part 36 of the Virginia Code.

H. Performance, Payment and Material and Labor Bonds

1. The successful bidder, if awarded the contract, shall provide a proper performance and payment bond, covering up to the full amount of the contract price as security for the faithful performance of all work under the contract and payment of all charges in connection therewith. Cost of said bond to be included in base bid. The failure of the bidder to whom the award is made to execute the agreement and supply the required bonds within ten (10) business days after award of contract or within such extended period as the Owner may grant, shall constitute a default and the Owner may award the next lowest bidder in succession and charge against the defaulting bidder the difference up to the total amount of the bidder's bid security.

I. Subcontractors

1. Names of the principal subcontractors must be listed as called for in the Form of Proposal. No change in this list may be made after the bid unless approved by the Architect/Engineer. Subcontractors and material suppliers, other than those listed in the Form of Proposal, shall be submitted to the Architect/Engineer for approval within 10 days after execution of the contract.

J. Submittal

1. Submit bid in a sealed opaque envelope. Identify the envelope with: A) Project Name; B) Name of Bidder; C) Registered Virginia Contractor Number; D) Bid Date. If bids are forwarded by mail, the sealed envelope containing the bid must be enclosed in another envelope addressed as specified in the Form of Proposal with the notation "BID ENCLOSED" on the face thereof.

K. Modification and Withdrawals

1. Modification of bids already submitted will be considered if delivered prior to the time fixed for opening of bids. Written modifications may be delivered by mail or by the bidder personally or his properly identified representative or messenger. Telephonic and FAX modifications will not be considered. Modifications shall not reveal the original or revised bid. Delivery of modifications shall be the responsibility of the bidder.

L. Negotiation with Lowest Responsive and Responsible Bidder

1. The Public Body may negotiate with the apparent low bidder in accordance with Title 2.2, Chapter 43, Part 18 of the Virginia Public Procurement Act.

M. Withdrawal of Bid Due to Error

1. A bidder may withdraw his bid from consideration in accordance with Virginia Code Title 2.2, Chapter 43, Part 30 of the Virginia Public Procurement Act.

N. State Sales Tax

1. Bidders should be aware of the sales tax as applicable to the State of Virginia.

O. Opening

1. Bids will be opened as called for in the Invitation to Bid.

P. Award

1. The contract will be awarded to the lowest responsible bidder complying with the conditions of the Form of Proposal. The lowest bid does not refer to the lowest base bid, but the lowest total bid comprising the base bid plus or minus any/or all alternate bid items accepted, and not necessarily in the order in which they appear in the Form of Proposal.

Q. Execution of Contract

1. The Owner reserves the right to accept any bid and to reject any and all bids, and to waive any irregularities or informality in bids received whenever such waiver or rejection is in his own best interest.

2. Each bidder shall be prepared, upon written notice of bid acceptance, to commence work within fifteen (15) days following receipt of official written order from the Owner to proceed, or on date stipulated in such order.

3. The accepted bidder shall assist and cooperate with the Owner in preparing the Formal Contract Agreement between Owner and Contractor, Stipulated Sum, A.I.A. Document A101, 2017 Edition, and within fifteen (15) days following its presentation shall execute same and return it to the Architect/Engineer for distribution to Owner.

R. State of Virginia Requirements

The Code of Virginia, Title 2.2, Chapter 43, Part 11 requires each contract for more than \$10,000 to include provisions 1 and 2 below:

1. During the performance of this contract, the Contractor agrees as follows:
 - a. The Contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin, except where religion, sex or national origin is a bona fide occupational qualification reasonably necessary to the normal operation of the Contractor. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of the nondiscrimination clause.
 - b. The Contractor, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, will state that such Contractor is an equal opportunity employer.
 - c. Notices, advertisements and solicitations placed in accordance with federal law, rule or regulation shall be deemed sufficient for the purpose of meeting the requirements of this section.

2. The Contractor will include the provisions of the foregoing paragraphs a, b, and c in every subcontract or purchase order of over \$10,000, so that the provisions will be binding upon each subcontractor or vendor. (1982, C. 647.)

SCC Registration

The SCC Registration requirement (attached to Form of Proposal) shall apply to this project.

S. Federal Requirements

1. No contractor or subcontractor shall, during the performance of this contract, knowingly employ an unauthorized alien, as defined by the Federal Immigration Reform and Control Act of 1986.

T. County, Virginia Public Schools Requirements

1. Criminal Background Certification. See Form of Proposal.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

Dr. Terry Arbogast, Superintendent
Giles County Public Schools
151 School Road
Pearisburg, VA 24134

A. Pursuant to and in accordance with your "Invitation to Bid" and "Instructions to Bidders" relating thereto, the undersigned agrees to furnish all labor and materials and to perform all work necessary for construction of **Macy McClaugherty Elementary/Middle School Renovations**, Giles County Public Schools, in accordance with the contract documents (drawings, specifications and addenda) as prepared by ZMM ARCHITECTS ENGINEERS, dated July 7, 2023, for the lump sum price of:

BASE BID (Includes general contingency allowance of \$250,000 as indicated on page 2 of Section 012100 "Allowances" paragraph 1.7, A.):

_____ Dollars (\$ _____).

ALTERNATE BID ITEMS (See Section 012300 - ALTERNATES):

Alternate No. 1 – Furnish labor and materials exterior window replacement, as indicated on the drawings.

ADD \$_____.

LINE ITEMS:

The stated Base Bid is subject to the following additions for line items from which the Owner will select. Line items shall have a bid included for each manufacturer listed. ('Provide' means 'furnish and install.' Include in bids below all related coordination and modification requirements associated with the Work of each line item.)

Line Item No. 1 - Provide Building Control System (BCS) appearing below, one of which to be selected by Owner, as identified on the Drawings and in Division 25 Specifications to be Added to Base Bid as follows:

- A. Manufacturer: Alerton Controls, Hoffman Building Technologies, (540) 725 – 8701
(Basis of Design)

ADD to Base Bid the sum of: _____

_____ Dollars (\$ _____).

B. Manufacturer: Automated Logic, Premier Energy Systems, (304) 252 - 1918

ADD to Base Bid the sum of: _____
_____ Dollars (\$ _____).

C. Manufacturer: ASI Controls, RDS, Inc., (304) 757 - 3314

ADD to Base Bid the sum of: _____
_____ Dollars (\$ _____).

UNIT PRICES

The bidder shall submit unit prices in the following schedule for all items listed below.

The following unit prices shall be used in determining additions to or deductions from the contracts when authorized changes in the work are directed. They shall apply when such changes involve materials, specifications, methods, and designs the same as those required in similar work and/or specified. Unit prices shall include the furnishing of all labor and materials, complete in place, and overhead and profit, unless otherwise noted. Unit prices provided shall apply to any project bid, unless otherwise specified.

Addition/Deduction (Same Value)

- | | | |
|----|--|----------------------|
| A. | Removal of existing damaged roof decking and provide new 60 mil EPDM membrane over new ½" coverboard on new rigid roof insulation. (Beyond Base Bid Price) | \$ _____ per sq. ft. |
| B. | Suspended Acoustical Tile Ceiling | \$ _____ per sq. ft. |

In submitting this bid, I agree:

1. To hold my bid valid for a period of sixty (60) days.
2. To accept the provisions of the Instructions to Bidders regarding disposition of bid security.
3. To enter into and execute a contract, if awarded on the basis of this bid, and to furnish performance bond and payment bond in accordance with Article 11.1.2 of AIA A201- General Conditions of the Contract for Construction.
4. To accomplish the work in accordance with the contract documents.
5. That I have examined the contract documents and the site.
6. If awarded contract on Base Bid, I (we) agree to perform the work to completion and ready for occupancy and use within _____ days of the date of the Owner's Notice to Proceed (Bidder to propose number of days). The Bidder understands that the Owner may retain a sum as set forth in Section 011000 - "Summary of the Work," for each day thereafter, Sundays and holidays included, that the Work remains uncompleted, such sum is agreed upon as the proper measure of liquidated damages which the Owner will sustain per diem by the failure of the Contractor to complete the Work in the stipulated time, and the sum is not to be construed in any sense a penalty.

The names of all subcontractors as listed below are required to be submitted to the Architect/Engineer's office within two business days after the bids are due.

Subcontractors for the following work shall be as listed (**Note:** List only **one** for each category):

HVAC: _____

Electrical: _____

Roof: _____

Windows: _____

Addenda can be retrieved via ShareFile.

I acknowledge access to the following addenda:

Number _____ Dated _____

Number _____ Dated _____

Number _____ Dated _____

Number _____ Dated _____

The successful vendor certifies that the vendor, all principals and subrecipients, are not suspended or debarred from providing the services described in this contract. Further, Giles County Public Schools reserves the right to review the List of Parties Excluded From Federal Procurement or Nonprocurement Programs to determine that the successful vendor, including all principals and subrecipients, has not been suspended or debarred from providing the services described in this contract.

CRIMINAL BACKGROUND CERTIFICATION

The Contractor shall provide certification that he or she has not been convicted of a felony or any offense involving the sexual molestation or physical or sexual abuse or rape of a child and whether he or she has been convicted of a crime of moral turpitude. To protect the safety of students and school employees, Contractor certifies to the School Board that none of Contractor=s employees, whether new or current, full-time or part-time, permanent or temporary, who will be present on the Site or other school property and may have any contact with students or school employees, (i) have been convicted of a felony, any offense involving sexual molestation, physical or sexual abuse or rape of a child, or a felony involving lying, cheating or stealing; or (ii) have been the subject of a founded case of child abuse or neglect.

Contractor shall conduct an investigation of the criminal history, sex offender status and agency determinations of child abuse of each employee who will be present on the Site or other school property and may have contact with students or school employees. Contractor shall conduct all such investigations with the written consent of affected employees and in compliance with all applicable laws. Contractor certifies that it has conducted such an investigation for all current employees who will be involved in the work to be performed pursuant to this Agreement, and will conduct such an investigation for any future employees who will be involved in the Work to be performed pursuant to this Agreement. Contractor shall keep records of all investigations and shall make such records available to the School Board upon request.

If any employee of Contractor who will be present on the Site or other school property and may have contact with students or school employees is arrested for, charged with, or convicted of any such offense, or becomes the subject of a child abuse investigation, Contractor shall notify the Superintendent of the arrest, charge, conviction or investigation within forty-eight (48) hours after Contractor is made aware of the arrest, charge, conviction or investigation. The School Board reserves the right to exclude such employee from positions that may involve contact between such employee and students or school employees, or to exclude such individual from school property entirely.

Contractor shall include the provisions regarding criminal background certifications in all contracts with its subcontractors who will provide goods or services for GCPS, if any, so that such provisions are binding on all such subcontractors of Contractor.

Failure by Contractor or one of its subcontractors to conduct investigations or to make the certifications required by this provision may constitute a breach of this Agreement and grounds for termination or rescission of the Agreement. (Code of Virginia ' 22.1-296.1)

The following (attached) must be completed and attached as a part of this Form of Proposal:

SCC REGISTRATION REQUIREMENTS

Registered as a contractor under Title 54.1, Chapter 11, Code of Virginia

State Registration Number_____

Name of Firm

Address

Address

Legal Name of Corporation

State of Incorporation

By_____ (Officer Authorized Signature)

By_____ (Printed Name)

Title_____

Date_____

Phone_____

Email _____

Federal Tax ID # _____

GILES COUNTY PUBLIC SCHOOLS

151 School Road
Pearisburg, Virginia 24134
Phone: (540) 921-1421

Compliance with Virginia Law for Transacting Business in Virginia.

The undersigned hereby agrees, if this Bid/Proposal is accepted by GCPS, for such services and/or items that the undersigned has met the requirements of the Virginia Code Section 2.2-4311.2

Please complete the following by checking the appropriate line that applies and providing the requested information:

- A.** Bidder/offeree is a Virginia business entity organized and authorized to transact business in Virginia by the SCC and such bidder's/offeree's Identification Number issued to it by the SCC is _____. (The SCC number is **NOT** your federal ID number).
- B.** Bidder/offeree is an out-of-state (foreign) business entity that is authorized to transact business in Virginia by the SCC and such bidder's/offeree's Identification Number issued to it by the SCC is _____.
- C.** Bidder/offeree does not have an Identification Number issued to it by the SCC and such bidder/offeree is not required to be authorized to transact business in Virginia by the SCC for the following reason(s):

Please attach additional sheets of paper if you need to explain why such bidder/offeree is not required to be authorized to transact business in Virginia.

Legal Name of Company (as listed on W-9)

Legal Name of Bidder

Date

Authorized Signature

Print or Type Name and Title

VIRGINIA STATE CORPORATION COMMISSION (SCC)
INFORMATION REQUIRED

The attention of each Bidder is directed to Virginia Code Section 2.2-4311.2 (effective July 1, 2010) which requires a bidder or offeror organized or authorized to transact business in the Commonwealth of Virginia pursuant to Title 13.1 or Title 50 of the Code of Virginia, as amended, or as otherwise required by law, shall include in its bid or proposal the Identification Number issued to such bidder or offeror by the Virginia State Corporation Commission (SCC).

Furthermore, any bidder or offeror that is not required to be authorized to transact business in the Commonwealth of Virginia as a domestic or foreign business entity under Title 13.1 or Title 50 or as otherwise required by law shall include in its bid or proposal a statement describing why the bidder or offeror is not required to be so authorized.

For more information and answers to your questions please contact the Virginia State Corporation Commission (SCC). Website: <http://www.scc.virginia.gov/index.aspx>

SCC General Information

804-371-9967

Frequently Asked Questions: <http://www.scc.virginia.gov/clk/befaq/forinva.aspx#a1>

Email: sccinfo@scc.virginia.gov

Contact Information: <http://www.scc.virginia.gov/contact.aspx>

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

A. General

1. The "Standard Form of Agreement Between Owner and Contractor", A.I.A. Form A101, 2017 Edition, of the American Institute of Architects, is a part of this Project Manual to the same extent as if bound herein. Copies of this document may be inspected at or received from the office of the Architect/Engineer upon request.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

A. General

1. The "Performance Bond", A.I.A. Form A312, 2010 Edition, of the American Institute of Architects, is a part of this Project Manual to the same extent as if bound herein. Copies of this document may be inspected at or received from the office of the Architect/Engineer upon request.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

A. General

1. The "Payment Bond", A.I.A. Form A312, 2010 Edition, of the American Institute of Architects, is a part of these specifications to the same extent as if bound herein. Copies of this document may be inspected at or received from the office of the Architect/Engineer upon request.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

A. General

1. The "Bid Bond", A.I.A. Form A310, 2010 Edition, of the American Institute of Architects, is a part of this Project Manual to the same extent as if bound herein. Copies of this document may be inspected at or received from the office of the Architect/Engineer upon request.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

A. General

1. The "Supplemental Attachment for Accord Certificate of Insurance", A.I.A. Form G715, 2017 Edition, of the American Institute of Architects, is a part of this Project Manual to the same extent as if bound herein. Copies of this document may be inspected at or received from the office of the Architect/Engineer upon request.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

A. General

1. The "General Conditions of the Contract for Construction", A.I.A. Form A201, 2017 Edition, of the American Institute of Architects, is a part of these specifications to the same extent as if bound herein. Copies of this document may be inspected at or received from the office of the Architect/Engineer upon request.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

01. General Conditions:

The "General Conditions of the Contract for Construction", A.I.A. Document A201-2017, Articles 1-15, inclusive, are a part of the contract and are incorporated herein.

02. Supplements:

The following supplements modify, change, delete, or add to the General Conditions. Where any part of the General Conditions are modified or voided by these articles, the unaltered provisions of that part shall remain in effect.

ARTICLE 1 - GENERAL PROVISIONS

1.5.2 Change "pursuant to Sections 1.7 and 1.8" to read "pursuant to Section 1.7"

1.7 Delete 2nd sentence.

1.7.1 New Subparagraph: "Use of ZMM ARCHITECTS ENGINEERS Document Management System Required:

.1 The Contractor shall use the internet-based document management system prescribed by ZMM. Currently, this system is ShareFile, and its use and access by the Contractor is free of charge. At its sole discretion, ZMM may change document management systems prior to final ratification of the Contract for Construction. Any document management software will be free of charge for the Contractor to access and use. The Contractor may also grant access to the document management system, free of charge, to their subcontractors, suppliers, etc.

.2 The Contractor shall utilize the document management system for the following tasks throughout the project:

.a All submittals to ZMM. This includes, but may not be limited to shop drawings, schedules, field reports, cost proposals, formal project correspondence, RFIs, CCDs, etc.

.3 ZMM will provide a user guide with specific requirements and instructions. The Contractor may request a copy of this document from ZMM prior to bid."

1.8 Delete in its entirety.

ARTICLE 2 - OWNER

2.3.6 Delete in its entirety and substitute the following:

"Drawings, specifications, and addenda will be provided to the Contractor in digital format via ShareFile. The Contractor will be responsible for printing his/her own drawings, specifications, and addenda for execution of the work."

ARTICLE 3 - CONTRACTOR

3.2.5 New Subparagraph: "Should conflict occur in Contract Documents and the Bidder does not ask for and obtain a written decision, before submission of bid, as to which method or material will be required, then it shall be deemed that the Bidder has based his bid on the more expensive way of performing the work."

3.7.4 Delete in its entirety.

3.8.2 Item .2 change to read - "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 allowances; and"

3.9 Superintendent

3.9.4 New Subparagraph: "The Contractor's superintendent shall give special attention to all phases of work nearing completion, and shall remain on the job site, in active control of work, until all phases of the work have been completed, tested, cleared, and accepted by the Owner or his representative. The superintendent shall not be a foreman and shall not perform or supervise any manual labor. The superintendent shall have 10 years experience as a superintendent."

3.9.5 New Subparagraph: "Should the superintendent at any time, in the opinion of the Architect/Engineer or Owner, fail to perform his duties satisfactorily, he shall be removed from the project upon request of the Architect/Engineer and a suitable replacement employed. The replacement shall be approved by the Owner and the Architect/Engineer."

3.9.6 New Subparagraph: "The Contractor shall have on-site, for the duration of his work, a competent superintendent capable of the following:

- .1 Supervising the tradesmen and any subcontractors.
- .2 Reading and interpreting the Contract Documents.
- .3 Orderly coordination of his work with the Architect/Engineer in the daily execution of The Work.
- .4 Laying out his work.
- .5 Representing the Contractor with the Owner and Architect/Engineer in the daily execution of The Work.
- .6 Controlling and establishing good quality in the completed work.
- .7 A resumé on the Contractor's proposed superintendent must be submitted to and approved by the Owner and the Architect/Engineer prior to assignment to the project.
- .8 After acceptance of the Contractor's superintendent, he may not be transferred from this project without written permission from the Architect/Engineer."

3.9.7 New Subparagraph: "The Superintendent employed by the Contractor shall have a minimum of ten (10) years successful commercial experience as the primary Superintendent on projects of similar size and complexity as the Work. The Contractor shall submit to the Architect a resume and other supporting documentation showing that the proposed Superintendent is competent and has the minimum work experience required to execute the Work. The Owner reserves the right to request additional supporting documentation regarding the proposed Superintendent's qualifications and to require the Contractor to propose an alternate

Superintendent who better meets the requirements contained in this Article, as may reasonably be determined by the Owner. The Contractor shall notify the Architect and Owner in writing of any proposed replacement of the Superintendent. The Contractor shall not replace a competent Superintendent without prior or written approval from the Owner. The requirements contained in this Article shall apply to any proposed replacement Superintendent, regardless if the proposed tenure is to be temporary or permanent."

- 3.9.8 New Subparagraph: "The Contractor shall employ a Project Manager to be assigned to the Work. The Project Manager employed by the Contractor shall have a minimum of ten (10) years successful commercial experience as Project Manager on projects of similar size and complexity as the Work. The Contractor shall submit to the Architect a resume and other supporting documentation showing that the proposed Project Manager is competent and has the minimum work experience required to execute the Work. The Owner reserves the right to request additional supporting documentation regarding the proposed Project Manager's qualifications and to require the Contractor to propose an alternate Project Manager who better meets the requirements contained in this Article, as may reasonably be determined by the Owner. The Contractor shall notify the Architect and Owner in writing, of any proposed replacement of the Project Manager. The Contractor shall not replace a competent Project Manager without prior written approval from the Owner. The requirements contained in this Article shall apply to any proposed replacement Project Manager, regardless if the proposed tenure is to be temporary or permanent. The Project Manager shall not act as the Superintendent or replacement for the Superintendent without written approval from the Owner."

3.10 **Contractor's Construction and Submittal Schedules**

- 3.10.4 New Subparagraph: "Within fifteen (15) business days of award of the contract, the Contractor shall submit a Construction Schedule to the Architect and Owner for review. The Architect and Owner shall review the schedule and offer any comments they have in writing within ten (10) business days. Such review and comments shall be for informational purposes only and shall not constitute endorsement of any errors or omissions that may appear in the schedule, nor shall it constitute a review of the Contractor's means and methods.

The Construction Schedule shall be a comprehensive, fully developed, horizontal Gantt chart type. The schedule shall begin at the Notice to Proceed date and end no later than the contractual date of completion. Contract date shall not be changed by submission of a schedule that shows an early completion date.

- .1 Activities: At a minimum, the schedule shall show the following:
 - .a Activity Duration: Define activities (tasks) so no activity duration is longer than twenty (20) days.
 - .b Procurement Activities: Include procurement activities as separate activities in the schedule. Procurement activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - .c Submittal Review Time: Include review and at least one resubmittal into the schedule for each submittal listed on the Submittal Log in the specifications. Review periods shall be the maximum time allowed by the specifications. There shall be no time extensions granted for submittals that require more than one resubmittal.
 - .d Startup, Balancing, Testing and Commissioning Activities: Indicate all activities associated with systems and equipment Startup, Balancing, Testing and Commissioning, including training of Owner's personnel. Each system

and piece of equipment subject to these activities shall be represented as a separate activity in the schedule.

- .e Punch Lists, including Above Ceiling Inspections: Indicate punch lists as milestones in the schedule. Include separate activities for completing punch list work within time limits prescribed by the Contract Documents.
- .f Substantial Completion: Indicate completion in advance of date established for Substantial Completion, allowing time for Architect's administrative procedures necessary for certification of Substantial Completion.
- .g Final Completion: Indicate time for punch list work, submittals and administrative procedures between Substantial Completion and Final Completion.
- .2 Constraints: Include constraints and work restrictions indicated in the Contract Documents, including the prescribed Monday-Thursday work week and Friday make-up day.
- .3 Critical Path: Indicate the critical path tasks throughout the project. Alert the Owner and Architect if the critical path changes and why it changed.
- .4 Float: Indicate float for each activity. The project owns the float and it may be used by either the Contractor, the Owner, or the Architect without affecting the critical path, and without penalty.
- .5 Percent Complete: Indicate percent complete for all activities."

3.10.5 New Subparagraph: "For purposes of calculating the additional days due to inclement weather, the normal work week for this project will be Monday through Thursday, 10 hours per day. Starting and quitting times will be established at the first jobsite meeting. Friday will be used as a makeup day for any time lost during the week due to inclement weather or other progress delays. Any Contractor working extended additional hours in a particular week due to his work being behind will be responsible for any overtime costs incurred by the Owner and the Clerk-of-the-Works, who may be required to work these extended hours to support his work. Delays due to a single weather day experienced Monday through Thursday will not be allowed if Friday is utilized or could have been utilized as a makeup day."

3.11 **Documents and Samples at the Site**

Delete "upon completion of the Work" and insert "prior to final payment".

3.12 **Shop Drawings, Product Data and Samples**

3.12.11 New Subparagraph: "Shop drawings and samples shall be dated and shall contain: name of project, description or names of equipment, materials and items, and complete identification of locations at which materials or equipment are to be installed. Cut sheets of materials showing items to be used shall be submitted."

3.12.12 "Unless otherwise specified, electronic shop drawing submittals are preferred, but if hard copies are submitted, the number of shop drawings, product data, and the number of samples which the Contractor shall submit and, if necessary, resubmit, is the number that the Contractor requires to be retained, plus **one** which will be retained by the Architect/Engineer, plus **two** that will be retained by the Owner."

3.15 **Cleaning Up**

3.15.3 New Subparagraph: "Clean all areas affected by the work to the satisfaction of the Owner. Remove broken or scratched glass and replace with new glass. Remove paint droppings, spots,

and dirt from finished surfaces. Clean plumbing fixtures, hardware, floors, electrical switches and switchplates, and equipment. Contractor shall keep interior of the building free of stored or unattended combustible materials. All glass shall be cleaned 5 days before acceptance by the Owner."

ARTICLE 4 - ARCHITECT

4.2.2 Add the following sentence:

"The Contractor shall reimburse the Owner for compensation paid to the Architect for additional site visits made necessary by the fault, neglect or request of the Contractor."

4.2.8.1 New Subparagraph: "No change in the work will give rise to an increase in the contract sum without a change order, and the Contractor waives any claim for such an increase based upon unjust enrichment, course of dealings or implied or express acceptance."

ARTICLE 7 - CHANGES IN THE WORK

7.2 **Change Orders**

7.2.2 New Subparagraph: "In subparagraphs 7.1.1, 7.1.2 and 7.1.3, the allowance for overhead in direct labor cost shall be 46.7% (FICA, FUI, SUI, Workmen=s Compensation, Vacation, Holidays, Sick, Health Insurance, Life Insurance, 401K); the allowance for overhead in direct material and equipment cost shall be the current sales tax where the project is located; the allowance for overhead and profit combined, included in the total cost to the Owner, shall be based upon the following schedule: For the Contractor, for work performed by his own forces, 20% of the cost; for the Contractor, for work not performed by his own forces, 10% of the cost; for subcontractors, for work performed by his own forces, 20% of the cost. Cost to which overhead is applied shall be limited to the following: cost of materials, including sales tax and cost of delivery; cost of labor, including social security, and unemployment insurance (labor cost may include a pro rata share of foreman's time only in the case where an extension of contract time is granted due to the change), workman's compensation insurance, vacation, holidays, sick, health insurance, life insurance, and 401K, rental value of special power tools and equipment required specifically for this work. Rental of tools and equipment required for general work can be charged only in the case where an extension of contract time is granted due to the change. Overhead shall include the following: bond premiums, supervision, superintendence, wages of timekeepers, watchmen and clerks, small tools, incidentals, general office expenses, and all other expenses not included in "cost". If the net value of a change results in a credit from the Contractor or subcontractor, the credit given shall be the net cost plus overhead and profit. The cost as used herein shall include all items of labor, materials, and equipment."

7.3.1 Delete in its entirety and substitute the following:

"Construction Change Directives (CCD) - A Construction Change Directive is a written request for pricing from the Architect or, when signed by the Owner, a directive to carry out the work prescribed by the CCD. The Owner, by Construction Change Directive, without invalidating the Contract, orders 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 by Change Order at a later date. The Owner may sign the CCD, ordering the work to commence, as prescribed in Item 1. or 2. below:

1. Upon receipt of and agreement to the Contractor's proposed cost/credit and/or adjustment of Contract Time. The Architect has the authority to request cost and time proposals of the Contractor without written consent of the Owner, however, the Owner's signature is required on the CCD as authorization for the work to proceed.
2. The Architect and Owner may both sign a CCD to direct the Contractor to proceed with work immediately. Costs and time will be negotiated and agreed to at a later date.

When a CCD is issued by the Architect to request pricing, the Contractor shall submit cost and time proposals within ten (10) business days of the date of the CCD. If work prescribed by the CCD may immediately impact the critical path, the Contractor shall notify the Architect and Owner immediately and shall submit the cost and time proposal in less than ten (10) business days, in order to mitigate or otherwise minimize the impact of the potential change on critical path activities. The Contractor shall track the cost and time proposal using the CCD number only.

The Contractor may initiate a Cost Proposal when he believes there is cause to do so. Contractor's cost proposals shall be tracked by sequential numbers preceeded by "CP". The Architect will review and respond to the Contractor initiated cost proposals within ten (10) business days. Failure of the Contractor to submit a Contractor initiated cost proposal within thirty (30) calendar days of cause for the alleged cost shall render the claim for additional compensation null and void. Once the Architect agrees to the terms of a Contractor initiated Cost Proposal, he shall create a Construction Change Directive (CCD) and obtain Owner and Contractor signatures as formal approval of the terms of the Cost Proposal. In lieu of a CCD, the Architect may include Contractor initiated Cost Proposals in a Change Order, as incorporation into the Contract."

- 7.3.2 Add the following: "A Construction Change Directive may also be used in the absence of total agreement on cost and time, as provided in Paragraph 7.3.4."
- 7.3.6 Delete in its entirety.
- 7.3.7 Change last sentence to read as follows: "Such agreement shall be recorded at a later date as a Change Order."
- 7.3.10 Add the following to the last sentence: ", and may not be issued until later in the project if there exists a Contingency Allowance, or other allowances, from which to draw from for the cost of the Construction Change Directive."

ARTICLE 8 - TIME

- 8.3 **Delays and Extensions of Time** - Delete in its entirety and substitute the following:

"8.3 **Delays and Extensions of Time**

- 8.3.1 Contract time stipulated under other sections of the Contract Documents may be extended by Change Order to provide an additional work day for each full work day that the Contractor is prevented from working by reason of one or more of the following causes:
 - .1 Unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not limited to, catastrophes and/or acts of God, acts of

- another Contractor in the performance of a separate contract with the Owner, epidemics, quarantine restrictions, strikes or freight embargoes;
- .2 An unusual amount of severe weather to such an extent as to be definitely abnormal and beyond conditions that may be reasonably anticipated. For the purpose of this contract, a total of three (3) working days per calendar month shall be anticipated as "normally bad or severe weather", and such time will not be considered justification for an extension of time: No weather delay extensions will be considered unless, in the opinion of the Architect/Engineer, the weather condition affected the critical path adequately to justify a delay;
- .a Claims for delay due to inclement weather shall be made by the 10th of the month following the month of the delay. No additional compensation for weather delays shall be granted.
 - .b Other claims shall be made no more than ten (10) calendar days after the commencement of the delay.
 - .c Claims made beyond these time limits shall be null and void.
 - .d Requests for extension of time shall be fully documented by including copies of daily logs, letters, shipping orders, delivery tickets, and other supporting information.
 - .e Normal working days are based on a four day week, Monday through Thursday, 10 hours per day.
 - .f Delays due to a single weather day experienced Monday through Thursday will not be allowed if Friday is utilized or could have been utilized as a makeup day.
- .3 All claims for delays shall be evaluated by the Architect using the most recent construction schedule in possession of the Architect at the time of the delay and a construction schedule revised by the Contractor, demonstrating the delay. The schedules must exhibit that the change, or weather, affected critical path tasks or used more than the available float for a task or tasks to justify an extension in contract time.
- .4 Where phased construction is prescribed by the Contract Documents, approved contract time extensions shall extend the duration of the phase in which the delay occurred. Durations of other phases will remain unchanged, and the dates of substantial and final completion shall be extended.
- .5 Stoppage of work, ordered by Owner or Architect/Engineer, for reasons over which Contractor has no control. The Contractor shall, within ten (10) days after the beginning of such delay notify the Owner and Architect/Engineer in writing of the cause of the delay. The Architect/Engineer will then ascertain the facts and extent of delay, and notify the Contractor within ten (10) working days of the Owner's decision in the matter. Notice of delay and requests for extension of time shall set forth the cause, and number of additional working days the Contractor desires the contract extended.
- .6 With the exception of overhead and profit allowed where changes in the work occur, no additional compensation will be allowed for time extensions.

- 8.3.2 No claims for extension of time will be considered when based on delays caused by conditions existing at the time bids were received, and of which the Contractor might be reasonably expected to have full knowledge at the time of bidding, or upon delays caused by failure on the part of the Contractor to anticipate properly the requirements of the work contracted for as to materials, labor and equipment. All claims for extension of time shall be made in writing to the Architect/Engineer within the time limits prescribed by the Contract Documents; otherwise they shall be waived.
- 8.3.3 Completion date stipulated under other sections of the Contract Documents may be extended by Change Order to compensate for additional work that may be ordered by the Owner,

provided such work is over and beyond the scope of work covered by original contract, and is of such nature as to materially affect the date of completion."

ARTICLE 9 - PAYMENTS AND COMPLETION

9.3 Applications for Payment

9.3.4 New Subparagraph: "Amount payable monthly to be ninety-five percent (95%) of amount of work in place, or materials stored on the site on the first day of the month. If the Contractor is behind schedule, or there are quality problems, the Owner may retain up to 10%. The retainage may not be reduced or released by the Owner until the project is fully completed and accepted by the Owner."

9.5 Decisions to Withhold Certification

9.5.1 Add the following:

"8 if the construction schedule is not properly maintained and/or if revised construction schedules are not submitted to the Owner and the Architect at least twice monthly, coinciding with progress meetings unless otherwise agreed upon by the Owner and Architect.

.9 failure to process Construction Change Directives, Change Orders, Shop Drawing submittals, or other material associated with the Contract for Construction within time limits established by the Contract Documents, or if no time limits are established, within a reasonable amount of time to avoid delays and allow sufficient review time for the Owner and Architect."

9.5.3.1 New Subparagraph: "The Owner shall not be in breach for withholding payment so long as it does so in good faith based upon a bona fide dispute. The Contractor may not stop work during the pendency of a bona fide dispute. Until the dispute is resolved, the associated sum shall be placed in escrow."

9.9 Partial Occupancy or Use

9.9.1.1 New Subparagraph: "When the Contractor is ready for final inspection, he shall give notice to the Architect/Engineer, with a copy to the Owner in the following words:

"The work on the contract for (show name of project as it appears in the Form of Agreement), having been fully completed, except as stipulated herein below, it is requested that a final inspection be made promptly by the Architect/Engineer. The following work is incomplete through no fault or negligence of the Contractor: (list any work the Contractor regards as exceptionable and after each item substantiate why its incompleteness is not due to his fault or negligence.)"

No final inspection shall be made until such time as the Architect/Engineer and the Owner have received a letter in the exact form indicated above."

ARTICLE 10 - PROTECTION OF PERSONS AND PROPERTY

10.3.3 Delete in its entirety.

Add the following new paragraphs:

"10.5 General

10.5.1 All phases of work under this contract shall conform to the applicable requirements of the Occupational Safety and Health Act (Public Law 91-596) as adopted by the U.S. Department of Labor."

ARTICLE 11 - INSURANCE AND BONDS

11.1 Contractor's Insurance and Bonds

11.1.1.1 New Subparagraphs: "The insurance required by subparagraph 11.1.1 shall be written for not less than any limits of liability required by law or by those set forth below, whichever is greater, and shall include contractual liability insurance as applicable to the Contractor's obligations under paragraph 3.18.

.1 The Contractor's comprehensive general liability insurance and automobile liability shall be in an amount not less than one million dollars (\$1,000,000) for injuries, including accidental death, to any one person and subject to one million dollars (\$1,000,000) on account of one occurrence.

.2 Property damage liability insurance shall be in an amount not less than fifty-thousand dollars (\$50,000).

.3 Liability insurance should include all major divisions of coverage and shall be on a comprehensive general basis, including:

.1 Premises - Operations (Including X-C-U)

.2 Owner's and Contractor's Protective

.3 Products and Completed Operations

.4 Contractual - Including specific provision for the Contractor's obligations under paragraph 3.18."

11.1.2.1 New Subparagraph: "The successful bidder, if awarded the contract, shall provide a proper performance and payment bond, covering up to the full amount of the contract price as security for the faithful performance of all work under the contract and payment of all charges in connection therewith. Cost of said bond to be included in base bid. The failure of the bidder to whom the award is made to execute the agreement and supply the required bonds within fifteen (15) days after award of contract or within such extended period as the Owner may grant, shall constitute a default and the Owner may award the next lowest bidder in succession and charge against the defaulting bidder the difference up to the total amount of the bidder's bid security."

11.1.3 Delete in its entirety and substitute therefore: "Furnish in duplicate, certificates herein called for and specifically set forth, evidence of all coverage required by 11.1.1 and 11.1.1.1 and the Contractor shall furnish to the Architect/Engineer copies of any endorsement that is subsequently issued amending coverage or limits."

11.2 Delete in its entirety.

11.5.2 Delete beginning with 4th sentence through the end of the paragraph.

Add the following new paragraphs:

"11.6 Construction Property Insurance (Builders Risk)

11.6.1 Unless otherwise provided in the Special Conditions, the Owner agrees to include the interest of the Owner, Contractor(s), subcontractors, and sub-subcontractors in an insurance policy covering all loss to the work, materials, and equipment by perils covered under the "Special" Property form, including theft, malicious mischief and vandalism. The policy will be written by an insurance company licensed to issue such policies in the **State of Virginia**. The Contractor will be furnished a copy of the Certificate of Insurance after the Contract is executed. The Owner will purchase, pay for, and maintain this insurance throughout the life of this Contract, and therefore, the cost of Builders Risk Insurance shall not be included in the Contractor's bid.

11.6.2 The insurance to be furnished by the Owner will cover only those materials and equipment which will become a permanent part of the completed project and scaffolding, construction forms and temporary structures if their values are chargeable to the project.

11.6.3 The amount of the insurance provided hereunder shall be at all times at least equal to the full value of the work, material and equipment complete and in place (as part of the permanent project) and the value of material and equipment delivered to the site or approved off-site storage locations.

11.6.4 The insurance to be provided hereunder shall include coverage for materials and equipment accepted for incorporation into the completed project and stored on the site of the work, stored in an off-site location which has been approved by the Owner, or in transit.

11.6.5 The insurance to be furnished by the Owner will include a deductible of one thousand dollars (\$1,000.00) per occurrence on all perils of loss with the exception of Flood and Earthquake subject to the insurance policy forms and exclusions. The deductible shall be paid by the Contractor, or Contractor(s) in proportion to their respective portions of loss if the loss affects more than one (1) Contractor or subcontractor.

11.6.6 Following any loss which the Contractor believes may be covered by the insurance to be provided hereunder, the Contractor shall immediately notify the Owner. The Owner will report to the insurance company losses on behalf of the Contractor. The Contractor shall cooperate with the Owner and the insurer, or its authorized representatives, in their efforts to investigate and settle the claim, including providing any and all requested information, documentation and reports and providing safe access to the site for inspection. Contractors' failure to provide timely notification of loss to the Owner, or Contractors' failure to provide requested and adequate information or documentation, shall not prejudice the Owner in any manner whatsoever.

11.6.6.1 The Contractor is responsible for notifying law enforcement or other applicable authorities in the event of a loss and for compiling all pertinent and required information in a timely manner.

11.6.6.2 Following a loss, the Contractor shall immediately take all necessary and reasonable steps to protect the property from further damage or loss.

- 11.6.6.3 All costs incurred by the Contractor associated with the loss not covered by the loss settlement shall be borne by the Contractor.
- 11.6.7 Any loss insured under the policy to be provided hereunder shall be adjusted with the Owner and made payable to the Owner as trustee for the insureds, as their interests may appear. The proceeds of any insured loss shall be credited to the Capital Project account of which the Contract is funded and shall be distributed in accordance with such agreement as the parties in interest may reach. Actual disbursement of insurance proceeds in the agreed upon amounts shall be made by the Owner to the Contractor(s) in accordance with the prevailing standard procedures of the Owner' Business Office.
- 11.6.8 The Owner reserves the right to choose and determine the manner in which any damaged work covered by the insurance provided hereunder shall be replaced or repaired and the extent to which replacement or repair shall be accomplished. In the event the Owner chooses not to replace or repair damaged work, or chooses to have repairs or replacement accomplished by others, the Contractor(s) shall be paid in full by the Owner for the actual value of all work accomplished on the affected portion of the damaged facility prior to the time of the loss. The Contractor(s) shall not have any claim or be entitled to any payment, including loss of profit, for the value of lost or uncompleted work. Nor shall the provision in any way release the Contractor or the Contractor's surety from obligations under the Contract to fully complete the undamaged portions of the project. In the event the Owner chooses to have the repair or replacement of the damaged work performed under this Contract, said work shall be paid for and accomplished in accordance with the Change Order provisions of this Contract.
- 11.6.9 The Owner and the Contractor waive all rights against each other and the subcontractors, sub-subcontractors, officers, agents and employees of each other for damages caused by insured perils to the extent covered by the insurance provided hereunder, except such rights as they may have to the proceeds of such insurance held by the Owner as trustee.
- 11.6.10 If the Owner chooses to occupy or use a portion or portions of the work prior to substantial completion thereof, such occupancy shall not commence prior to a time mutually agreed to by the Owner and Contractor(s) and to which the insurance company or companies providing the Property Insurance have consented by endorsement to the policy or policies. The insurance provided hereunder shall not be canceled or lapsed on account of such partial occupancy. Consent of the Contractor(s) and of the insurance company or companies to such occupancy or use shall not be unreasonably withheld.
- 11.6.11 The Owner makes no guarantee, expressed or implied, in providing the hereunder described Property Insurance, that said Insurance will cover any and all losses to the complete satisfaction of the Contractor(s) nor shall the Owner be under any obligation whatsoever to make good any loss or portion of loss not covered by said Insurance.
- 11.6.11.1 The Owner assumes no liability, and the Contractor shall have no claim against them for the amount of loss claimed by the Contractor which exceeds the actual proceeds received from the Insurance provided hereunder. The Contractor shall have no claim against the Owner for any loss caused by perils not covered by the Insurance provided by the Owner hereunder, nor shall the Contractor have any claim against them for any loss to Contractor's materials, tools, equipment or personal property not covered by the said Insurance.
- 11.7 **Indemnification**

- 11.7.1 The Contractor shall indemnify, protect, defend and hold harmless the Owner, their agents and employees from and against any and all claims, demands, judgments, or causes of action, including costs and attorney's fees by any party or parties whatever for loss, damage, injury, fines or penalties of any kind or character either to persons or property directly or indirectly arising out of the operations performed under the Contract except such loss, damage or injury as is caused by the sole negligence of the Owner. This indemnity agreement shall impose liability on the Contractor to the fullest extent permitted by the laws of the state governing performance thereof, and any provision hereof not permitted by such laws is expressly deleted from said agreement.
- 11.7.2 "Injury" or "damage" as these words are used in the foregoing paragraph, shall be construed to include, but not be limited to, injury or damage consequent upon the failure of or use or misuse by the Contractor, his subcontractors, agents or employees in providing supervisory, inspection or engineering services or of any design, application, professional advice or opinion rendered to the Owner or on the Owners' behalf as well as any substance, material, machinery, hoist, rigging, block, scaffolding, or any and all kinds of equipment whether or not owned, furnished or lent by the Owner.
- 11.7.3 The purchase of insurance by the Contractor shall in no event be construed as a fulfillment or discharge of the obligations set forth in this section."

ARTICLE 13 - MISCELLANEOUS PROVISIONS

- 13.1 Delete 2nd sentence in its entirety.

Add the following new paragraphs:

13.6 Legally Required Provisions

- 13.6.1 The Code of Virginia, Title 2.2, Chapter 43, Part 11 requires each contract for more than \$10,000 to include provisions 1 and 2 below:

- .1 During the performance of this contract, the Contractor agrees as follows:
- .a The Contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin, except where religion, sex or national origin is a bona fide occupational qualification reasonably necessary to the normal operation of the Contractor. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of the nondiscrimination clause.
 - .b The Contractor, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, will state that such Contractor is an equal opportunity employer.
 - .c Notices, advertisements and solicitations placed in accordance with federal law, rule or regulation shall be deemed sufficient for the purpose of meeting the requirements of this section.

- .2 The Contractor will include the provisions of the foregoing paragraphs a, b, and c in every subcontract or purchase order of over \$10,000, so that the provisions will be binding upon each subcontractor or vendor. (1982, c. 647.)

13.6.2 All public bodies shall include in every contract over \$10,000 the following provisions:

- .1 During the performance of this contract, the contractor agrees to (i) provide a drug-free workplace for the contractor's employees; (ii) post in conspicuous places, available to employees and applicants for employment, a statement notifying employees that the unlawful manufacture, sale, distribution, dispensation, possession, or use of a controlled substance or marijuana is prohibited in the contractor's workplace and specifying the actions that will be taken against employees for violations of such prohibition; (iii) state in all solicitations or advertisements for employees placed by or on behalf of the contractor that the contractor maintains a drug-free workplace; and (iv) include the provisions of the foregoing clauses in every subcontract or purchase order of over \$10,000, so that the provisions will be binding upon each subcontractor or vendor.
- .2 For the purposes of this section, "drug-free workplace" means a site for the performance of work done in connection with a specific contract awarded to a contractor in accordance with this chapter, the employees of whom are prohibited from engaging in the unlawful manufacture, sale, distribution, dispensation, possession or use of any controlled substance or marijuana during the performance of the contract. 2000, c. 417, § 11-51.1; 2001, c. 844.

13.6.3 Any contract awarded by any state agency, or any contract awarded by any agency of local government in accordance with § 2.2-4352, shall include:

1. A payment clause that obligates the contractor to take one of the two following actions within seven days after receipt of amounts paid to the contractor by the state agency or local government for work performed by the subcontractor under that contract:
 - a. Pay the subcontractor for the proportionate share of the total payment received from the agency attributable to the work performed by the subcontractor under that contract; or
 - b. Notify the agency and subcontractor, in writing, of his intention to withhold all or a part of the subcontractor's payment with the reason for nonpayment.
2. A payment clause that requires (i) individual contractors to provide their social security numbers and (ii) proprietorships, partnerships, and corporations to provide their federal employer identification numbers.
3. An interest clause that obligates the contractor to pay interest to the subcontractor on all amounts owed by the contractor that remain unpaid after seven days following receipt by the contractor of payment from the state agency or agency of local government for work performed by the subcontractor under that contract, except for amounts withheld as allowed in subdivision 1.
4. An interest rate clause stating, "Unless otherwise provided under the terms of this contract, interest shall accrue at the rate of one percent per month."

5. Any such contract awarded shall further require the contractor to include in each of its subcontracts a provision requiring each subcontractor to include or otherwise be subject to the same payment and interest requirements with respect to each lower-tier subcontractor.
6. A contractor's obligation to pay an interest charge to a subcontractor pursuant to the payment clause in this section shall not be construed to be an obligation of the state agency or agency of local government. A contract modification shall not be made for the purpose of providing reimbursement for the interest charge. A cost reimbursement claim shall not include any amount for reimbursement for the interest charge.”

1990, c. 824, § 11-62.11; 1992, c. 110; 2001, c. 844.

ARTICLE 15 - CLAIMS AND DISPUTES

- 15.1.7 Delete in its entirety.
- 15.2.1 5th line, delete "mediation" and replace with "litigation".
- 15.2.5 Beginning on the 4th line, delete "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 Delete "mediation" and replace with "litigation".
- 15.2.6.1 First sentence, delete "mediation" and replace with "litigation". 2nd sentence, delete "mediation" and replace with "litigation"; delete "mediate" and replace with "litigate".
- 15.3 Delete in its entirety.
- 15.4 Delete in its entirety.

GILES COUNTY PUBLIC SCHOOLS
MACY MCCLAUGHERTY
ELEMENTARY/MIDDLE SCHOOL RENOVATIONS
STATE PROJECT NO.: 035-39-00-102

SECTION 011000

SUMMARY OF THE WORK

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DEFINITIONS

- A. Whenever the term "Owner" is used in this specification or on the drawings, it refers to the Giles County School Board.
- B. Whenever the term "Architect/Engineer" is used in this specification, it refers to ZMM ARCHITECTS ENGINEERS, Blacksburg, Virginia, who by contract with the Owner is authorized to prepare all drawings and specifications and to administer the construction after award of the contract.
- C. Wherever the term "Contractor" or "General Contractor" is used in this specification, it refers to the contractor who by contract with the Owner is responsible for the furnishing of all labor and materials and performing all work as described herein.
- D. Wherever the term "existing" is used in this specification or on the drawing it refers to work that currently exists.
- E. "Provide" shall mean "provide new materials and installation, complete with all accessories, parts and/or services to be ready for its intended use".

1.3 WORK UNDER THIS CONTRACT

- A. The work to be done hereunder includes furnishing of all labor and materials for the renovations to Macy McClougherty Elementary/Middle School that includes the following: Roof Replacement, Window Replacement, HVAC Replacement, Limited Interior Painting and Ceiling Replacement, etc.
- B. The Owner, prior to the start of any construction work in the specified area, will remove the following items:
 - 1. Loose furnishings and equipment

1.4 WORK BY OWNER UNDER SEPARATE CONTRACTS

- A. The Owner will provide an on-site owner's representative (Clerk-of-the-Works). This will not eliminate the Contractor's responsibility for Quality Control as required in Section 014000, QUALITY REQUIREMENTS. The duties and responsibilities of the Clerk-of-the-Works are as follows:
 - 1. Observe the quality and progress of the construction to determine in general that it is proceeding in accordance with the Contract Documents. Notify the Architect/Engineer immediately if, in the Clerk-of-the-Works opinion, work does not conform with the Contract

- Documents or requires special investigation by the Architect/Engineer or Contractor, and document same in the Clerk-of-the-Works' Daily Report.
2. Monitor the construction progress and assist in the preparation of progress reports.
 3. Review Contract Documents with the Contractor's superintendent so as to have a complete understanding of the scope of the project.
 4. Consider the Contractor's suggestions and recommendations, evaluate them, discuss them with the Architect/Engineer and assist the Architect/Engineer when applicable in making a final decision. Maintain liaison with the Contractor and all subcontractors on the project only through the Contractor's superintendent.
 5. Attend project meetings as the Owner's representative and report to the Architect/Engineer in writing on the proceedings.
 6. Observe tests at the project site which are required by the Contract Documents and report any oddities in the conduction of these tests to the Architect, outlining all details relative to the test procedures. Record the conditions and resolutions made by the Architect/Engineer in the Clerk-of-the-Works' Daily Report. Review testing invoices, if any, to be paid by the Owner.
 7. Maintain records at the construction site in an orderly manner in accordance with the Architect/Engineer's procedures. Include correspondence where applicable, such as Contract Documents, Change Orders, Construction Change Authorizations, reports of site conferences, Shop Drawings, Product Data, Samples, supplementary drawings, color schedules, requests for payment, names and addresses of contractors, subcontractors and principal material suppliers. Maintain a complete copy of the original plans and specifications.
 8. Keep a log book containing project progress and reports and submit reports on the progress of the Contractor's work to the Architect/Engineer noting conditions in the Clerk-of-the-Works Daily Report which may cause delay in completion. The log must contain activities related to the project, weather conditions, nature and location of work being performed, arrival of materials, visitors, and tests performed. The Project Architect/Engineer will provide Field Reports (observation reports) documenting his site visits.
 9. Record and maintain a running record of outstanding, unresolved issues. The record shall include the issue, date of occurrence, and date of resolution. After an item is reported to be corrected, it shall be deleted from the list.
 10. Report, in writing, to the Owner and A/E any notifications from the Contractor of dates and times that services will be disrupted.
 11. Notify the A/E if work begins before required shop drawings, product submittals, or samples have been approved by the A/E. Receive and log samples required to be furnished at the site; notify the A/E when they are ready for examination; record the A/E's approval or other action; and maintain custody of approved samples.
 12. If inspectors representing local, State, or Federal agencies having jurisdiction visit the site, accompany such inspectors during their trips through the project, record and report in the Clerk-of-the-Works' Daily Report the results of such inspections.
 13. Observe the Contractor's Record Drawings at intervals appropriate to the stage of construction and notify the Architect/Engineer of any apparent failure by the Contractor to maintain up-to-date records.
 14. Review Applications for Payment submitted by the Contractor with the Architect/Engineer and assist in making recommendations for disposition.
 15. Assist the Architect/Engineer in reviewing the list of items to be completed or corrected which is submitted by the Contractor with a request for issuance of a Certificate of Substantial Completion. When applicable, assist the Architect/Engineer in reviewing the documentation and record documents to be furnished to the Owner by the Contractor at Substantial Completion, and verify that the Contractor has met the requirements of the Contract Documents for training the Owner's personnel in the operation and maintenance of all building equipment and systems.

16. Assist the Architect/Engineer in final inspection of the work. Assist the Architect/Engineer in reviewing the documentation and record documents to be furnished to the Owner by the Contractor upon completion of the work.
17. At no time shall the Clerk-of-the-Works assume responsibilities of the Architect/Engineer or Architect/Engineers representative. The Clerk-of-the-Works has limitations of authority and does not provide the following:
 - a. Issue change orders or direct the Contractor or any of his subcontractors to make changes to the original, approved plans and specifications.
 - b. Interpret plans and specifications for General Contractor or his subcontractors or expedite their work.
 - c. Interpret or advise the General Contractor or his subcontractors regarding Federal, State, or county regulations.
 - d. Assume any authority of or for the architects and engineers of this project.
 - e. Pass judgment on completeness or the lack of completeness of the Architect/Engineer's work on this project to the General Contractor, subcontractor, or any of their people.

1.5 CONSTRUCTION SCHEDULE

- A. Work shall commence immediately after “Notice to Proceed” issued on behalf of the Owner and Substantial Completion must be achieved by the agreed upon date and Bidder agrees to pay liquidated damages for each consecutive calendar day thereafter until achieving Substantial Completion.

1.6 CONTRACTOR USE OF SITE

- A. The Contractor shall limit his use of the site to the areas indicated under the Contract in order to allow for owner occupancy. Portions of the site beyond areas on which work is indicated are not to be disturbed.
- B. Keep existing roads and entrances serving the premises clear and available to the Owner and public at all times. Do not use these areas for parking or storage of materials without prior approval from the Owner.
- C. Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of office, storage sheds, etc., to the areas agreed upon with the Owner.
- D. Lock automotive type vehicles, such as passenger cars and trucks and other mechanized or motorized construction equipment, when parked and unattended, so as to prevent unauthorized use.
- E. The Contractor shall issue identification badges to all authorized workers.
- F. The site and building are classified as a non-smoking/non-tobacco products area and this policy is to be strictly enforced.
- G. Do not use fire lanes for construction traffic or storage.

1.7 OWNER OCCUPANCY OF SITE AND BUILDING DURING CONSTRUCTION

- A. The building will be occupied during the work. If water service to domestic or sprinkler systems must be turned off, then work requiring the disruption in service shall be performed when the

building is unoccupied. Unoccupied times shall be identified by the Owner, and the Contractor shall ensure that complete water service is restored prior to the building becoming occupied again.

- B. All areas of work shall be protected from dust and debris caused by the work. All areas of work shall be completely cleaned at the end of each work day. Protection and cleaning are the sole responsibility of the Contractor. The Contractor shall reimburse the Owner for cleaning, or other labor and materials necessitated by the Contractor's neglect.
- C. The Contractor shall provide insulated, dust-proof temporary barriers as required to minimize impact on the temperature of adjacent spaces and containing all contaminants from the construction.
- D. The building shall be left in a secure, water-tight condition at the end of each work day.
- E. Power shall remain uninterrupted. Any proposed power interruption shall be coordinated with the Clerk-of-the-Works. The Contractor shall give 72 hours advance notice for any power interruption.
- F. Any relocation of low voltage cabling shall be approved and coordinated with the GCPS IT Department through the Clerk-of-the-Works not less than one (1) week prior to the work. No I.T. or other low voltage devices shall be disturbed by the work. All low voltage and I.T. components shall be protected throughout the project. Any damaged low voltage and/or I.T. device or component shall be replaced by the Contractor at no additional cost to the Owner, and to the Owner's satisfaction.
- G. Site work shall not interfere with administrative operations and shall not pose a threat to the safety of staff. The Contractor shall provide safety fence as required by the Owner and Authorities Having Jurisdiction to ensure safe separation of work.

1.8 DRESS

- A. Proper dress is necessary for reasons of health and safety and shall meet the requirements established by the Contractors involved. Contractor shall also inform workers to dress in a manner that displays professionalism. Clothing that bears inappropriate or offensive language (at the discretion of the Owner) or slogans is not allowed.

1.9 PRODUCT HANDLING

- A. Product Handling: Space at the project for storage of materials and products is limited. Coordinate the deliveries of materials and products with the scheduling and sequencing of the work so that storage requirements at the project are minimized. In general, do not deliver individual items of equipment and material to the project substantially ahead of the time of installation. Limit each shipment of bulk and multiple-use materials to the quantities needed for installations within three (3) weeks of receipt.

1.10 INTENT OF CONTRACT DOCUMENTS

- A. The contract documents are complementary, and what is called for in one place shall be as binding as if called for in all places. In case of conflict or variance among the contract drawings, the specifications shall take precedence over the drawings. Figured dimensions shall be used in preference to scaling the drawings. In case of conflict between large and small scale plans, the large scale plans shall govern. In case of conflict between riser diagrams and plans, the plans shall govern.

- B. The mechanical and electrical drawings show the general arrangement of all piping, wiring, equipment and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. The mechanical and electrical work shall conform to the requirements shown on all of the drawings. General and structural drawings shall take precedence over mechanical and electrical drawings. Because of the small scale of the mechanical and electrical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, boxes, offsets, transitions, and other accessories as may be required to meet such conditions. The Contractor, at his sole expense, shall relocate, or otherwise reconcile, any existing construction that interferes with installation of new work. Refer to Section 011000, Para. 1.7 for requirements of continued use and occupancy.

1.11 CODES AND STANDARDS

- A. All materials and workmanship shall comply with all applicable codes, state and federal laws, local ordinances, industry standards, utility company regulations, and all other criteria which normally apply to work of this nature.
- B. In case of difference between building codes, state laws, federal laws, local ordinances, industry standards, utility company regulations, other criteria and the contract documents, the more stringent regulations will apply. The Contractor shall promptly notify the Architect/Engineer in writing of any such difference.
- C. If the Contractor performs any work that does not comply with these contract documents or the requirements of the applicable building codes, state laws, local ordinances, industry standards, utility company regulations, and other applicable criteria, he shall bear all costs arising in correcting the deficiencies.
- D. The standards referred to, except as modified in the specifications, shall have full force and effect as though printed in these specifications. These standards are not furnished to bidders for the reason that it is assumed that the manufacturer and trades involved are familiar with their requirements. The Architect/Engineer will furnish, upon request, information as to how copies of the standards referred to may be obtained.

1.12 EQUIPMENT DEVIATIONS

- A. Equipment or Connections Different from Those Shown: Where equipment requiring different arrangements or connections from those shown is proposed by the Contractor and is not objected to by the Architect/Engineer, it shall be the responsibility of the Contractor to install the equipment to operate properly and in harmony with the intent of the drawings and specifications. The Contractor shall make all incidental changes in piping, ductwork, supports, insulation, wiring, heaters, controls, and other associated facilities. He shall provide all additional motors, controllers, valves, fittings, and other additional equipment required for proper operation of the system, including all required changes in affected trades. The Contractor shall be responsible for the proper location of roughing-in and connections. All such changes shall be made at no increase in the contract price to the Owner.
- B. Electric Equipment Ratings: The electrical design is based upon estimated load requirements and upon typical classes of equipment component arrangement. Where the equipment actually provided requires circuits, wiring, controls or protective devices different from those indicated, all required modifications shall be made by the Contractor at no increase in contract price to the Owner.

1.13 BUILDING PERMIT

- A. The General Contractor and his subcontractors shall obtain and pay for all required building permits from Giles County, Virginia. All connection fees for water, sewer and permanent electrical power shall be paid for by the Owner. All inspections required by the local jurisdiction shall be scheduled by the Contractor with sufficient lead time. All connection fees and use charges for temporary utilities shall be paid by the Contractor until Substantial Completion of the entire building is achieved. Public Improvement Securities required by localities shall be obtained/paid by the Owner.

1.14 REGISTRATION AND PERFORMANCE AND PAYMENT BONDS

- A. Bidders are required under Title 54.1, Chapter 11, Code of Virginia (1950), as amended, to be licensed as a "Class A Contractor" before submitting a bid of one hundred twenty thousand (\$120,000) dollars or more; or to be licensed as a "Class B Contractor" before submitting a bid of ten thousand (\$10,000) dollars or more but less than one hundred twenty thousand (\$120,000) dollars; or be licensed as a "Class C Contractor" before submitting a bid of no more than ten thousand dollars (\$10,000). Each Bidder will be required to give their State Registration Number on their proposal.
- B. In accordance with Title 2.2, Chapter 43, Part 37 of the code of Virginia, Performance and Payment Bonds shall be provided for construction contracts exceeding \$500,000.00.

1.15 INSPECTION FOR SUBSTANTIAL COMPLETION AND FINAL COMPLETION

- A. The Contractor shall notify the Owner, in writing on the Certificate of Substantial Completion, of the date when the Work or designated portion thereof, will be, in his opinion, substantially complete and ready for inspection and testing to determine if it has reached Substantial Completion. The notice shall be given at least ten days in advance of said date and shall be forwarded through the Architect/Engineer, who will attach his written endorsement as to whether or not he concurs with the Contractor's statement that the Work will be ready for inspection and testing on the date given. The Architect/Engineer's endorsement is a convenience to the Owner only and shall not relieve the Contractor of his responsibility in the matter nor shall the Architect/Engineer's endorsement be deemed to be evidence that the Work was substantially complete and ready for inspection and testing. Inspection and testing shall take place at a time(s) mutually agreeable to the Contractor, Owner and Architect/Engineer. The inspection shall include a demonstration by the Contractor that all equipment, systems and operable components of the project function properly and in accordance with the Contract Documents. The Contractor shall furnish access for the inspection and testing as provided in General Conditions. The inspection and testing shall determine whether Substantial Completion has been accomplished and shall result in a written list of unfinished Work and Defective Work, commonly referred to as a "punch list", which must be finished and corrected to obtain Final Completion. After successful completion of the testing and the Architect/Engineer determines that, in its opinion, the Work, either in whole or in part, is substantially complete, the Architect/Engineer shall notify the Owner, in writing that the Work, or a specified portion thereof, is recommended to be declared substantially complete. The Owner shall notify the Contractor, in writing, of the date the Owner accepts the Work, or the specified portion thereof, as substantially complete or the Owner shall notify the Contractor of the deficiencies to be corrected or completed before such Work will be accepted as substantially complete.
- B. The Contractor shall notify the Owner, in writing of the date when the Work has reached or will reach Final Completion and will be ready for final inspection and testing. The notice shall be given at least five days in advance of said date and shall be forwarded through the Architect/Engineer, who will attach his endorsement as to whether or not he concurs in the Contractor's statement that the

Work will be ready for inspection and testing on the date given. That inspection and any necessary testing shall be conducted in the same manner as the inspection for Substantial Completion. When the

Work is finally and totally complete, including the elimination of all defects, the Work shall be finally accepted by the Owner and final payment shall be made in accordance with General Conditions.

- C. The Architect/Engineer shall conduct the inspections. The Owner's Clerk-of-the-Works shall conduct the reinspections. If one or more Substantial or Final Completion reinspections are required, the Contractor shall reimburse the Owner for all costs of reinspection or, at the Owner's option, the costs may be deducted from payments due to the Contractor.

1.16 LIQUIDATED DAMAGES

- A. All work shall be substantially complete by the agreed upon date. For each day after the Contract date of Substantial Completion that the work is not substantially complete, the Contractor shall pay to the Owner as liquidated damages the amount of \$1,000 per day for the Owner's added administrative expense to the Owner to administer the Project during the period of delay. The Owner may deduct any liquidated damages from the money due or to become due to the Contractor. If the amount of liquidated damages exceeds any amounts due to the Contractor, the Contractor shall pay the difference to the Owner within ten (10) days after receipt of a written request from the Owner for payment.
- B. At the time the Architect certifies the Project or parts thereof are substantially completed, the Architect shall identify the remaining items to be completed for final completion of the Project and shall establish with the Contractor a reasonable time for completion of those items. The items to be completed and the time established for their completion shall be set forth in the Certificate of Substantial Completion. The Owner may deduct any liquidated damages from the money due or to become due to the Contractor. If the amount of liquidated damages exceeds any amounts due to the Contractor, the Contractor shall pay the difference to the Owner within ten (10) days after receipt of a written request from the Owner for payment

1.17 PRECONSTRUCTION CONFERENCE

- A. After award of the contract, but before start of construction, the Contractor, Owner, and Architect/Engineer shall meet at the site to discuss procedures to be followed during construction. See Section 013200, CONSTRUCTION PROGRESS DOCUMENTATION.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 012100

ALLOWANCES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements governing allowances.
 - 1. Selected materials and equipment are specified in the Contract Documents by allowances. In some cases, these allowances include installation.
 - 2. Allowances have been established to defer selection of actual materials and equipment to a later date when additional information is available for evaluation.
 - 3. Reference Paragraph 3.8 of the General Conditions, and modifications in Supplementary Conditions.
 - a. The following is Paragraph 3.8 stated for convenience:

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."

- 4. Allowance(s) shall be included in Base Bid for the project.

1.3 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise the Architect/Engineer of the date when the final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At the Architect/Engineer'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 the Architect/Engineer from the designated supplier.

1.4 SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.
- B. Submit invoices or delivery slips to show the actual quantities of materials delivered to the site for use in fulfillment of each allowance.

1.5 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed for the Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. At Project closeout, credit unused amounts remaining in the contingency allowance to the Owner by Change Order.

1.6 UNUSED MATERIALS

- A. Return unused materials to the manufacturer or supplier for credit to the Owner, after installation has been completed and accepted.
 - 1. When requested by the Architect/Engineer, prepare unused material for storage by Owner where it is not economically practical to return the material for credit. When directed by the Architect/Engineer, deliver unused material to the Owner's storage space. Otherwise, disposal of unused material is the Contractor's responsibility.

1.7 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1 - Provide a general contingency allowance of \$250,000.

PART 2 - PRODUCTS

Not used.

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PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 012300

ALTERNATES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements governing Alternates.

1.3 DEFINITIONS

- A. Definition: An alternate is 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 the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate that Work into the 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 mentioned as part of the Alternate.
- B. Notification: Immediately following the award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate whether alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other Work of this Contract.
- D. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1:

Furnish labor and materials for exterior window replacement as shown on drawings.

END OF SECTION

SECTION 012500

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Division 1 Section "Submittal Procedures" specifies requirements for submitting the Contractor's Construction Schedule and the Submittal Schedule.
 - 2. Division 1 Section "Product Requirements" specifies requirements governing the Contractor's selection of products and product options.

1.4 DEFINITIONS

- A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:
 - 1. Revisions to the Contract Documents requested by the Owner or Architect/Engineer.
 - 2. Specified options of products and construction methods included in the Contract Documents.
 - 3. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

1.5 SUBMITTALS

- A. Substitution Request Submittal: The Architect/Engineer will consider requests for substitution if received within 60 days after Notice to Proceed with the Work. Requests received more than 60 days after commencement of the Work may be considered or rejected at the discretion of the Architect.
 - 1. Submit three (3) copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for change-order proposals.
 - 2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
 - 3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:

- a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors, that will be necessary to accommodate the proposed substitution.
 - b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, durability, and visual effect.
 - c. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
 - d. Samples, where applicable or requested.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
 - g. The Contractor's certification that the proposed substitution conforms to requirements in the Contract Documents in every respect and is appropriate for the applications indicated.
 - h. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
- B. Architect/Engineer's Action: If necessary, the Architect/Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. The Architect/Engineer will notify the Contractor of acceptance or rejection of the substitution within two (2) weeks of receipt of the request, or one week of receipt of additional information or documentation, whichever is later. Acceptance will be in the form of a Construction Change Directive or in the form of shop drawing submittal approval for "or equal" request.
1. Use the product specified if the Architect cannot make a decision on the use of a proposed substitute within the time allocated.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Conditions: The Architect/Engineer will receive and consider the Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by the Architect/Engineer. If the following conditions are not satisfied, the Architect/Engineer will return the requests without action except to record noncompliance with these requirements.
1. Extensive revisions to the Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of the Contract Documents.
 3. The request is timely, fully documented, and properly submitted.
 4. The specified product or method of construction cannot be provided within the Contract Time. The Architect will not consider the request if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
 5. The request is directly related to an "or-equal" clause or similar language in the Contract Documents. The burden of proof of equality rests with the Contractor, who must furnish adequate supporting data.
 6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 7. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where the Contractor certifies that the substitution will overcome the incompatibility.

8. The specified product or method of construction cannot be coordinated with other materials and where the Contractor certifies that the proposed substitution can be coordinated.
 9. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.
- B. The Contractor's submittal and the Architect's acceptance of Shop Drawings, Product Data, or Samples for construction activities not complying with the Contract Documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval.

PART 3 - EXECUTION

Not used.

Attachment: Substitution Request Cover Sheet (After Bid)

END OF SECTION

SUBSTITUTION REQUEST COVER SHEET (AFTER BID)

TO: ZMM ARCHITECTS ENGINEERS
1116 South Main Street
Blacksburg, VA 24060
Fax: (540) 951-0219

This form must be submitted by a Prime Contractor. Submissions by subcontractors, suppliers or product representatives will not be permitted and will be rejected.

PROJECT TITLE:

PRIME CONTRACTOR:

ADDRESS:

AUTHORIZED SIGNATURE:

DATE:

SECTION:

PARAGRAPH:

SPECIFIED ITEM:

PROPOSED SUBSTITUTE:

Substitutions are only permitted by Prime Contractor for one of the following reasons which are outlined in Paragraph 2.1 of Section 012500, SUBSTITUTION PROCEDURES. Substitution requests submitted for reasons other than that listed below will be rejected and returned without action. Indicate below the reason for this proposed substitution request.

_____ The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

_____ The specified product or method of construction cannot receive necessary approval by governing authority, and the requested substitution can be approved.

_____ The request is directly related to an "or equal" clause or similar language in the Contract Documents.

_____ The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where the Contractor certifies that the substitution will overcome the incompatibility.

_____ The specified product or method of construction cannot be coordinated with other materials and

where the Contractor certifies that the proposed substitution can be coordinated.

_____ The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.

Substitution requests must be received by the Architect within 60 days after Notice to Proceed with the Work to be considered.

Substitution requests must include all information indicated in Paragraph 1.5 of Section 012500, SUBSTITUTION PROCEDURES and must meet all requirements stated elsewhere in the Project Manual.

SECTION 012600

CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.
 - 1. All "Requests for Information" (RFI), Proposal Request, and Change Orders (CO) and Cost Proposals (CP) shall be coordinated and routed through the General Contractor.
 - 2. The Contractor shall utilize copies of the "Request for Information" Form attached to the end of this section. The Architect/Engineer will send the response to the General Contractor. No response will be made directly to any subcontractor.
 - 3. The Architect/Engineer will issue all Proposal Requests. Form attached to the end of this section.
 - 4. The Contractor shall use the File Management System prescribed by ZMM ARCHITECTS ENGINEERS to route and receive the documents detailed in this section.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Division 1 Section "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 2. Division 1 Section "Submittal Procedures" for requirements for the Project Construction Schedule.
 - 3. Division 1 Section "Payment Procedures" for administrative procedures governing Applications for Payment.

1.4 MINOR CHANGES IN THE WORK

- A. The Architect/Engineer will issue a response to Request for Information, an Architect's Supplemental Instruction, or a Proposal Request authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time.

1.5 CHANGES IN THE WORK THAT MAY AFFECT CONTRACT SUM AND/OR CONTRACT TIME

- A. The Architect/Engineer will issue a Proposal Request containing detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal Requests issued solely by the Architect/Engineer are for information only. Do not

- consider them as an instruction either to stop work in progress or to execute the proposed change, unless also signed by the Owner.
2. Within ten (10) business days of receipt of a Proposal Request, the Contractor shall submit a statement of cost necessary to execute the change to the Architect/Engineer for the Owner's review.
 - a. Include a list of quantities of products required and material unit costs, with the total amount of purchases to be made. Include labor quantities and labor unit costs. Where requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time. If no statement is included, it shall be assumed that the work has no effect on Contract Time.
- B. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a Request for Information with recommendations to the Architect/Engineer, or a Cost Proposal (CP) with detail of cost as if it were a Proposal Request.
1. Contractor shall include a statement outlining the 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 Contract Time.
 2. The Architect/Engineer will respond to the RFI and then issue a Proposal Request as indicated above if required.
 3. Contractor shall reimburse the Owner through the Contract for Construction for any expenses related to the Architect's services resulting from changes requested by the Contractor if for the benefit of the Contractor.
- C. Proposal Request and Contractor initiated Cost Proposals will be included in Change Orders prior to project closeout.
- 1.6 ALLOWANCES
- A. Allowance Adjustment: For allowance-cost adjustment, the Architect/Engineer shall base each Change Order on the difference between the actual purchase amount and the allowance, multiplied by the final measurement of work-in-place. Where applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
1. Include installation costs in the purchase amount only where indicated as part of the allowance.
 2. When requested, prepare explanations and documentation to substantiate the margins claimed.
 3. The Owner reserves the right to establish the actual 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 the Contractor's handling, labor, installation, overhead, and profit. Submit claims within ten (10) business days of receipt of the Change Order or Proposal Request authorizing work to proceed. Claims submitted later than ten (10) business days shall be considered null and void.

1.7 CHANGE ORDER PROCEDURES

- A. Change Orders will be executed as follows:
1. At the end of the project to establish final adjustments to Contract Sum and Contract Time, based on Proposal Request approved throughout the project, should a Contingency Allowance or other allowances, exist as part of the Contract amount and has not been exceeded by approved Proposal Request costs.
 2. When no Contingency Allowance, or other allowances, exists as part of the Contract amount, Change Orders will be used to order changes in the work that may affect Contract Sum and/or Contract Time.
 3. A Change Order may be used to approve the terms of a Contractor initiated Cost Proposal, should the Architect not choose to issue a corresponding Proposal Request.

1.8 REQUESTS FOR INFORMATION (RFIs)

- A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Progress meeting, prepare and submit an RFI in the form specified.
1. RFIs shall originate with General Contractor. RFIs submitted by entities other than General Contractor will be returned 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.
 3. Frivolous or unnecessary RFIs will be returned with no response.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Project name.
 2. Date.
 3. Name of Contractor.
 4. Name of Architect.
 5. RFI number, numbered sequentially.
 6. Specification Section number and title and related paragraphs, as appropriate.
 7. Drawing number and detail references, as appropriate.
 8. Field dimensions and conditions, as appropriate.
 9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 10. Contractor's signature.
 11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
 - a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
 12. Date by which a response from the Architect/Engineer is needed to avoid affecting critical path tasks.
- C. Hard-Copy RFIs: Form at the end of this Section.
1. Identify each page of attachments with the RFI number and sequential page number.
- D. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- E. Architect's Action: Architect will review each RFI, determine action required, and return it. Allow seven working days for Architect's response for each RFI.
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 RFIs with numerous errors.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
 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 Change Order Proposal Request as contained within this section.
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within ten (10) business days of receipt of the RFI response. Requests for time extensions related to RFI responses that are received after ten (10) business days shall be considered null and void.
- 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 two (2) business days if Contractor disagrees with response.
- G. 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.
 8. Identification of related Minor Change in the Work, Architect's Supplemental Instructions, Proposal Request, Change Order or Contractor initiated Cost Proposal, as appropriate.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION



AIA[®] Document G709[™] – 2018

Proposal Request

PROJECT: *(name and address)*

CONTRACT INFORMATION:

Contract For: General Construction
Date:

Architect's Project Number:
Proposal Request Number: 001
Proposal Request Date:

OWNER: *(name and address)*

ARCHITECT: *(name and address)*

ZMM ARCHITECTS ENGINEERS
1116 South Main Street
Blacksburg, VA 24060

CONTRACTOR: *(name and address)*

The Owner requests an itemized proposal for changes to the Contract Sum and Contract Time for proposed modifications to the Contract Documents described herein. The Contractor shall submit this proposal within Ten (10) days or notify the Architect in writing of the anticipated date of submission.

(Insert a detailed description of the proposed modifications to the Contract Documents and, if applicable, attach or reference specific exhibits.)

THIS IS NOT A CHANGE ORDER, A CONSTRUCTION CHANGE DIRECTIVE, OR A DIRECTION TO PROCEED WITH THE WORK DESCRIBED IN THE PROPOSED MODIFICATIONS.

REQUESTED BY THE ARCHITECT:

Randy S. Jones, Principal

PRINTED NAME AND TITLE



Request for Information

<i>From</i>	<i>To</i>	<i>Project</i>
Contractor:	ZMM	Name:
Address:	1116 South Main Street	Commission # Drawing #:
	Blacksburg, VA 24060	Spec Section:
	Phone: (540) 552-2151	Paragraph:
Phone:	Fax: (540) 951-0219	Date:
Fax:	Attention:	Date Due: RFI #:

Required Information

Contractor's Recommendation

Architect's Response

By:

Date:

1116 South Main Street • Blacksburg, VA 24060 • P: 540-552-2151 • F: 540-951-0219 • www.zmm.com

ZMM Use Only: C ☐ A ☐ S ☐ P ☐ M ☐ E ☐

SECTION 012900

PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

1.3 SUBMITTALS

- A. Schedule of Values:
 - 1. Within 15 calendar days of receipt of a notice of award, prepare and deliver to ZMM ARCHITECTS ENGINEERS a schedule of values. The schedule of values shall consist of a detailed breakdown of the contract price, giving quantities for each of the various kinds of work, unit prices, and extended prices therefor. The detailed breakdown shall be divided into each construction category. The required schedule shall be based on the actual breakdown of the bid price. Subcontractors who may be involved in work under more than one of these categories shall be advised of this requirement in order to furnish such data without delay. The schedule of values shall list material and labor separately.
 - 2. Payments will not be made until the schedule of values has been submitted to and approved by ZMM ARCHITECTS ENGINEERS.

1.4 APPLICATION FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect/Engineer and paid for by the Owner.
 - 1. The initial Application for Payment, the Application for Payment at the time of Substantial Completion, and the final Application for Payment involve additional requirements.
- B. Payment Application Times: Each progress payment date is as indicated in the Agreement. The period of construction Work covered by each Application or Payment is the period indicated in the Agreement.
- C. Payment Application Forms: Use AIA Document G702 as the form for Application for Payment.
- D. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents. Incomplete applications will be returned without action.
 - 1. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the Application.
- E. Draft for Review: At least 3 days prior to transmittal of formal application, the Contractor shall email a draft copy of the application to the Architect and Clerk of the Works for review and comment.

- F. Transmittal: Submit 3 executed copies of each formal Application for Payment to the Architect/Engineer by means ensuring receipt within 24 hours; one copy shall be complete, including waivers of lien and similar attachments, when required. The comments of the Owner and Architect following their review of the draft application shall be addressed in the formal Application.
- G. Formal pay applications shall be delivered to the Architect at the jobsite Progress Meeting prior to application due date, unless otherwise agreed upon by Owner and Architect.
- H. Initial Application for Payment: Administrative actions, submittals, and approvals that must precede or coincide with submittal of the first Application for Payment include the following:
 - 1. Schedule of Values submitted and approved by Architect.
 - 2. Contractor's construction schedule.
 - 3. Copies of building permits.
 - 4. Copies of authorizations and licenses from governing authorities for performance of the Work.
 - 5. Certificates of insurance and insurance policies.
 - 6. Performance and payment bonds.
 - 7. Data needed to acquire Owner's insurance.
- I. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment; this application shall reflect any Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
 - 1. Administrative actions and submittals that shall precede or coincide with this application include:
 - a. Occupancy permits and similar approvals.
 - b. Warranties (guarantees) and maintenance agreements.
 - c. Maintenance instructions.
 - d. Meter readings.
 - e. Changeover information related to Owner's occupancy, use, operation, and maintenance.
 - f. Final cleaning.
 - g. Application for reduction of retainage and consent of surety.
 - h. Advice on shifting insurance coverages.
 - i. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion.
- J. Final Payment Application: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
 - 1. Completion of Project closeout requirements.
 - 2. Completion of items specified for completion after Substantial Completion.
 - 3. Assurance that unsettled claims will be settled.
 - 4. Assurance that Work not complete and accepted will be completed without undue delay.
 - 5. Transmittal of requirement Project construction records to Owner.
 - 6. Proof that taxes, fees and similar obligations have been paid.
 - 7. Removal of temporary facilities and services.
 - 8. Removal of surplus materials, rubbish and similar elements.
- K. Waivers of Mechanics Liens: With Final Application for Payment, submit waivers of mechanics lien from every entity who may lawfully be entitled to file a mechanics lien arising out of the Contract, and related to the Work covered by the payment. The following shall be submitted:
 - 1. Contractor's Affidavit of Payment of Debts and Claims (AIA G706).
 - 2. Contractor's Affidavit of Release of Liens (AIA G706A).

3. Consent of Surety to Final Payment (AIA G707).

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 013100

COORDINATION

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:
 - 1. General project coordination procedures.
 - 2. Conservation.
 - 3. Coordination drawings.
 - 4. Administrative and supervisory personnel.
 - 5. Cleaning and protection.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Division 1 Section "Construction Progress Documentation" for preconstruction conference and progress meetings.
 - 2. Division 1 Section "Submittal Procedures" for preparing and submitting the Contractor's Construction Schedule.
 - 3. Division 1 Section "Product Requirements" for coordinating general installation.
 - 4. Division 1 Section "Closeout Procedures" for coordinating contract closeout.

1.4 COORDINATION

- A. Coordinate construction operations included in various Sections of these Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation. No claim for extra compensation or extension of contract time will be allowed for conditions resulting from lack of said coordination.
 - 1. Schedule construction operations in the 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 assure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Consider restrictions on use of the building and Owner's occupancy during construction.
 - 5. The Contractor shall use the File Management System prescribed by ZMM ARCHITECTS ENGINEERS to route and receive the documents detailed in this section.

- B. Coordination of Options and Substitutions: Where the contract documents permit the selection from several product options and where it becomes necessary to authorize a substitution, do not proceed with purchasing until coordination of interface requirements has been checked and satisfactorily established.
- C. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.
 - 1. Prepare similar memoranda for the Owner and separate contractors where coordination of their work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of construction schedules.
 - 2. Preparation of the Schedule of Values.
 - 3. Installation and removal of temporary facilities.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Project closeout activities.
 - 7. Utility company's coordination.
- E. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work.

1.5 SUBMITTALS

- A. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components. Preparation of Coordination Drawings is the responsibility of the Contractor.
 - 1. Show the relationship of components shown on separate Shop Drawings.
 - 2. Indicate required installation sequences.
 - 3. For locations where several elements of mechanical or electrical, or combined mechanical and electrical, work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings to a scale of 1/4"-1'-0" or larger showing the actual physical dimensions required for the installation.
 - 4. Prepare and submit coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.
 - 5. Comply with requirements contained in Section "Submittal Procedures."
- B. Discrepancies in Contract Drawings: The Contractor shall promptly notify the Architect/Engineer of all errors, omissions, or discrepancies which he finds on the drawings. The Contractor shall not proceed with the work involved in such errors, omissions, or discrepancies until written instructions are given by the Architect/Engineer. The Contractor shall be responsible for all work erroneously installed prior to receiving said written instructions.

- C. Staff Names: Within 15 days of commencement of construction operations, submit a list of the Contractor's principal staff assignments, including the superintendent and other personnel in attendance at the Project Site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers.
 - 1. Post copies of the list in the Project meeting room, the temporary field office, and each temporary telephone.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

- A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
- B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.
- C. Test and Inspections: As part of the coordination requirements, the Contractor shall have a representative of his at all tests and inspections required, including those performed by subcontractors. The Contractor shall be responsible for ensuring that all tests and inspections are conducted as required and that the work is acceptable. The Contractor shall immediately inform the Architect/Engineer of all tests and inspections that fail to meet specification requirements. The Contractor shall immediately do everything within his power; including stopping work in progress, to make sure work that does not meet specifications does not get permanently installed or covered up.

3.2 CLEANING AND PROTECTION

- A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at Substantial Completion.
- B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.
- C. 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. Where applicable, such exposures include, but are not limited to, the following:
 - 1. Excessive static or dynamic loading.
 - 2. Excessive internal or external pressures.
 - 3. Excessively high or low temperatures.
 - 4. Thermal shock.
 - 5. Excessively high or low humidity.

6. Air contamination or pollution.
7. Water or ice.
8. Solvents.
9. Chemicals.
10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining, and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High-speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Destructive testing.
25. Misalignment.
26. Excessive weathering.
27. Unprotected storage.
28. Improper shipping or handling.
29. Theft.
30. Vandalism.
31. Dust and dirt on and in mechanical equipment and ductwork.

END OF SECTION

SECTION 013200

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for project meetings including, but not limited to:
 - 1. Preconstruction Conference.
 - 2. Preinstallation Conference.
 - 3. Progress Meetings.
- B. All conferences shall follow COVID-19 safety guidelines as issued by the Governor of Virginia and/or Giles County Public Schools.

1.3 PRECONSTRUCTION CONFERENCE

- A. The Architect/Engineer shall schedule a Preconstruction Conference and organizational meeting to be held at the project site or other convenient location no later than 15 days after execution of the Agreement and prior to commencement of construction activities. The Architect/Engineer shall conduct the meeting to review responsibilities and personnel assignments.
- B. Attendees: The following parties shall be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work.
 - 1. Owner.
 - 2. Clerk-of-the-Works.
 - 3. Architect/Engineer.
 - 4. Contractor.
 - a. Project Manager.
 - b. Superintendent.
 - 5. Major subcontractors.
 - 6. Inspection and testing agencies.
- C. Agenda: Discuss items of significance that could affect progress including such topics as:
 - 1. Designation of responsible personnel.
 - 2. Tentative construction schedule.
 - 3. Critical work sequencing.
 - 4. Use of the premises.
 - 5. Parking availability.
 - 6. Office, work and storage areas, equipment deliveries and priorities.
 - 7. Safety procedures.
 - 8. First aid.

9. OSHA.
10. Security.
11. Housekeeping.
12. Working hours.
13. Distribution of Contract Documents.
14. Relation and coordination of major subcontractors.
15. Procedures for processing field decisions and Change Orders.
16. Procedures for processing Applications for Payment.
17. Submittals of shop drawings, product data, and samples.
18. Preparation of record documents.

1.4 PREINSTALLATION CONFERENCE

- A. Prior to installation of building components, the General Contractor shall coordinate with the Architect/Engineer to schedule a Preinstallation Conference to be held at the project site or other mutually agreed location with the installing subcontractor, General Contractor, Architect/Engineer, Owner representative and any other affected subcontractor. See **individual specification sections** for preinstallation conference requirements.
- B. The subcontractor must be prepared to outline the procedures to be followed and how they affect other subcontractors.
- C. All parties shall review the progress of other construction activities and preparations for the particular activity under consideration at each Preinstallation Conference, including requirements for the following:
 1. Contract Documents.
 2. Options.
 3. Purchases.
 4. Deliveries.
 5. Shop Drawings, Product Data, and quality-control samples.
 6. Review of mockups.
 7. Possible conflicts.
 8. Compatibility problems.
 9. Time schedules.
 10. Weather limitations.
 11. Manufacturer's recommendations.
 12. Warranty requirements.
 13. Compatibility of materials.
 14. Acceptability of substrates.
 15. Temporary facilities.
 16. Space and access limitations.
 17. Governing regulations.
 18. Safety.
 19. Inspecting and testing requirements.
 20. Required performance results.
 21. Recording requirements.
 22. Protection.
- D. General Contractor shall record significant discussions and agreements and disagreements of each conference, and the approved schedule. General Contractor shall promptly distribute the record of the meeting to everyone concerned, including the Architect/Engineer, Subcontractor, and the Owner.

- E. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.5 PROGRESS MEETINGS

- A. Architect/Engineer or their representative shall conduct progress meetings at the project site at regularly scheduled intervals. Notify the General Contractor and Owner of scheduled meeting dates. Coordinate dates of meetings with preparation of the payment request.
- B. Attendees: In addition to representatives of the Owner, General Contractor and Architect/Engineer, it is mandatory that each subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination or performance of future activities be represented at these meetings by persons familiar with the project and authorized to conclude matters relating to progress. Failure to attend may be reason for withholding of progress payment to Contractor.
- C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the current status of the project.
 - 1. Contractor's Construction Schedule: An updated Construction Schedule is required at each meeting and not less than twice monthly. Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind 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.
 - 2. Review the following with each entity present. Provide color copies of schedule to all those in attendance.
 - a. Note field observations, problems and decisions.
 - b. Identify problems which impede planned progress.
 - c. Review off-site fabrication problems.
 - d. Develop corrective measures and procedures to regain planned schedule.
 - e. Revise Contractor's Construction Schedule as indicated.
 - f. Plan progress during next work period.
 - g. Coordinate projected progress with subcontractors.
 - h. Review submittal schedules, expedite as required to maintain schedule.
 - i. Review maintaining of quality and work standards.
 - j. Review changes proposed for:
 - 1) Effect on Contractor's Construction Schedule.
 - 2) Effect on Completion Date.
 - k. Complete other current business.
 - 3. Contractor shall submit the following:
 - a. Updated submittal log to insure that every item and shop drawing, that is indicated to be submitted, has been submitted.
 - b. Updated equipment list indicating approval status, projected fabrication and delivery dates of major equipment, thus insuring delivery on time.
 - c. Updated Construction Schedule.
- D. Reporting: No later than three (3) days after each progress meeting date, Architect/Engineer shall distribute copies of minutes of the meeting to each party present and to other parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report. If, within two (2) business days of the distribution of the meeting minutes, requests for

corrections are received by the Architect/Engineer from anyone in attendance, the Architect/Engineer shall, if in agreement with the requested changes, edit the meeting minutes and redistribute the edited version. Any requests for revisions received after two (2) business days of initial distribution shall be considered null and void.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 013233

PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.

1.3 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos by uploading to web-based Project management software site. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in web-based Project management software site:
 - a. Name of Project.
 - b. Date photograph was taken.
 - c. Unique sequential identifier keyed to accompanying key plan.

1.4 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.

- B. Metadata: Record accurate date and time from camera.
- C. File Names: Name media files with date Project area and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Construction Manager.
 - 1. Flag excavation areas construction limits before taking construction photographs.
 - 2. Take photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- C. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
 - 1. Underground utilities.
 - 2. Underslab services.
 - 3. Piping.
 - 4. Electrical conduit.
 - 5. Waterproofing and weather-resistant barriers.
- D. Periodic Construction Photographs: Take photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Additional Photographs: Architect or Construction Manager may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Immediate follow-up when on-site events result in construction damage or losses.
 - b. Photographs shall be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - c. Substantial Completion of a major phase or component of the Work.
 - d. Owner's request for special publicity photographs.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 013300

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This section specifies administrative and procedural requirements for submittals required for performance of the work, including:
 - 1. Submittal procedures.
 - 2. Contractor's construction schedule.
 - 3. Daily construction reports.
 - 4. Submittal cover sheet for shop drawings, product data and samples.
 - 5. Shop drawings.
 - 6. Product data.
 - 7. Samples.
- B. Administrative Submittals: Refer to other Division 1 sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:
 - 1. Permits.
 - 2. Applications for Payment.
 - 3. Performance and Payment Bonds.
 - 4. Insurance Certificates.
 - 5. List of Subcontractors.
- C. The Schedule of Values submittal is included in section "Payment Procedures."
- D. Inspection and test reports are included in section "Quality Requirements."

1.3 SUBMITTAL PROCEDURES

- A. Submittal: Unless otherwise specified, electronic shop drawing submittals are preferred, but if hard copies are submitted, the number of shop drawings, product data, and the number of samples which the Contractor shall submit and, if necessary, resubmit, is the number that the Contractor requires to be retained, plus **one** which will be retained by the Architect/Engineer, plus **two** that will be retained by the Owner.
 - 1. The Contractor may make comments on shop drawings during their review in some color other than red. The Architect/Engineer will make all comments in **red only**. (This will identify which party has made the comments.)
- B. If the number of resubmittals of shop drawings exceeds two, the Owner shall charge the Contractor a resubmittal review fee in the amount of \$100 per resubmittal, which is then added to the Architects fee. No time extensions shall be granted for processing and review of Shop Drawings submitted more than two times.

- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
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 elements of the work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The Architect/Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
 3. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
 - a. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Architect/Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
 - b. If an intermediate submittal is necessary, process the same as the initial submittal.
 - c. Allow two weeks for reprocessing each submittal.
 - d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Architect/Engineer sufficiently in advance of the work to permit processing.
 - e. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 - 1) Provide a space approximately 4" x 5" on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.
 - 2) Include the following information on the label for processing and recording action taken.
 - Project name.
 - Date.
 - Name and address of Architect/Engineer.
 - Name and address of Contractor.
 - Name and address of Subcontractor.
 - Name and address of supplier.
 - Name of manufacturer.
 - Number and title of appropriate Specification Section.
 - Drawing number and detail references, as appropriate.
 - f. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Architect/Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action.
 - 1) On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

1.4 SHOP DRAWINGS, PRODUCT DATA AND SAMPLE SUBMITTALS

- A. Contractor Responsibilities:
1. Contractor shall carefully review all submittals upon receipt. By approving and forwarding submittal, Contractor represents that he has verified all governing field measurements and field

construction criteria and that he has confirmed that all catalog numbers and similar data comply with Contract Document requirements.

2. Coordinate each submittal with requirements of Work and of Contract Documents.
3. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect/Engineer approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Architect/Engineer in writing of such deviation at the time of submittal and the Architect has given written approval to the specific 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/Engineer's approval thereof.
4. Begin no work which requires submittals until return of submittals with Architect/Engineers' stamp and initials or signature indicating approval.

B. Architect/Engineer's Duties:

1. Review submittals with reasonable promptness.
2. Maintain logs of all submittals.
3. Review for general agreement with:
 - a. Design concept of project.
 - b. Information given in Contract Documents.
4. Affix stamp and initials or signature certifying to review of submittals.
5. Review of separate item does not constitute review of an assembly in which that item functions.

1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Prepare a fully developed, horizontal bar-chart type Contractor's construction schedule for the benefit of all parties involved. Submit within 15 business days of the date established for "Commencement of Work".

1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the work as indicated in the "Schedule of Values".
2. Within each time bar, indicate completion percentage in 10 percent increments. As work progresses, place a contrasting mark in each bar to indicate Actual Completion.
3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
4. Secure time commitments for performing critical elements of the work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the work.
5. Coordinate the Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests and other schedules.
6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Architect/Engineer's procedures necessary for certification of Substantial Completion.

B. Distribution: Following response to the initial submittal, print and distribute copies to the Architect/Engineer, Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Project meeting room and temporary field office.

1. When revisions are made, distribute 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 construction activities.

- C. Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule at each bi-weekly progress meeting, or otherwise, not less than twice monthly.

1.6 DAILY CONSTRUCTION REPORTS

- A. Prepare a daily construction report, recording the following information concerning events at the site; and submit duplicate copies to the Architect/Engineer and the Clerk-of-the-Works at weekly intervals.
 - 1. Person completing the report.
 - 2. List of subcontractors at the site.
 - 3. Approximate count of personnel at the site.
 - 4. High and low temperatures, general weather conditions.
 - 5. Accidents and unusual events.
 - 6. Meetings and significant decisions.
 - 7. Stoppages, delays, shortages, losses.
 - 8. Emergency procedures.
 - 9. Orders and request of governing authorities.
 - 10. Change orders received, implemented.
 - 11. Services connected, disconnected.
 - 12. Equipment or system tests and start-ups.
 - 13. Partial completions, occupancies.
 - 14. Substantial completions authorized.

1.7 SUBMITTAL COVER SHEET

- A. The Contractor shall utilize the attached Submittal Cover Sheet for all items requiring a shop drawing, product data or samples. **If Submittal Cover Sheet is not attached, submitted material will not be reviewed and will be returned to the Contractor.** Include all submittal reviews on Construction Schedule. Anticipate two reviews of shop drawings.

1.8 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Drawings or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

- B. Shop drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information.

Dimensions.

Identification of products and materials included.

Compliance with specified standards.

Notation of coordination requirements.

Notation of dimensions established by field measurement.

Certification that all materials are asbestos-free.

- 1. Do not use shop drawings without an appropriate final stamp indicating action taken in connection with construction.
- 2. Within thirty (30) calendar days after award of Contract, Contractor shall submit to Architect/Engineer a complete submission of all products for which colors are to be selected.

Submission shall include a list of products indicating manufacturer's name, model number or name, brochures, color selections, physical samples, and all pertinent data.

3. In order for the Architect/Engineer to prepare a color board, the selection of colors for approved shop drawings will be withheld until color samples on all building products have been submitted. No individual color selection(s) will be made until complete submission of all project color samples are received.

- C. Coordination drawings are a special type of shop drawing that show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or function as intended.

1. Submit coordination drawings for integration of different construction elements. Show sequences and relationships of separate components to avoid conflicts in use of space.

1.9 PRODUCT DATA

- A. Collect product data into a single submittal for each element of construction or system. Product data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where product data must be specifically prepared because standard printed data is not suitable for use, submit as "Shop Drawings".

1. Mark each copy to show applicable choices and options. Where printed product data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:

Manufacturer's printed recommendations.

Compliance with recognized trade association standards.

Compliance with recognized testing agency standards.

Application of testing agency labels and seals.

Notation of dimensions verified by field measurement.

Notation of coordination requirements.

2. Do not submit product data until compliance with requirements of the Contract Documents has been confirmed.

- B. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

1. Do not proceed with installation until an applicable copy of product data is in the installer's possession.
2. Do not permit use of unmarked copies of product data in connection with construction.

1.10 SAMPLES

- A. Submit full-size, fully fabricated samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture and pattern.

1. Mount, display, or package samples in the manner specified to facilitate review of qualities indicated. Prepare samples to match Architect/Engineer's sample. Include the following:

Generic description of the sample.
Sample source.
Product name or name of manufacturer.
Compliance with recognized standards.
Availability and delivery time.

- B. Submit samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
 - 1. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation and similar construction characteristics.
- C. Preliminary Submittals: Where samples are for selection of color, pattern, texture or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.
 - 1. Preliminary submittals will be reviewed and returned with the Architect/Engineer's action indicated.
- D. Maintain sets of samples, as returned, at the Project site, for quality comparisons throughout the course of construction.
 - 1. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
 - 2. Sample sets may be used to obtain final acceptance of the construction associated with each set.
- E. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the work. Show distribution on transmittal forms.
 - 1. Field samples specified in individual Sections are special types of samples. Field samples are full-size examples erected on site to illustrate finishes, coatings, or finish materials and to establish the standard by which the work will be judged.
 - a. Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

1.11 ARCHITECT/ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Architect/Engineer will review each submittal, mark to indicate action taken, and return promptly.
- B. Compliance with specified characteristics is the Contractor's responsibility.
- C. Action Stamp: The Architect/Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked to indicate the action taken.
 - 1. Do not permit submittals marked "Not Approved, Revise and Resubmit" to be used at the Project site, or elsewhere where work is in progress.

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PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SUBMITTAL COVER SHEET
(Attach to each copy of each submittal.)

PROJECT:

ARCHITECT/ENGINEER: **ZMM, Inc.**
1116 South Main Street
Blacksburg, VA 24060

A/E COMMISSION:

PRIME CONTRACTOR: _____

SUBCON./SUPPLIER: _____

MANUFACTURER: _____

ITEM SUBMITTED: _____ **SUBMITTAL #:** _____

SPEC. SECTION #: _____ **PARAGRAPH #:** _____

DRAWING REFERENCE: _____ **DETAIL #:** _____

CERTIFICATION: (Circle one.)

- A. Certified to comply with Drawings and Specifications.
- B. Certified to comply with Drawings and Specifications except as noted on attached Submittal Deviation Sheet.

Signature: Subcontractor/Supplier Date

Signature: Prime Contractor Date

<div style="border: 1px solid black; height: 200px; margin-bottom: 10px;"></div>	<input type="checkbox"/> APPROVED	<input type="checkbox"/> APPROVED AS NOTED
	<input type="checkbox"/> DISAPPROVED	<input type="checkbox"/> REVISE AND RESUBMIT
	<input type="checkbox"/> RECEIPT ACKNOWLEDGED	
	<p>COMMENTS MADE ON THE SHOP DRAWINGS DURING THIS REVIEW DO NOT RELIEVE THE CONTRACTOR FROM COMPLIANCE WITH REQUIREMENTS OF THE DRAWINGS AND SPECIFICATIONS. THIS CHECK IS ONLY FOR REVIEW OF GENERAL CONFORMANCE WITH THE DESIGN CONCEPT OF THE PROJECT AND GENERAL COMPLIANCE WITH THE INFORMATION GIVEN IN THE CONTRACT DOCUMENTS. THE CONTRACTOR IS RESPONSIBLE FOR: CONFIRMING AND CORRELATING QUANTITIES AND DIMENSIONS, SELECTING FABRICATION PROCESSES AND TECHNIQUES OF CONSTRUCTION, COORDINATING THIS WORK WITH THAT OF ALL OTHER TRADES, AND PERFORMING WORK IN A SAFE AND SATISFACTORY MANNER. NOTE ANY DEVIATIONS IN ATTACHED SUBMITTAL DEVIATION SHEET.</p> <p>DATE: _____ BY: _____ ZMM, Inc.</p>	

(PRIME CONTRACTOR APPROVAL STAMP)

(ARCHITECT/ENGINEER REVIEW STAMP)

SECTION 014000

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This section specifies administrative and procedural requirements for quality control services.
- B. Quality control services include inspections, tests and related actions including reports, performed by independent agencies, governing authorities, and the Contractor. They do not include Contract enforcement activities performed by the Architect/Engineer and Clerk-of-the-Works.
- C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with Contract Document requirements.
- D. Requirements of this section relate to customized fabrication and installation procedures, not production of standard products.
 - 1. Specific quality control requirements for individual construction activities are specified in the sections that specify those activities. Those requirements, including inspections and tests, cover production of standard products as well as customized fabrication and installation procedures.
 - 2. Inspections, tests and related actions specified are not intended to limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for the Contractor to provide quality control services required by the Architect/Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this section.

1.3 THREE PHASES OF CONTROL

- A. The Contractor shall actively perform overall quality control of all work under the Contract. The Contractor shall perform three phases of control to ensure that all work complies with Contract requirements. The Three Phases of Control shall adequately cover all work and shall include the following for each definable feature of work: A definable feature of work is a task which is separate and distinct from other tasks and requires separate control requirements.
 - 1. Preparatory Phase: Notify the Clerk-of-the-Works at least 2 work days in advance of each preparatory phase. The superintendent shall conduct the preparatory phase with the Clerk-of-the-Works and the foreman responsible for the definable feature. Document the results of the preparatory phase actions in the Daily Construction Report. Perform the following prior to beginning work on each definable feature of work:
 - a. Review each paragraph of the applicable specification sections;
 - b. Review the Contract drawings;

- c. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required;
 - d. Review the testing plan and ensure that provisions have been made to provide the required QC testing;
 - e. Examine the work area to ensure that the required preliminary work has been completed;
 - f. Examine the required materials, equipment and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data;
 - g. Review the safety plan and appropriate activity hazard analysis to ensure that applicable safety requirements are met, and that required Material Safety Data Sheets (MSDS) are submitted; and
 - h. Discuss construction methods.
2. Initial Phase: Notify the Clerk-of-the-Works at least 2 work days in advance of each initial phase. When construction crews are ready to start work on a definable feature of work, the superintendent shall conduct the initial phase with the Clerk-of-the-Works and the foreman responsible for that definable feature of work. Observe the initial segment of the definable feature of work to ensure that the work complies with Contract requirements. Any work not in conformance with specifications shall be stopped immediately by the Contractor and corrective measures taken. Document the results of the initial phase in the Daily Construction Report. Repeat the initial phase for each new crew to work on-site, or when acceptable levels of specified quality are not being met. Perform the following for each definable feature of work:
- a. Establish the quality of workmanship required;
 - b. Resolve conflicts;
 - c. Review the Safety Plan and the appropriate activity hazard analysis to ensure that applicable safety requirements are met; and
 - d. Ensure that testing is performed by the approved laboratory.
3. Follow-Up Phase: Perform the following for on-going work daily, or more frequently as necessary until the completion of each definable feature of work and document in the Daily Construction Report:
- a. Ensure the work is in compliance with Contract requirements;
 - b. Maintain the quality of workmanship required;
 - c. Ensure that testing is performed by the approved laboratory;
 - d. Ensure that rework items are being corrected; and
 - e. The superintendent shall maintain a list of work that does not comply with the Contract, identifying what items need to be reworked, the date the item was originally discovered, and the date the item was corrected. There is no requirement to report a rework item that is corrected the same day it is discovered. Attach a copy of the "Contractor Rework Items List" to the last Daily Construction Report of each month. The Contractor shall be responsible for including on this list items needing rework including those identified by the Clerk-of-the-Works.

1.4 RESPONSIBILITIES

- A. Contractor Responsibilities: The Contractor shall provide inspections, tests and similar quality control services, specified in individual specification sections and required by governing authorities, except where they are specifically indicated to be the Owner's responsibility, or are provided by another identified entity; these services include those specified to be performed by an independent agency and not by the Contractor. Costs for these services shall be included in the Contract Sum.
 - 1. The Contractor shall employ and pay an independent agency to perform specified quality control services.

2. It is the responsibility of the Contractor to coordinate inspections with the independent agency. The Contractor shall bear any cost incurred due to a lack of coordination, i.e., independent agency personnel present on site while no activity requiring testing is occurring.
- B. Retesting: The Contractor is responsible for retesting where results of required inspections, tests or similar services prove unsatisfactory and do not indicate compliance with Contract Document requirements, regardless of whether the original test was the Contractor's responsibility.
 1. Cost of retesting construction revised or replaced by the Contractor is the Contractor's responsibility, where required tests were performed on original construction.
- C. Associated Services: The Contractor shall cooperate with agencies performing required inspections, tests and similar services and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to:
 1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests.
 2. Taking adequate quantities of representative samples of materials that require testing or assisting the agency in taking samples.
 3. Providing facilities for storage and curing of test samples, and delivery of samples to testing laboratories.
 4. Providing the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
 5. Security and protection of samples and test equipment at the Project site.
- D. Duties of the Testing Agency: The independent testing agency engaged to perform inspections, sampling and testing of materials and construction specified in individual specification sections shall cooperate with the Architect/Engineer and Contractor in performance of its duties, and shall provide qualified personnel to perform required inspections and tests.
 1. The agency shall notify the Architect/Engineer and Contractor promptly of irregularities or deficiencies in the Work during performance of its service.
 2. The agency is not authorized to release, revoke, alter or enlarge requirements of the Contract Documents, or approve or accept any portion of the Work.
 3. The agency shall not perform any duties of the Contractor.

1.5 OBLIGATIONS

- A. All of the Contractor's quality control inspection services and the inspectors shall be unbiased and directly responsive to the Owner and the Architect/Engineer. Written Inspection Reports on completed inspections AND inspections in progress shall be completed each day and at the end of the inspection and copies given first to the Owner and Architect/Engineer and then to the Contractor. The Owner and Architect/Engineer shall have the right to ask the Contractor's inspectors questions at any time. The Contractor's inspectors shall answer all questions and concerns of the Owner and Architect/Engineer directly, professionally, honestly, completely and immediately, without interference from or permission from the Contractor or any of his subcontractors, suppliers, or agents. All costs for inspection services shall be shown separately on the schedule of prices, and payments will only be authorized by the Architect/Engineer and Owner for inspection services that have been provided as detailed in this paragraph. If the Contractor fails to allow the reporting of any inspections as described in this paragraph, the retention percentage on all work will be immediately increased to 10% and remain at that level until such time that the questioned work is retested, and reported to the Architect/Engineer and Owner to be at the specified quality. If work is done without the inspectors present, the retention percentage on all work will be immediately increased to 10% and

remain at that level until such time that the work is redone with the inspector present, to the specified quality.

- B. AT least twice per month, at the site, the inspectors must review all of their inspections thus far with the Owner and the Architect/Engineer.
- C. All inspectors and testers must be currently certified in the applicable field of inspections that they are performing; e.g., soils for soils inspection, concrete for concrete inspection, etc. All inspectors and testers must have at least 5 years experience in inspecting their respective area of responsibility.

1.6 SUBMITTALS

- A. The independent testing agency shall submit a certified written report of each inspection, test or similar service, to the Architect/Engineer, in duplicate, unless the Contractor is responsible for the service. If the Contractor is responsible for the service, submit a certified written report of each inspection, test, or similar service through the Contractor, in duplicate. The Architect/Engineer will provide reporting forms and logs to the independent testing agency.
 - 1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
 - 2. Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to:
 - Date of issue.
 - Project title and number.
 - Name, address and telephone number of testing agency.
 - Dates and locations of samples and tests or inspections.
 - Names of individuals making the inspection or test.
 - Designation of the Work and test method.
 - Identification of the product and Specification Section.
 - Complete inspection or test data.
 - Test results and an interpretations of test results.
 - Ambient conditions at the time of sample-taking and testing.
 - Comments or professional opinion as to whether inspected or tested Work complies with Contract Document requirements.
 - Name and signature of laboratory inspector.
 - Recommendations on retesting.
- B. The independent testing agency shall maintain a running Deficiencies Log to track each deficiency discovered during all on-site inspections, testing performed in the laboratory, or any other such deficiency occurring within an area of the work which the independent testing agency has been contracted to inspect.
 - 1. The deficiency log shall be a continuous running log of all deficiencies noted during inspections and shall include, at a minimum, the following pieces of information for each deficient item:
 - a. Item number.
 - b. Date the item was originally discovered.
 - c. Location (floor, column grid, etc.).
 - d. Description - A written description of the deficiency.
 - e. Reference - A reference to the specification section, drawing sheet number, shop drawing sheet number, etc. indicating the contract provision to which the item does not comply.
 - f. Status - indicate either "Open" or "Resolved".

- g. Date Corrected - The date upon which the deficiency was brought into compliance with the contract documents.
 - h. Comments - Any pertinent information on the deficiency. Once resolved, this item should indicate the justification for resolution of the item such as "Accepted by Engineer of Record in RFI ????" or "Retesting indicated compaction within acceptable limits", etc.
- 2. Prior to project closeout, each item on the deficiency list shall be resolved to the satisfaction of the Architect/Engineer.
 - 3. Deficiency logs shall be updated and submitted weekly.
 - 4. The deficiency log to be used for this project is included at the end of this Section of the Specifications. If the independent testing agency has its own deficiency log developed, said log may be used to document deficiencies if first approved by the Architect/Engineer.

1.7 QUALITY ASSURANCE

- A. Qualification for Service Agencies: Engage inspection and testing service agencies, including independent testing laboratories, which are prequalified as complying with "Recommended Requirements for Independent Laboratory Qualification" by the American Council of Independent Laboratories, and which specialize in the types of inspections and tests to be performed.
 - 1. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the State in which the Project is located.
 - 2. Qualifications of inspectors on site shall include 5 years inspection in type of work, and certified for the type of work performed.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: Upon completion of inspection, testing, and sample-taking and similar services, repair damaged construction and restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed finishes.
- B. Protect construction exposed by or for quality control service activities, and protect repaired construction.
- C. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing or similar services.

END OF SECTION



DEFICIENCY LOG

Date: _____

Project No. _____

Project: _____

INDEPENDENT TESTING AGENCY: _____

No.	Date	Location	Description	Status	Reference	Date Corrected	Comments
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

Date: _____ Project No. _____ Project: _____

[illegible]

SECTION 015000

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This section specifies requirements for temporary services and facilities, including utilities, construction and support facilities, security and protection.
- B. Temporary utilities required include, but are not limited to:
 - 1. Water service and distribution. (Contractor can use water from existing building for construction purposes only.)
 - 2. Electric power and light. (Contractor can use electric power and light from existing building for construction purposes only.)
 - 3. Telephone and internet service.
- C. Temporary construction and support facilities required include, but are not limited to:
 - 1. Temporary heat.
 - 2. Storage sheds.
 - 3. Sanitary toilet facilities, including hand wash facilities with soap, and drinking water.
 - 4. Temporary enclosures.
 - 5. Waste disposal services.
 - 6. Construction aids and miscellaneous services and facilities.
- D. Security and protection facilities required include, but are not limited to:
 - 1. Temporary fire protection.
 - 2. Temporary fences, barricades, gates, warning signs, lights.
 - 3. Environmental protection.

1.3 QUALITY CONTROL

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - 1. Building code requirements.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, Fire Department and Rescue Squad rules.
 - 5. Environment protection regulations.
- B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities."

1. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services", prepared jointly by AGC and ASC, for industry recommendations.
 2. Electrical Service: Comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.
- 1.4 PROJECT CONDITIONS
- A. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Water: Provide potable water approved by local health authorities.

2.2 EQUIPMENT

- A. General: Provide new equipment. If acceptable to the Architect/Engineer, undamaged, previously used equipment in serviceable condition may be used. Provide equipment suitable for use intended.
- B. Water Hoses: Provide 3/4" heavy-duty, abrasion-resistant, flexible rubber hoses 100 ft. long, with pressure rating greater than the maximum pressure of the water distribution system; provide adjustable shut-off nozzles at hose discharge.
- C. Electrical Outlets: Provide properly configured NEMA polarized outlets to prevent insertion of 110-120 volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button and pilot light, for connection of power tools and equipment.
- D. Electrical Power Cords: Provide grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress.
- E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered glass enclosures, where exposed to breakage. Provide exterior fixtures where exposed to moisture.
- F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM or another recognized trade association related to the type of fuel being consumed.
- G. Temporary Toilet Units: Provide self-contained single-occupant toilet units of the chemical, aerated recirculation, or combustion type, properly vented and fully enclosed with a glass fiber reinforced polyester shell or similar nonabsorbent material.

- H. First Aid Supplies: Comply with governing regulations.
- I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
 - 1. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the project adequately and result in minimum interference with performance of the work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed, or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Engage the appropriate local utility company to connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
 - 1. Arrange with the company and existing users for a time when service can be interrupted, where necessary, to make connections for temporary services.
- B. Temporary Lighting: Whenever overhead floor or roof deck has been installed, provide temporary lighting with local switch.
 - 1. Install and operate temporary lighting that will fulfill security and protection requirements, without operating the entire system, and will provide adequate illumination for construction operations and traffic conditions.
- C. Temporary Telephones and Internet: Provide temporary telephone and internet service for all personnel engaged in construction activities, throughout the construction period.

3.3 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

- A. Locate storage sheds, sanitary facilities and other temporary construction and support facilities for easy access, but within temporary construction fence.
 - 1. Maintain temporary construction and support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.
- B. Temporary Construction Heat: Provide temporary heat required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

1. Heating Facilities: Except where use of the permanent system is authorized, provide heat source that emits no odors or harmful fumes.
 - a. Use of gasoline-burning space heaters, open flame, or salamander type heating units is prohibited.
 - C. Storage and Fabrication Sheds: Install storage and fabrication sheds, sized, furnished and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within the building or elsewhere on the site.
 - D. Sanitary facilities to include temporary toilets, wash facilities with soap, and drinking water fixtures. Comply with regulations and health codes for the type, number, location, operation and maintenance of fixtures and facilities. Install where facilities will best serve the project's needs.
 1. Provide toilet tissue, hand soap, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.
 - E. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
 - F. Drinking Water Facilities: Provide containerized tap-dispenser bottled-water type drinking water units, including paper supply.
 - G. Temporary Enclosures: Provide temporary enclosure for protection of construction in progress and completed, from exposure, foul weather, other construction operations and similar activities.
 1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.
 3. Close openings through floor or roof decks and horizontal surfaces.
 - H. Temporary Exterior Lighting: Install exterior yard lights where required for safety and/or security.
 - I. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 degrees F. (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.
- 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION
- A. Barricades, Warning Signs and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.
 - B. Enclosure Fence: Install around construction area as required for safety of building occupants and the public. Provide egress gates at locations where corridors exit the building. These gates shall be unlocked whenever the building is occupied. Provide Owner with keys to gates.

- C. Security Enclosure and Lockup: Install temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft and similar violations of security.
 - 1. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- D. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons on or near the site. Maintain erosion control devices. Comply with all local codes pertaining to these issues.
- E. Fire/Smoke: No plastic materials shall be used in temporary construction within the building.

3.5 OPERATION, TERMINATION AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation and similar facilities on a 24-hour day basis where required to achieve indicated results and to avoid possibility of damage.
 - 2. Protection: Prevent water filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Termination and Removal: Unless the Architect/Engineer requests that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of the Contractor.
 - 2. Remove temporary stone that is not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that does not comply with requirements for fill or subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances which might impair growth of plant materials or lawns. Repair or replace street paving, curbs and sidewalks at the temporary entrances, as required by the governing authority.
 - 3. At Substantial Completion, clean and renovate permanent facilities that have been used during the construction period, including but not limited to:
 - a. Replace significantly worn parts that have been subject to unusual operating conditions.
 - b. Replace lamps that are burned out or noticeably dimmed by substantial hours of use.
 - c. Replace air filters immediately prior to Owner occupancy. New filters shall not come from attic stock.
 - d. Clean dirty coils.

END OF SECTION

SECTION 016600

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Division 1 Section "Submittal Procedures" specifies requirements for submitting the Contractor's Construction Schedule and the Submittal Schedule.
 - 2. Division 1 Section "Substitution Procedures" specifies administrative procedures for handling requests for substitutions made after award of the Contract.

1.4 DEFINITIONS

- A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
 - 1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
 - 2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
 - 3. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.5 SUBMITTALS

- A. Product List: Prepare a list showing products specified in tabular form acceptable to the Architect. Include generic names of products required. Include the manufacturer's name and proprietary product names for each item listed.
 - 1. Coordinate product list with the Contractor's Construction Schedule and the Schedule of Submittals.
 - 2. Form: Prepare product list with information on each item tabulated under the following column headings:

- a. Related Specification Section number.
 - b. Generic name used in Contract Documents.
 - c. Proprietary name, model number, and similar designations.
 - d. Manufacturer's name and address.
 - e. Supplier's name and address.
 - f. Installer's name and address.
 - g. Projected delivery date or time span of delivery period.
3. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of an initial product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.
 4. Completed List: Within 60 days after date of commencement of the Work, submit 3 copies of the completed product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.
 5. Architect's Action: The Architect will respond in writing to Contractor within 2 weeks of receipt of the completed product list. No response within this period constitutes no objection to listed manufacturers or products but does not constitute a waiver of the requirement that products comply with Contract Documents. The Architect's response will include a list of unacceptable product selections, containing a brief explanation of reasons for this action.

1.6 QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
 1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the Architect to determine the most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.
- B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
 1. Each prime contractor is responsible for providing products and construction methods that are compatible with products and construction methods of other prime or separate contractors.
 2. If a dispute arises between prime contractors over concurrently selectable, but incompatible products, the Architect will determine which products shall be retained and which are incompatible and must be replaced.
- C. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.
 1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.

- d. Speed.
- e. Ratings.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
 - 1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 - 5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
 - 6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
 - 7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation.
 - 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
 - 2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
- B. Product Selection Procedures: The Contract Documents and governing regulations govern product selection. Procedures governing product selection include the following:
 - 1. Proprietary Specification Requirements: Where Specifications name only a single product or manufacturer, provide the product indicated. No substitutions will be permitted.
 - 2. Semiproprietary Specification Requirements: Where Specifications name 2 or more products or manufacturers, provide 1 of the products indicated. No substitutions will be permitted.
 - a. Where Specifications specify products or manufacturers by name, accompanied by the term "or equal" or "or approved equal," comply with the Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
 - 3. Nonproprietary Specifications: When Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these products only, the Contractor may propose any available product that complies with Contract requirements. Comply with Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.

4. Descriptive Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.
5. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements and are recommended by the manufacturer for the application indicated.
 - a. Manufacturer's recommendations may be contained in published product literature or by the manufacturer's certification of performance.
6. Compliance with Standards, Codes, and Regulations: Where Specifications only require compliance with an imposed code, standard, or regulation, select a product that complies with the standards, codes, or regulations specified.
7. Visual Matching: Where Specifications require matching an established Sample, the Architect/Engineer's decision will be final on whether a proposed product matches satisfactorily.
 - a. Where no product available within the specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category.
8. Visual Selection: Where specified product requirements include the phrase "... as selected from manufacturer's standard colors, patterns, textures ..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Architect/Engineer will select the color, pattern, and texture from the product line selected.
9. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.
 1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION

SECTION 017300

EXECUTION

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for cutting and patching.
- B. Refer to other Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
 - 1. Requirements of this Section apply to all Contracts. Refer to specifications for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.
 - 2. The Contractor shall use the File Management System prescribed by ZMM ARCHITECTS ENGINEERS to route and receive the documents detailed in this section.

1.3 SUBMITTALS

- A. Cutting and Patching Proposal: Where approval of procedures for cutting and patching is required before proceeding, submit a proposal describing procedures well in advance of the time cutting and patching will be performed and request approval to proceed. Include the following information, as applicable, in the proposal:
 - 1. Describe the extent of cutting and patching required and how it is to be performed; indicate why it cannot be avoided.
 - 2. Describe anticipated results in terms of changes to existing construction; include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
 - 3. List products to be used and firms or entities that will perform Work.
 - 4. Indicate dates when cutting and patching is to be performed.
 - 5. List utilities that will be disturbed or affected, including those that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.
 - 6. Where cutting and patching involves addition of reinforcement to structural elements, submit details and engineering calculations to show how reinforcement is integrated with the original structure.
 - 7. Approval by the Architect to proceed with cutting and patching does not waive the Architect's right to later require complete removal and replacement of a part of the Work found to be unsatisfactory.

1.4 QUALITY ASSURANCE

- A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.

1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
 - a. Foundation construction.
 - b. Bearing walls.
 - c. Structural concrete.
 - d. Structural steel.
 - e. Lintels.
 - f. Primary wood framing.
 - g. Structural decking.
 - h. Stair systems.
 - i. Miscellaneous structural metals.
 - j. Equipment supports.
 - k. Piping, ductwork, vessels and equipment.
 - B. Operational and Safety Limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance, or decreased operational life or safety.
 1. Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related systems:
 - a. Shoring, bracing, and sheeting.
 - b. Primary operational systems and equipment.
 - c. Water, moisture, or vapor barriers.
 - d. Membranes and flashings.
 - e. Fire protection systems.
 - f. Control systems.
 - g. Communication systems.
 - h. Conveying systems.
 - i. Electrical wiring systems.
 - C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in the Architect's opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching. Remove and replace Work cut and patched in a visually unsatisfactory manner.
 1. If possible, retain the original installer or fabricator to cut and patch the following categories of exposed Work, or if it is not possible to engage the original installer or fabricator, engage another recognized and experienced and specialized firm:
 - a. Processed concrete finishes.
 - b. Matched-veneer woodwork.
 - c. Preformed metal panels.
 - d. Acoustical ceilings.
 - e. Finished wood flooring.
 - f. Carpeting.
 - g. Wall covering.
 - h. HVAC enclosures, cabinets or covers.
- 1.5 WARRANTY
- A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use materials that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Before cutting existing surfaces, examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered.
 - 1. Before proceeding, meet at the site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Avoid cutting existing pipe, conduit, or ductwork serving the building, but scheduled to be removed or relocated, until provisions have been made to bypass them.

3.3 PERFORMANCE

- A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
 - 1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible, review proposed procedures with the original installer; comply with the original installer's recommendations.
 - 1. In general, where cutting is required, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.

3. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.
 4. Where services are required to be removed, relocated, or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.
- C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
 2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing the patch, after the patched area has received primer and second coat.
- 3.4 CLEANING
- A. Thoroughly clean areas and spaces where cutting and patching is performed or used as access. Remove completely paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore damaged pipe covering to its original condition.

END OF SECTION

SECTION 017700

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This section specifies administrative and procedural requirements for project closeout, including but not limited to:
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Operating and maintenance manual submittal.
 - 4. Guarantee period.
 - 5. Final cleaning.
- B. Closeout requirements for specific construction activities are included in the appropriate sections of the specifications.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the work claimed as substantially complete. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
 - a. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the work is not complete.
 - 2. Advise the Owner of pending insurance change-over requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
 - 4. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates and similar releases.
 - 5. Submit record drawings, maintenance manuals, final completion photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra stock, and similar items.
 - 7. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
 - 8. Complete startup testing of systems and instruction of the Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
 - 9. Complete final cleanup requirements, including touchup painting.
 - 10. Touch up and otherwise repair and restore marred, exposed finishes.

- B. Inspection Procedures: On receipt of a request for inspection for certification of Substantial Completion, the Architect/ Engineer will either proceed with the inspection or advise the Contractor of unfulfilled requirements necessary for the inspection. Following the inspection, the Architect/Engineer will prepare the Certificate of Substantial Completion, or advise the Contractor of construction items that must be completed or corrected before the certificate will be issued.
1. The General Contractor will prepare a punch list (example form attached to the end of this section) of defects and omissions to the requirements of the contract documents.
 2. This punch list will be provided to all subcontractors for corrective actions.
 3. The General Contractor's superintendent, along with the foreman of the applicable subcontractors, will each be required to initial and date each item completed on their respective punch lists.
 4. Architect/Engineer will be notified when the items have been completed.
 5. The Architect/Engineer and/or Owner will verify that these items have been completed and will initial and date each item on the respective punch lists. If the Architect/Engineer or Owner observe additional items needing correction, they will add these items to the punch list for corrective measures by the appropriate contractor.
 6. Completion of the punch list items will form the basis for substantial completion.
 7. Once the Certificate of Substantial Completion has been issued with the list of any minor unfulfilled requirements (punch list) and agreed upon date for Final Acceptance, the Contractor will continue to fully complete the Work.

1.4 FINAL ACCEPTANCE

- A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following.
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted.
 2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 3. Submit a certified copy of the Architect/Engineer's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by the Architect/Engineer.
 4. Submit consent of surety to final payment.
 5. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 6. Submit statement to Architect/Engineer certifying that all temporary and permanent materials used on this project are asbestos-free.
 7. Submit test results to Architect/Engineer certifying that the project's domestic water system is not at risk for lead.
 8. Submit a final "liquidated damages" settlement statement.
 9. Submit a final "reimbursement of Architect" settlement statement.
- B. Completion Verification Procedure: The Architect/Engineer will verify completion of the Work upon receipt of notice that the Work, including inspection list (punch list) items from earlier inspections, has been completed and documented with General Contractor's initials and date, and with Subcontractor's initials and date.
1. Upon verification of completion, the Architect will prepare a certificate of final acceptance. If the Work is incomplete, the Architect will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.

1.5 RECORD DOCUMENT SUBMITTALS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Architect/Engineer's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 - 1. Mark record set with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
 - 2. Mark new information that is important to the Owner, but was not shown on Contract Drawings.
 - 3. Note related Change Order numbers where applicable.
 - 4. Organize record drawing sheets into a manageable set, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover.
- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy 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. Note related Change Orders, Record Drawings, and Product Data, where applicable.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
 - 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 Drawings, and Record Specifications, where applicable.

1.6 OPERATION AND MAINTENANCE DATA

- A. At time of completion, the Contractor shall furnish to the Owner complete operating and maintenance instructions for all mechanical equipment and electrical equipment in the project together with the names and addresses of the applicable subcontractors and suppliers. The manuals shall also contain spare parts listings, copies of warranties, wiring diagrams, and inspection procedures.
 - 1. Provide two (2) paper copies bound in a loose leaf notebook.
 - 2. Provide one (1) digitized copy on CD or USB Drive in electronic format (PDF).

1.7 GUARANTEE

- A. All materials, equipment and workmanship shall be guaranteed for one year from the date of Certificate of Occupancy, not from date of installation. Longer period of guarantee where called for in specifications shall take precedence over the one year guarantee.

- B. During the Guarantee Period, the Owner shall contact the Contractor directly on guarantee/warranty items as they occur. The Owner shall utilize the form at the end of this section.

1.8 GUARANTEE PERIOD INSPECTION

- A. Prior to the expiration date of the Contractor's one-year guarantee period, but not before 9 months of this period has elapsed, the Owner shall make an inspection of the building, equipment, and/or any other work included in the original Contract to determine whether any defects in materials or workmanship have developed. The Owner shall provide the Contractor with written notice of such defects. A copy of this written notice shall be sent to the Architect/Engineer.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and anti-pollution 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 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; shampoo 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.

- l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical, electrical, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - s. Clean areas of existing buildings and site that were affected by construction dust. These areas will be identified solely by the Owner.
 - t. Leave Project clean and ready for occupancy.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.
- D. Contractor shall not use the Owner's refuse containers.

END OF SECTION



Failure to include any items on this list by the architect/engineer does not alter the responsibility of the contractor to complete all work in accordance with the contract documents.

GUARANTEE REPORT FORM

DATE: _____

(Mr. _____) (General Contractor)

(_____ Company _____)

(_____ Address _____)

(_____ Address _____)

(_____ FAX Number _____)

RE: (Construction Project Title)
GUARANTEE ITEM

Gentlemen:

This notice is in regards to a guarantee item on the referenced construction project.

GUARANTEE REPORT NO. _____

DESCRIPTION OF DEFECT:

REPORTED BY: _____ *

REQUIRED DATE FOR REPAIR: _____

DATE OF DISCOVERY: _____ (date) _____ (By Owner)

DATE GENERAL CONTRACTOR
NOTIFIED THE
APPROPRIATE SUBCONTRACTOR: _____ (date) _____ (By General Contractor)

DATE ITEM REMEDIED: _____ (date) _____ (By General Contractor)

DATE THIS FORM RETURNED TO OWNER: _____ (date) _____ (By General Contractor)

GUARANTEE PERIOD EXPIRES: _____ (date) _____ (By Owner)

Sincerely,

(Mr./Ms. _____) (Owner)

(_____ Company _____)

(_____ Address _____)

(_____ Address _____)

(_____ FAX Number _____)

* Please return this form to me when repair has been accomplished.

SECTION 017800

WARRANTIES

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section specifies general administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers standard warranties on products and special warranties.
 - 1. Refer to the General Conditions for terms of the Contractor's special warranty of workmanship and materials.
 - 2. General closeout requirements are included in Section 017700, CLOSEOUT PROCEDURES.
 - 3. Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in the individual Sections of Divisions 2 through 26.
 - 4. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS

- A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.4 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- E. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.5 SUBMITTALS

- A. Submit written warranties to the Architect prior to the date certified for Substantial Completion. If the Architect's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Architect.
- B. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Architect for approval prior to final execution.
 - 1. Refer to individual Sections of Divisions 2 through 26 for specific content requirements, and particular requirements for submittal of special warranties.
- C. Form of Submittal: At Final Completion, compile two copies of each required warranty properly executed by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- D. Bind warranties in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
 - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the 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 the installer.
 - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES", the Project title or name, and the name of the Contractor.
- E. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

GCPS – MACY MCCLAUGHERTY – ES/MS RENOVATIONS

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 017900

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 SUMMARY

- A. This 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 CD(s), DVD(s) and/or USB Drive(s).

1.3 SUBMITTALS

- A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module.
 - 1. At completion of training, submit one complete training manual for Owner's use.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Demonstration and Training CD(s), DVD(s) and/or USB Drive(s): Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date CD(s), DVD(s) and/or USB Drive(s) was/were recorded.
 - f. Description of vantage point, indicating location.
 - 2. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding CD(s), DVD(s) and/or USB Drive(s). Include name of Project and date of recording on each page.

1.4 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training.

- B. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.
- C. Preinstruction Conference: Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved operating and maintenance manuals. Do not submit instruction program until operating 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 equipment not part of a system, as required by individual Specification Sections, and as follows:
 - 1. Heat generation, including boilers, pumps, steam distribution piping, and water distribution piping.
 - 2. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
 - 3. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
 - 4. HVAC instrumentation and controls.
 - 5. Lighting equipment and controls.
- 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:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Regulatory requirements.
 - c. Equipment function.
 - d. Operating characteristics.
 - e. Limiting conditions.

2. Documentation: Review the following items in detail:
 - a. Emergency.
 - b. Operating and Maintenance manuals.
 - c. Project Record Documents.
 - d. Identification systems.
 - e. Warranties and Bonds.
 - f. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.

- e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- B. Scheduling: Provide instruction at mutually agreed on times. 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.
- C. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING CD(s), DVD(s) AND/OR USB DRIVE(s)

- A. General: Engage a qualified commercial photographer to record demonstration and training CD(s), DVD(s) and/or USB Drive(s). Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Recording Format: Provide high-quality CD(s), DVD(s) and/or USB Drive(s).
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
- D. Narration: Describe scenes on CD(s), DVD(s) and/or USB Drive(s) by audio narration by microphone while CD(s), DVD(s) and/or USB Drive(s) is/are recorded. Include description of items being viewed. Describe vantage point, indicating location.

END OF SECTION

SECTION 024119

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. In general, the work included under this section consists of, but is not limited to, the following:
 - 1. Removal of existing suspended acoustical tile ceiling, lighting, mechanical units, exterior glass block, etc.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Remodeling construction work and patching is included within the respective sections of specifications, including removal of materials for re-use and incorporated into remodeling or new construction.
 - 2. Relocation of pipes, conduits, ducts, other mechanical and electrical work is specified by respective trades.

1.4 JOB CONDITIONS

- A. Owner will continuously occupy areas of the building immediately adjacent to areas of selective demolition. Conduct selective demolition work in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of demolition activities which will severely impact Owner's normal operations.
- B. Owner assumes no responsibility for actual condition of items or structures to be demolished.
 - 1. The Owner will maintain conditions existing at time of commencement of contract insofar as practicable. However, variations within structure may occur by Owner's removal and salvage operations prior to start of selective demolition work.
- C. Remove items indicated to be removed, but of salvable value to Contractor, from structure as work progresses. Transport salvaged items from site as they are removed.
 - 1. Storage or sale of removed items on site is not permitted.
- D. Provide temporary barricades and other forms of protection as required to protect Owner's personnel

and general public from injury due to selective demolition work.

1. Provide protective measures as required to provide free and safe passage of Owner's personnel and general public to and from occupied portions of building.
2. Erect temporary covered passageways as required by authorities having jurisdiction.
3. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished, and adjacent facilities or work to remain.
4. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.
5. Protect floors with suitable coverings when necessary.
6. Construct temporary insulated solid dust-proof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dust-proof doors and security locks if required.
7. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
8. Remove protections at completion of work.

E. Promptly repair damages caused to adjacent facilities by demolition work at no additional cost to Owner.

F. Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

1. Do not close, block or otherwise obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

G. Use of explosives is not permitted.

H. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

1. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

I. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

1.5 SUBMITTALS

A. Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Owner's representative for review prior to commencement of work. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for dust and noise control protection.

B. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.

C. Coordinate with Owner's continuing occupation of portions of existing building, with Owner's

partial occupancy of completed new addition, and with Owner's reduced usage during summer months.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Prior to commencement of demolition work, inspect areas in which work will be performed. Photograph existing conditions to structure surfaces, equipment or to surrounding properties which could be misconstrued as damage resulting from selective demolition work; file with Owner's representative prior to starting work.

3.2 PREPARATION

- A. Temporary Shoring: Contractor shall 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, or adjacent construction and finishes to remain
 - 1. Strengthen or add new supports when required during progress of selective demolition.
 - 2. Cease operations and notify the Owner's representative immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.
- B. Cover and protect furniture, equipment and fixtures to remain from soiling or damage when demolition work is performed in rooms or areas from which such items have not been removed.
- C. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes to occupied portions of the building.
 - 1. Where selective demolition occurs immediately adjacent to occupied portions of the building, construct dust-proof partitions of minimum 4" studs, 5/8" drywall (joints taped) on occupied side, 1/2" fire-retardant plywood on demolition side, and fill partition cavity with sound- deadening insulation.
 - 2. Provide weatherproof closures for exterior openings resulting from demolition work.
 - 3. Existing ceiling tiles shall be removed in accordance with the recommendations of the IAQA Mold Remediation Certification Program.
- D. Locate, identify, stub off and disconnect utility services that are not indicated to remain.
 - 1. Provide by-pass connections as necessary to maintain continuity of service to occupied areas of building. Provide minimum of 72 hours advance notice to Owner if shut-down of service is necessary during change-over.

3.3 DEMOLITION

- A. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on drawings in accordance with demolition schedule and governing regulations.
 - 1. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
 - a. Provide new lintels at new openings in existing masonry walls as indicated.
 - 2. Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors or framing.
 - 3. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.
 - 4. Demolish foundation walls to a depth of not less than 12" below existing ground surface. Demolish and remove below-grade wood or metal construction. Break up below-grade concrete slabs.
 - 5. For interior slabs on grade, use removal methods that will not crack or structurally disturb adjacent slabs or partitions. Use power saw where possible.
 - 6. Completely fill below-grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel or sand, free of trash and debris, stones over 6" diameter, roots or other organic matter.
- B. Upon encountering unanticipated mechanical, electrical or structural elements which conflict with intended function or design, investigate and measure both nature and extent of the conflict. Submit report to Owner's representative in written, accurate detail. Pending receipt of directive from Owner's representative rearrange selective demolition schedule as necessary to continue overall job progress without delay.

3.4 REFRIGERANT RECOVERY

- A. The Contractor shall have a licensed refrigerant recovery technician evacuate all refrigerants from all refrigeration equipment being removed in accordance with EPA guidelines and regulations. The Contractor shall take all necessary precautions to not accidentally vent refrigerants to the atmosphere. The refrigerant shall become the property of the Contractor.

3.5 SALVAGE MATERIALS

- A. Where indicated on drawings as "Salvage-Deliver to Owner," carefully remove indicated items, clean, store, and turn over to Owner and obtain receipt.
 - 1. Historic artifacts, including cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historic significance remain the property of the Owner. Notify Owner's representative upon encountering such items and obtain acceptance regarding method of removal and salvage for Owner.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove debris, rubbish, and other materials resulting from demolition operations from building site. Transport and legally dispose of materials off site.
 - 1. Upon encountering hazardous materials during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling and protection against exposure or environmental pollution.
 - 2. Burning of removed materials is not permitted on project site.

3.7 CLEAN-UP AND REPAIR

- A. Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and leave interior areas broom clean.
- B. Repair demolition performed in excess of that required. Return structures and surfaces to remain to condition existing prior to commencement of selective demolition work. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION

SECTION 051200

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. In general, the work included under this section consists of, but is not limited to, the following:
 - 1. Labor and materials to complete structural steel work indicated on the drawings and specified herein; see AISC Code of Standard Practice for definition of structural steel.
- C. Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.
 - 1. Promptly notify Architect/Engineer whenever design of members and connections for any portion of the structure are not clearly indicated.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Division 5 Section "Metal Fabrications."
 - 2. Metal work specified in the mechanical and electrical sections.

1.4 SUBMITTALS

- A. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
 - 1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
 - 2. High-strength bolts (each type), including nuts and washers.
 - 3. Structural steel primer paint.
- B. Shop Drawings: Submit shop drawings including complete details and schedules for fabrication and assembly of structural steel members, procedures and diagrams.
 - 1. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.

2. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.
 3. Substitutions of sections or modifications of details, or both, and the reasons therefore shall be submitted with the shop drawings. Said changes shall be accomplished at no additional cost to the Owner.
 4. Fabrication of any item prior to receipt of approved and/or reviewed shop drawings is the responsibility of the Contractor.
 5. Shop and erection drawings shall be reviewed and stamped by the Contractor prior to review by the Architect/Engineer. The General Contractor is responsible for errors in detailing, fabrication and the correct fitting of structural members.
- C. Test Reports: Submit copies of reports of tests conducted on shop and field bolted and welded connections. Include data of type(s) of tests conducted and test results.

1.5 QUALITY ASSURANCE

- A. Erector Qualifications: A qualified erector with a minimum of 5 years of experience on successful projects of similar construction.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Sbd.

or

- C. Fabricator Qualifications: A qualified fabricator who participates in a third party monitored Quality Control Program compliant with applicable provisions of AISC 360-10 and 2015 IBC, paragraph 1704.2.5.
- D. Before authorizing the commencement of steel erection, the Contractor shall ensure that the steel erector is provided with the written notification required by 29 CFR 1926.752. Provide copy of this notification to the Architect/Engineer.
- E. Codes and Standards: Comply with provisions of following, except as otherwise indicated:
1. AISC "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence: "This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as a part of his preparation of these shop drawings."
 2. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and supplements thereto as issued.
 3. AISC "Specifications for Architecturally Exposed Structural Steel."
 4. AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
 5. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel"
 6. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."

- F. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."
 - 1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
 - 2. If recertification of welders is required, retesting will be Contractor's responsibility.
- G. Fabrication Plant: Comply with applicable provisions in current building code regarding plant certifications, quality control programs and special inspections.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.
- B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not delay work.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- D. Do not store materials on structure in a manner that might cause distortion or damage to members of supporting structures. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metal Surfaces, General: For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.
- B. Structural Steel W-Shapes: ASTM A 992, $F_y = 50$ ksi.
- C. Structural Steel Angles, Channels, S-Shapes, M-Shapes, Plates and Bars: ASTM A 36, $F_y = 36$ ksi.
- D. Cold-Formed Steel Tubing: ASTM A 500, Grade B, $F_y = 46$ ksi.
- E. Hot-Formed Steel Tubing: ASTM A 501, $F_y = 36$ ksi.
- F. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501.
 - 1. Finish: Black, except where indicated to be galvanized.
- G. Steel Castings: ASTM A 27, Grade 65-35, medium-strength carbon steel.
- H. Headed Stud-Type Shear Connectors: ASTM A 108, Grade 1015 or 1020, cold finished carbon steel; with dimensions complying with AISC specifications.

- I. Anchor Bolts: ASTM F 1554, Grade 36, headed type unless otherwise indicated.
- J. Unfinished Threaded Fasteners: ASTM A 307, Grade A, regular low-carbon steel bolts and nuts.
 - 1. Provide hexagonal heads and nuts for all connections.
- K. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:
 - 1. Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A 325.
 - 2. Direct tension indicator washers may be used at Contractor's option.
- L. Electrodes for Welding: E70XX unless noted otherwise.
- M. Structural Steel Primer Paint: Rust-inhibitive zinc-chromate paint, fast curing, lead-free universal primer.

2.2 GROUT

- A. Nonshrink Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRD-C 621 and/or ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include but are not limited to the following:
 - a. "Euco N-S Grout"; Euclid Chemical Co.
 - b. "Masterflow 713"; Master Builders.
 - c. "SonogROUT"; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.
 - d. "Five Star Grout"; U.S. Grout Corp.

2.3 FABRICATION

- A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC specifications and as indicated on final shop drawings. Provide camber in structural members where indicated. Where new construction ties or relates to existing structures, the Contractor shall field verify all dimensions prior to fabrication of any framing members.
 - 1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
 - 2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
 - 3. Sheared and flame-cut edges shall be finished smoothly by grinding, chipping, or planing, the radii of re-entrant flame-cut fillets shall be not less than one inch and as much larger as practicable. Bearing plates of beams and girders shall have full contact with the flanges. The ends of stiffeners shall be milled or ground to secure an even bearing against the flange angles or shall be welded to the flanges and web. The corners of stiffener plates shall be cut to clear fillets of beams.

- B. Connections: Weld or bolt shop connections, as indicated. Connections not detailed on the drawings shall be designed for the reactions shown on the drawings, or, if reactions are not shown, the connections shall be designed for one-half the allowable uniformly distributed load on the member, based on the uniform load tables of the AISC Manual (Thirteenth Edition), plus two kips. Connections shall be designed in accordance with the recommendations given in the AISC Manual of Steel Construction, Thirteenth Edition. One-sided or other types of eccentric connections will be permitted only where indicated on the contract drawings or approved by the Architect/Engineer.
- C. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts."
- D. Welded Construction: Comply with AWS code for procedures, appearance and quality of welds, and methods used in correcting welding work. All welds shall be made with E70XX electrodes.
 - 1. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.
- E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Shop weld shear connectors, spaced as shown, to beams and girders in composite construction unless field welding is indicated. Use automatic end welding of headed stud shear connectors in accordance with manufacturer's printed instructions.
- F. All holes shall be cut, drilled, or punched perpendicular to metal surfaces. No hole shall be flame cut or enlarged by burning. Holes in bearing plates shall be drilled.
- G. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work where required or shown.

2.4 SHOP PAINTING

- A. General: Shop paint structural steel, except those members or portions of members to be embedded in concrete or mortar.
 - 1. Do not paint surfaces which are to be welded or high-strength bolted with friction-type connections.
 - 2. Do not paint surfaces which are scheduled to receive sprayed-on fireproofing.
 - 3. Apply 2 coats of paint to surfaces which are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- B. Surface Preparation: After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale, and spatter, slag or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows:
 - 1. SP-1 "Solvent Cleaning."
 - 2. SP-3 "Power Tool Cleaning."
- C. Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 1.5 mils. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces.

2.5 PAINT

- A. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that field measurements, surfaces, substrates, adjacent materials, supports and conditions are as required, and ready to receive Work. Where new construction ties or relates to existing structures, the Contractor shall field verify all dimensions prior to fabrication of any framing member.
- B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves and anchor bolts having integral anchors, which are to be embedded in concrete or masonry construction.
- C. Report in writing to Architect/Engineer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
- D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

- A. The erection of structural steel shall be in accordance with the applicable provisions of the AISC specification.
- B. Anchor bolts and anchors shall be properly located and built into connecting work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.
- C. The use of external force to pull beams or columns into alignment for attachment to anchor bolts will not be permitted as such force can cause cracking of masonry. Replace fabricated members or mis-aligned anchor bolts to insure a proper fit.
- D. Column base and bearing plates shall be provided under all columns and other members resting on walls, slabs, or piers. Base and bearing plates may be attached or loose, as approved on the shop drawings. Base plates and bearing plates shall be supported and lined on steel wedges and shims. After the supported members have been plumbed and properly positioned and the anchor nuts tightened, the entire bearing area under the plate shall be dry-packed solidly with non-shrinking grout. Wedges and shims shall be cut off flush with edges of columns and bearing plates, and shall be left in place. Leveling plates may be used at the Contractor's option.

- E. Provide temporary shoring or bracing members of sufficient strength to support imposed loads until such time as permanent members are connected in final position. Provide temporary guy lines to achieve proper alignment of structural steel as erection proceeds.
- F. Gas Cutting: The use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. The use of a gas-cutting torch will be permitted only on minor members, when the member is not under stress, and then only after the approval of the Architect/Engineer has been obtained.
- G. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting to provide minimum dry film thickness of 1.5 mils.
 - 1. Refer to Section 099113 for finish painting where any structural steel is exposed to view in the final state.
- H. Corrosion Protection: Coat the base of columns that extends below grade with a heavy coat of bituminous paint.

3.3 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
 - 2. Testing agency will visually inspect all structural connections.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. In addition to testing requirements listed below, structural steel inspections shall comply with applicable provisions of the International Building Code (IBC) Chapters 17 and 22.
- E. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".
 - 1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.
- F. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T".
 - 4. Ultrasonic Inspection: ASTM E 164.

- G. In addition to visual inspection, field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:
 - 1. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.

END OF SECTION

SECTION 055000

METAL FABRICATIONS

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. In general, the work to be performed under this section consists of, but is not limited to, the following:
 - 1. Miscellaneous framing and supports.
 - 2. Steel ladders.

1.3 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this section.
- B. Definitions in OSHA 1910.23 Fixed Ladders (Occupational Safety and Health Administration of The United States).

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 specification sections.
 - 1. Product data, including manufacturer's specifications, anchor details, and installation instructions for products used in miscellaneous metal fabrications, including paint products and grout.
 - 2. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.
 - a. Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified professional engineer who was responsible for their preparation.
 - 3. Samples representative of materials and finished products as may be requested by Architect/Engineer.

4. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel", "D1.3 "Structural Welding Code - Sheet Steel", and D1.2 "Structural Welding Code - Aluminum."
 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Engineering Qualifications: Professional engineer licensed to practice in jurisdiction where project is located and experienced in providing engineering services of the kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.
 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Steel Tubing: ASTM A 500, Grade B.

- D. Uncoated Structural Steel Sheet: Product type (manufacturing method), quality, and grade, as follows:
 - 1. Cold-Rolled Structural Steel Sheet: ASTM A 611, Grade A, unless otherwise indicated or required by design.
 - 2. Hot-Rolled Structural Steel Sheet: ASTM A 570, Grade 30, unless otherwise indicated or required by design loading.
- E. Uncoated Steel Sheet: Commercial quality, product type, (method of manufacture) as follows:
 - 1. Cold-Rolled Steel Sheet: ASTM A 366.
- F. Galvanized Steel Sheet: Quality as follows:
 - 1. Structural Quality: ASTM A 446; Grade A, unless another grade required for design loading, and G90 coating designation unless otherwise indicated.
 - 2. Commercial Quality: ASTM A 526, G90 coating designation unless otherwise indicated.
- G. Steel Pipe: ASTM A 53; Type F, standard weight (Schedule 40) finish as follows:
 - 1. Black finish, unless otherwise indicated.
 - 2. Galvanized finish for exterior installations.
- H. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
- I. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.
- J. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded.

2.2 FASTENERS

- A. General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.
- C. Lag Bolts: Square head type, FS FF-B-561.
- D. Machine Screws: Cadmium plated steel, FS FF-S-92.
- E. Wood Screws: Flat head carbon steel, FS FF-S-111.
- F. Plain Washers: Round, carbon steel, FS FF-W-92.
- G. Drilled-In Expansion Anchors: Expansion anchors complying with FS FF-S-325, Group VIII (anchors, expansion, [nondrilling]), Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF-B-575, Grade 5.
- H. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class, and style as required.
- I. Lock Washers: Helical spring type carbon steel, FS FF-W-84.

- J. Adhesive Anchors: Provide Hilti HIT HY epoxy system with screen tubes or an approved equal.

2.3 PAINT

- A. Shop Primer for Ferrous Metal: Manufacturer's or fabricator's standard, fast-curing, lead-free, universal modified alkyd primer selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure complying with performance requirements of FS TT-P-645.
- B. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight and complying with DOD-P-21035 or SSPC-Paint-20.
- C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12 except containing no asbestos fibers.
- D. Zinc Chromate Primer: FS TT-P-645.

2.4 FABRICATION

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Remove sharp or rough areas on exposed traffic surfaces.
- F. Weld corners and seams continuously to comply with AWS recommendations and the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

- H. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- I. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of jointed pieces. Clearly mark units for reassembly and coordinated installation.
- J. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide x 1/4 inch x 8 inches long.

2.6 STEEL LADDERS

- A. General: Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.
- B. Siderails: Continuous steel flat bars, 1/2 inch x 2-1/2 inches, with eased edges, spaced 20 inches apart.
- C. Bar Rungs: Bar channels 2" x 5/8" x 1/4" thickness, spaced 12 inches o.c.
- D. Support each ladder at top and bottom and at intermediate points spaced not more than 3'-0" o.c. by means of welded or bolted steel brackets.
 - 1. Size brackets to support total design load of 500 pounds and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.
 - 2. Extend side rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
- B. Finish metal fabrications after assembly.

2.8 STEEL AND IRON FINISHES

- A. Galvanizing:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick and heavier.
- B. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP6 "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA1 "Paint Application Specification No. 1" for shop painting.

2.9 ALUMINUM FINISHES

- A. Finish designations: Prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
- B. As Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
- C. Class I Clear Anodized Finish: AA-M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural: clear film thicker than 0.7 mil) complying with AAMA 607.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that field measurements, surfaces, substrates, adjacent materials, supports and conditions are as required, and ready to receive Work.
- B. Report in writing to Architect/Engineer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.3 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- E. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

3.4 ADJUSTING AND CLEANING

- A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

- B. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 061000

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Rooftop equipment bases and support curbs.
 - 2. Wood blocking, cants, and nailers.
 - 3. Wood furring and grounds.
 - 4. Wood sleepers.
 - 5. Utility shelving.
 - 6. Plywood backing panels.
 - 7. Window and door buck engineered framing system.
- B. Related Requirements:
 - 1. Section 313116 "Termite Control" for site application of borate treatment to wood framing.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
- C. Exposed Framing: Framing not concealed by other construction.
- D. OSB: Oriented strand board.
- E. Timber: Lumber of 5 inches nominal size or greater in least dimension.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 1. Wood-preservative-treated wood.
 2. Fire-retardant-treated wood.
 3. Engineered wood products.
 4. Shear panels.
 5. Power-driven fasteners.
 6. Post-installed anchors.
 7. Metal framing anchors.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

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, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber 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. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.
- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all rough carpentry unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Treatment shall not promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat items indicated on Drawings, and the following:
 1. Framing for raised platforms.
 2. Framing for stages.
 3. Concealed blocking.
 4. Roof construction.
 5. Plywood backing panels.

2.4 ENGINEERED WOOD PRODUCTS

- A. Source Limitations: Obtain each type of engineered wood product from single source from a single manufacturer.
- B. Window and Door Buck Engineered Framing System:
 1. Basis-of-Design: PreBuck, 2555 28th St. SW: Wyoming, MI 49519 – StrandGuard TimberStrand LSL 1.30E Engineered Lumber by PreBuck Engineered Framing Systems
 2. Meets AWPA U1-15 for Use Category 2 (UC2).
 3. NAHB Research Center Green Approved.
 4. MDI resin, 100 percent waterproof when cured.
 5. Treated with zinc borate through complete cross section.
 6. Typical material 1-1/2 inches thick; built-up as required.
 7. Metal flange, 1-1/2 inch x 1-1/2 inch, 20 gauge galvanized metal, as applicable.
 8. Fasteners: 3-4 16D nails, minimum, each corner.
 9. Two continuous dovetail keyways at entire perimeter to eliminate air infiltration.
 10. Non-obstructive with insulated concrete forming (ICF) web.
 11. Unit self-aligns on wall.
 12. Acceptable for direct contact with concrete, non-corrosive to metals, insect and fungi resistive.
 13. Materials: StrandGuard TimberStrand LSL 1.30E Engineered Lumber, ICC ESR-1387.
 - a. Treatment: Zinc borate through complete cross section.
 - b. Bending Strength: 1900 psi.
 - c. Tensile Strength: 1075 psi.
 - d. Shear Strength: 150 psi.
 - e. Compression – Perpendicular to Grain: 670 psi.
 - f. Specific Gravity: 0.50 into the face, 0.42 into the edge.
 - g. R-value of 1-1/2 inch thickness: 1.86.

2.5 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.
 - 5. Furring.
 - 6. Grounds.
 - 7. Utility shelving.
- B. Dimension Lumber Items: Construction or No. 2 Standard, Stud, or No. 3 grade lumber of the following species:
 - 1. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
 - 2. Eastern softwoods; NeLMA.
- C. Utility Shelving: Lumber with 15 percent maximum moisture content of the following species and grades:
 - 1. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- D. Concealed Boards: 15 percent maximum moisture content and the following species and grades:
 - 1. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 - 2. Eastern softwoods; No. 2 Common grade; NeLMA.
- E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

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

2.7 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.8 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.
- C. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

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 rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, 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. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

- F. Do not splice structural members between supports unless otherwise indicated.
- G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- H. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
 - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- I. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- J. Comply with AWPAC M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- K. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- L. Securely attach rough 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 (IBC).
 - 2. ICC-ES evaluation report for fastener.
- M. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal-size furring horizontally at 24 inches o.c.

3.4 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.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 075323

ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

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. Adhered ethylene-propylene-diene-terpolymer (EPDM) roofing system.
 - 2. Vapor retarder.
 - 3. Roof insulation.
 - 4. Cover board.
 - 5. Walkways.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
 - 3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.

7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. For insulation and roof system component fasteners/adhesives, include copy of SPRI's Directory of Roof Assemblies listing.
- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
 1. Layout and thickness if insulation.
 2. Base flashings and membrane terminations.
 3. Flashing details at penetrations.
 4. Tapered insulation, thickness, and slopes.
 5. Roof plan showing orientation of steel roof deck and orientation of roof membrane and adhesive spacings and patterns for adhered roofing system.
- C. Samples for Verification: For the following products:
 1. Roof membrane and flashings of color required.
 2. Walkway pads or rolls, of color required.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates:
 1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of complying with performance requirements.
 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- C. Product Test Reports: For components of roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
- D. Evaluation Reports: For components of roofing system, from ICC-ES.
 1. Field Test Reports.
 2. Concrete internal relative humidity test reports.
 3. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
- E. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.
- B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.9 DELIVERY, STORAGE, AND HANDLING

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

1.10 FIELD CONDITIONS

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

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
 - 1. Special warranty includes roofing membrane, base flashings, roofing accessories, roof insulation, fasteners, cover boards, and other components of membrane roofing system.

2. Warranty Period: 20 years from date of Substantial Completion.
 3. Warranty wind speed coverage shall be 90 mph ground wind speed (measured at 10 meters above grade). Wind speed shall be noted on warranty.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, vapor retarders, and walkway products, for the following warranty period:
1. Warranty Period: Two years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and flashings shall remain watertight.
1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D 3746, ASTM D 4272, or the Resistance to Foot Traffic Test in FM Approvals 4470.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
1. Fire/Windstorm Classification: Class 1A-90.
 2. Hail-Resistance Rating: MH.
- D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING

- A. EPDM Sheet: ASTM D 4637/D 4637M, Type I, nonreinforced, EPDM sheet with factory-applied seam tape.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.

- c. Johns Manville; a Berkshire Hathaway company.
- d. Versico Roofing Systems.
- 2. Thickness: 60 mils, nominal.
- 3. Exposed Face Color: Black.
- 4. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

2.3 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: 60-mil-thick EPDM, partially cured or cured, according to application.
- C. Slip Sheet: Manufacturer's standard, of thickness required for application.
- D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- E. Roof Vents: As recommended by roof membrane manufacturer.
 - 1. Size: Not less than 4-inch diameter.
- F. Bonding Adhesive: Manufacturer's standard.
- G. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch-wide minimum, butyl splice tape with release film.
- H. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.
- I. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening components to substrate, and acceptable to roofing system manufacturer.
- K. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.4 VAPOR RETARDER

- A. Adhered Vapor barrier – 40 mil thick composite consisting of 35-mil self adhering rubberized asphalt membrane laminated to a 5-mil UV resistant poly film with an anti-skid surface compatible with manufacturer's low rise adhesive, or manufacturer's laminated vapor barrier of equivalent thickness approved for use over fluted metal deck.
 - 1. Install over primed deck with low-VOC, methylene chloride-free adhesive primer.

2.5 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM roof membrane manufacturer, approved for use in FM Approvals' RoofNav-listed roof assemblies.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 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. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. GAF.
 - d. Johns Manville; a Berkshire Hathaway company.
 - 2. Compressive Strength: 20 psi.
 - 3. Size: 48 by 48 inches.
 - 4. Thickness:
 - a. Base Layer: 2-1/2 inches
 - b. Minimum System R-Value: 30.
- C. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4 inch.
 - 3. Slope:
 - a. Roof Field: 1/8 inch per foot unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.6 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 - a. Apply at 12" on center maximum. Coordinate with manufacturer's requirements for required spacings less than 12" o.c.
 - b. Provide primer coat compliant with manufacturer's instructions.
- C. Insulation (Coverboard):
 - 1. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C 1289, Type II, Class 4, Grade 1 and with the following characteristics:
 - a. Board Size: 48 x 96 inch.
 - b. Board Thickness: 1/2 inch.
 - c. Thermal Resistance: R-value of 2.9.
 - d. Board Edges: Square.
 - e. Manufacturers:
 - 1) Firestone Building Products Co.; : www.firestonebpco.com
 - 2) Carlisle SynTec: www.carlisle-syntec.com

- 3) GenFlex Roofing Systems; : www.genflex.com
- f. Substitutions: See Section 012500 - Substitution Procedures.

2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
 - 1. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.
- D. Prep and prime existing deck as required for compliance with manufacturer's system requirements for adhered roofing systems.

3.4 VAPOR RETARDER INSTALLATION

- A. Self-Adhering-Sheet Vapor Retarder: Prime substrate using Contact Adhesive/Primer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
 - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
 - 2. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.5 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Adhesive Attachment:
 - 1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows.
 - a. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - b. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - c. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - d. Fill gaps exceeding 1/4 inch with insulation.
 - e. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - f. Adhere base layer of insulation using Urethane Adhesive Bead. Bead spacing shall be as required for Warranty Coverage. Install adhesive bead so that the distance from the edge of the board does not exceed half the bead spacing.
 - 1) Check to ensure the substrate is clean, free of debris, and other contaminants, and dry. Adhesive cannot be applied to a wet or damp surface.
 - 2) Apply adhesive over the dry substrate area at the coverage rates indicated by the manufacturer's requirements.
 - 3) Allow adhesive to rise up approximately 1/8" and develop strings prior to setting insulation boards into adhesive.
 - 4) Walk the boards into the adhesive and roll using the 30" wide, 150 pound segmented steel roller to ensure full embedment.
 - 1. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.

- d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
- e. Trim insulation so that water flow is unrestricted.
- f. Fill gaps exceeding 1/4 inch with insulation.
- g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- h. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
 - 1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
 - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
 - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
 - 4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
 - a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 ADHERED ROOFING INSTALLATION

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll membrane roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel and Owner's testing and inspection agency.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeters.
- G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

- H. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement.
 - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 - 2. Apply lap sealant and seal exposed edges of roofing terminations.
 - 3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.
- I. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape.
 - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 - 2. Apply lap sealant and seal exposed edges of roofing terminations.
- J. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- K. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
- L. Adhere protection sheet over roof membrane at locations indicated.

3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.
 - 1. Install flexible walkways at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.

- e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
- f. Locations indicated on Drawings.
- g. As required by roof membrane manufacturer's warranty requirements.
- 2. Provide 6-inch clearance between adjoining pads.
- 3. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Owner will engage a qualified testing agency to perform the following tests:
 - 1. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - a. Perform tests before overlying construction is placed.
 - b. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
 - c. Flood each area for 24 hours.
 - d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - e. Testing agency shall prepare survey report indicating locations initial leaks, if any, and final survey report.
 - 2. Testing agency shall prepare survey report indicating locations of initial discontinuities, if any.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 076200

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 CONDITIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.
- B. In general, the work included under this section consists of, but is not limited to, the following:
 - 1. Flashing.
 - 2. Exposed trim.

1.3 RELATED WORK

- A. In general, the following related work is included in other sections of the specifications:
 - 1. Division 7 Section "Joint Sealants" for elastomeric sealants.
 - 2. Division 7 Roofing Sections for flashing and roofing accessories installed integral as part of roofing-system work.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 specification sections.
- B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
- C. Samples of sheet metal flashing trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
 - 1. 8-inch-square Samples of specified sheet materials to be exposed as finished surfaces.

2. 12-inch-long Samples of factory-fabricated products exposed as finished Work. Provide complete with specified factory finish.

- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.7 PROJECT CONDITIONS

- A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 METALS

- A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:
 1. Anodized Aluminum Sheet: ASTM B 209, 5005-H14, with a minimum thickness of 0.050 inch.
 2. Factory-Painted Aluminum Sheet: ASTM B 209, 3003-H14, with a minimum thickness of 0.040 inch, unless otherwise indicated.
- B. Stainless-Steel Sheet: ASTM A 167, Type 304, soft annealed, with No. 2D finish, except where harder temper is required for forming or performance; minimum 0.0187 inch thick, unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Solder for Stainless Steel: ASTM B 32, Grade Sn60, used with an acid flux of type recommended by stainless-steel sheet manufacturer; use a noncorrosive rosin flux over tinned surfaces.
- B. Stainless-Steel Welding Rods: Type recommended by stainless-steel sheet manufacturer for type of metal sheets furnished.
- C. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.

- D. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coat.
- E. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
- F. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."
- G. Epoxy Seam Sealer: 2-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior and interior nonmoving joints, including riveted joints.
- H. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.
- I. Paper Slip Sheet: 5-lb/square red rosin, sized building paper conforming to FS UU-B-790, Type I, Style 1b.
- J. Polyethylene Underlayment: ASTM D 4397, minimum 6-mil-thick black polyethylene film, resistant to decay when tested according to ASTM E 154.
- K. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.
- L. Roofing Cement: ASTM D 4586, Type I, asbestos free, asphalt based.

2.3 FABRICATION, GENERAL

- A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
- B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
- D. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams, tin edges to be seamed, form seams, and solder.
- E. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- F. Expansion Provisions: Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form

expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

- G. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- H. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
- I. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
- J. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
 - 1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.4 SHEET METAL FABRICATIONS

- A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.
- B. Base Flashing: Fabricate from one of the following materials:
 - 1. Aluminum: 0.050 inch thick.
- C. Flashing Receivers: Fabricate from one of the following materials:
 - 1. Aluminum: 0.050 inch thick.
- D. Plumbing Vents and Support Piping: Pre-molded pipe boot flash as recommended by membrane manufacturer.

2.5 ALUMINUM FINISHES

- A. General: Comply with Aluminum Association's (AA) "Designation System for Aluminum Finishes" for finish designations and application recommendations.
- B. Class I, Clear Anodic Finish: AA-C22A41 (Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.
- C. High-Performance Organic Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.
 - 1. Fluoropolymer 2-Coat Coating System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2

- a. Color and Gloss: As selected by Architect from manufacturer's full range of choices for color and gloss.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that field measurements, surfaces, substrates, adjacent materials, supports and conditions are as required, and ready to receive Work.
- B. Report in writing to Architect/Engineer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

- A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
- B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Prein edges of sheets to be soldered to a width of 1-1/2 inches, except where pretinned surface would show in finished Work.
 1. Do not solder the following metals:
 - a. Aluminum.
 2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

- E. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.
 - 1. Use joint adhesive for nonmoving joints specified not be soldered.
- F. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- G. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- H. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.
 - 2. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.
- I. Roof-Drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation.
- J. Install plumbing vent flashing as recommended by the membrane manufacturer.

3.3 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
- B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION

SECTION 078413

PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
 - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
- B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the

necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hilti, Inc.
 - 2. 3M Fire Protection Products.
 - 3. Tremco, Inc.; Tremco Fire Protection Systems Group.

2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire-barrier walls.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Collars.
 - 3. Steel sleeves.

2.3 FILL MATERIALS

- A. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- B. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

- C. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

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

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3.4 CLEANING AND PROTECTION

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

3.5 PENETRATION FIRESTOPPING SCHEDULE

- A. Firestopping with No Penetrating Items:
 1. UL-Classified Systems: W-J- W-L- 0001-0999.
 2. F-Rating: 1 hour or 2 hours.
 3. Type of Fill Materials: As required to achieve rating.
- B. Firestopping for Metallic Pipes, Conduit, or Tubing:
 1. UL-Classified Systems: W-J- W-L- 1001-1999.
 2. F-Rating: 1 hour or 2 hours.
 3. Type of Fill Materials: As required to achieve rating.
- C. Firestopping for Nonmetallic Pipe, Conduit, or Tubing:
 1. UL-Classified Systems: W-J- W-K- W-L- 2001-2999.
 2. F-Rating: 1 hour or 2 hours.
 3. Type of Fill Materials: As required to achieve rating
- D. Firestopping for Electrical Cables:
 1. UL-Classified Systems: W-J- W-K- W-L- 3001-3999.
 2. F-Rating: 1 hour or 2 hours.
 3. Type of Fill Materials: As required to achieve rating.
- E. Firestopping for Insulated Pipes:
 1. UL-Classified Systems: W-J- W-L- 5001-5999.
 2. F-Rating: 1 hour or 2 hours.
 3. Type of Fill Materials: As required to achieve rating.
- F. Firestopping for Miscellaneous Electrical Penetrants:
 1. UL-Classified Systems: W-L- W-J- 6001-6999.
 2. F-Rating: 1 hour or 2 hours.
 3. Type of Fill Materials: As required to achieve rating.

- G. Firestopping for Miscellaneous Mechanical Penetrants:
 - 1. UL-Classified Systems: W-J- W-L- 7001-7999.
 - 2. F-Rating: 1 hour or 2 hours.
 - 3. Type of Fill Materials: As required to achieve rating.

- H. Firestopping for Groupings of Penetrants:
 - 1. UL-Classified Systems: W-J- W-L- 8001-8999.
 - 2. F-Rating: 1 hour or 2 hours.
 - 3. Type of Fill Materials: As required to achieve rating.

END OF SECTION

SECTION 079200

JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Mildew-resistant joint sealants.
 - 4. Butyl joint sealants.
 - 5. Latex joint sealants.
 - 6. Security Sealants

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.

2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

D. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with stone masonry substrates.
 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
 5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
 7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

1.7 FIELD CONDITIONS

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

1.8 WARRANTY

- A. Special Installer's Warranty: 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.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 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; Dow Corning® 791 Silicone Weatherproofing Sealant.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2000 SilPruf.
 - c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 265 LTS.
 - d. Pecora Corporation; PCS
 - e. Sika Corporation; Joint Sealants; Sikasil WS-295

- B. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 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; DOW CORNING® 999A SILICONE GLAZING SEALANT.
 - b. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 100 GC
 - c. Pecora Corporation; Pecora 860.
 - d. Polymeric Systems, Inc; PSI-601.
 - e. Sika Corporation; Joint Sealants; Sikasil-GP.

2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 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. BASF Corp. - Construction Chemicals; MasterSeal TX 1 (Pre-2014: Sonolastic TX1)
 - b. Bostik, Inc; Chem-Calk GPS1
 - c. ER Systems; an ITW Company; Pacific Polymers Elasto-Thane 230 MP.
 - d. Pecora Corporation; Dynatrol I-XL.
 - e. Polymeric Systems, Inc; Flexiprene 1000.
 - f. Schnee-Morehead, Inc., an ITW company; Permthane SM7108.
 - g. Sika Corporation; Joint Sealants; Sikaflex Textured Sealant.
 - h. Tremco Incorporated; Dymonic.
- B. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Use NT.
 - 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. Pecora Corporation; Dynatrol II.

2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

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; DOW CORNING® 786 SILICONE SEALANT -.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
 - c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 100 WF.
 - d. Pecora Corporation; Pecora 860.
 - e. Tremco Incorporated; Tremsil 200.

2.5 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.
 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. Bostik, Inc; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.

2.6 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 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. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - b. Pecora Corporation; AC-20
 - c. Tremco Incorporated; Tremflex 834.

2.7 SECURITY SEALANTS (PICK PROOF, PICK RESISTANT)

- A. General: Provide manufacturer's standard one-part, nonsag, mildew-resistant, paintable, pick-proof/resistant sealant of formulation that is recommended for application on interior locations subject to impact and tamper.
 1. Basis-of-Design Product: SureBond SB-190

2.8 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 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. BASF Construction Chemicals, LLC, Building Systems.
 - b. Construction Foam Products, a division of Nomaco, Inc.

- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining

after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

- a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
 - 4. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 - 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 - 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone cladding.
 - d. Joints in exterior insulation and finish systems.
 - e. Joints between metal panels.
 - f. Joints between different materials listed above.
 - g. Control and expansion joints in ceilings and other overhead surfaces.
 - h. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, S, NS, 25, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, S, P, 25, T, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry.

- d. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, S, NS, 25, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
- 1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Acrylic latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
- 1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Joint-Sealant Application: Concealed mastics.
- 1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Butyl-rubber based.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

SECTION 083113

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.
- B. Related Requirements:
 - 1. Section 077200 "Roof Accessories" for roof hatches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches in size.
- C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:

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. Babcock-Davis.
 - b. Larsens Manufacturing Company.
 - c. Nystrom, Inc.
2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As Indicated on Drawings.
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory finished.
6. Frame Material: Same material, thickness, and finish as door.
7. Latch and Lock: Latch bolt, key operated with interior release.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

- A. Fire-Rated, Flush Access Doors with Exposed Flanges:
 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. Babcock-Davis.
 - b. Larsens Manufacturing Company.
 - c. Nystrom, Inc.
 2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with exposed flange, self-closing door, and concealed hinge.
 3. Locations: Wall and ceiling.
 4. Door Size: As Indicated on Drawings.
 5. Fire-Resistance Rating: Not less than that indicated that of adjacent construction.
 6. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage, factory finished.
 7. Frame Material: Same material, thickness, and finish as door.
 8. Latch and Lock: Self-latching door hardware, operated by key with interior release.

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- E. Aluminum Extrusions: ASTM B 221, Alloy 6063.

- F. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- G. Frame Anchors: Same material as door face.
- H. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 - 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
 - 1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" 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.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.
 - a. Color: As selected by Architect from full range of industry colors.
- E. Stainless-Steel Finishes:
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finish: No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

SECTION 084113

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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. Exterior storefront framing.
- B. Related Sections:
 - 1. Section 084513 "Translucent Polycarbonate Window Systems."
 - 2. Section 088000 "Glazing."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

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.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

- C. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.

- e. Failure of operating components.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
- 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- B. Structural Loads:
- 1. Wind Loads: As indicated on Drawings.
- C. Deflection of Framing Members: At design wind pressure, as follows:
- 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.

- D. Structural: Test according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- E. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
 - 1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
- F. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
- G. Energy Performance: Certify and label energy performance according to NFRC as follows:
 - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.38 Btu/sq. ft. x h x deg F as determined according to NFRC 100, and 0.45 Btu/sq. ft. at operable units.
 - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
 - 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 15 as determined according to NFRC 500.
- H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 - 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - c. Interior Ambient-Air Temperature: 75 deg F.

2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide EFCO Corp series 403X (X Therm) 2"x 4 1/2" (exterior) or comparable product by one of the following:
 - 1. EFCO Corporation.
 - 2. Kawneer North America.
 - 3. Tubelite.
 - 4. United States Aluminum.

- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing accessories, from single manufacturer.

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: Thermally broken.
 - 2. Glazing System: Retained mechanically with gaskets on four sides.
 - 3. Glazing Plane: Center.
 - 4. Finish: High performance organic.
 - 5. Fabrication Method: Field-fabricated stick system.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.

2.4 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.5 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.6 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- D. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- E. Storefront Framing: Fabricate components for assembly using shear-block or screw spline system.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

- A. Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- B. Colors shall be selected from manufacturer's full range of anodized colors.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 088000 "Glazing."
- G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION

SECTION 084513

TRANSLUCENT POLYCARBONATE WINDOW SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for translucent window system as shown and specified herein.

1.2 WORK INCLUDED

- A. Design, engineer, manufacture and installation of translucent window system.
- B. All anchors, brackets, and hardware attachments necessary to complete the specified structural assembly, weatherability, and water-tightness performance requirements. All flashing up to but not penetrating adjoining work are also required as part of the system and shall be included.
- C. Trained and factory authorized labor and supervision to complete the entire panel installation.

1.3 RELATED WORK ELSEWHERE

- A. Sheet Metal and Flashing, Division 7
- B. Sealant, Division 7

1.4 QUALITY ASSURANCE

- A. The glazing panels must be evaluated and listed by recognized building code evaluation organization: International Council Evaluation Service Inc (ICC-ES).
- B. Materials and products shall be manufactured by a company continuously and regularly employed in the manufacturing, engineering, and designing, stocking and building of unitized translucent window/walls.
- C. Erection shall be by an installer who has been in the business of erecting similar material and can show evidence of satisfactory completion of projects of similar size, scope, and type.
- D. The manufacturer shall be responsible for the configuration and fabrication of the complete panel system, in accordance with the requirements of this specification.

1.5 SUBMITTALS

- A. Submit Shop drawings and color samples in accordance with Section 0133000.

- B. Manufacturer shall submit written guarantee accompanied by substantiating data, stating that the products to be furnished are in accordance with or exceed these specifications.
- C. Manufacturer shall submit full warranty and sales terms and conditions for verification of compliance with the requirements of this specification.
- D. Submittal: For glazing assemblies to comply with performance requirements and design criteria, include analysis data signed and sealed by a professional engineer licensed in the state of the project's location.
- E. The manufacturer shall submit certified test reports made by an independent organization. Reports shall verify that the material will meet all performance requirements of this specification. Previously completed reports will be acceptable if they are indicative of the products used on this project. Test reports required are:
 - 1. Self-Ignition Temperature (ASTM 1929-3).
 - 2. Burning Extent (ASTM D-635).
 - 3. Smoke Density (ASTM E-84).
 - 4. Interior Flame Spread (ASTM E-84).
 - 5. Color Difference (ASTM D-2244).
 - 6. Tests on a weathered glazing after approximately 10 years of actual exposure in Florida field conditions. Test shall include:
 - a. Uniform Static Air Pressure (ASTM E-330).
 - b. Impact Loading (ASTM E-695).
 - c. Cyclic Static Air Pressure and Missile Impact Level D (ASTM 1886 & E-1996).
 - 7. Weather evaluation before and after exposure to 300°F for 25 minutes. Include light transmission and color change (ASTM E-1175 and ASTM D-2244, respectively).
 - 8. Insulation U-Value for Center of Glazing (ASTM C1363).
 - 9. Insulation U-Value for System, glazing and aluminum framing (NFRC-100 and 700 Certification).
 - 10. Visible Light Transmission (VT) (ASTM E-972 and NFRC 202).
 - 11. Solar Heat Gain Coefficient (SHGC) based on tests or calculations which are based on tests per methodology and procedure given in the NFRC/Calorimeter Standard.
 - 12. Water Penetration (ASTM E-331).
 - 13. Structural Performance by Uniform Load (ASTM E-330).
 - 14. Cyclic static air pressure and Missile Impact Level D for exterior windows and curtain walls (ASTM 1886 & E-1996).
 - 15. Haze for glare measurement (ASTM D-1003).
 - 16. ICC Evaluation Service Report (ICC-ESR) for compliance with IBC Building Code.
 - 17. Sound Transmission Loss (STC) per ASTM E413
 - 18. Environmental Product Declaration (EPD) for submitted product with Life Cycle Assessment (LCA), Product Category Rule ISO 21930, Independent verification (external) ISO 14025

1.6 MAINTENANCE DATA

- A. The manufacturer shall provide recommended maintenance procedures, schedule of maintenance and materials required or recommended for maintenance.
- B. Submit installer certificate signed by installer, certifying compliance with project qualification requirements.

1.7 WARRANTY

- A. Provide a single source translucent window systems manufacturer warranty against defective materials and fabrication. Submit manufacturer's written warranty agreeing to repair failures in materials within 10 years from date of Substantial Completion.
- B. Provide the following single source translucent window manufacturer glazing warranties. Third party warranties shall not be acceptable. All warranties shall be maintained without any system maintenance requirements of the owner's responsibility. The expected humidity of the enclosed space shall not affect warranty length.
 - 1. Provide a lifetime warranty for both interior and exterior glazing covering:
 - a. Delamination of the glazing from the internal structure.
 - b. Fiberbloom; development of a rough exterior surface.
 - 2. Provide a ten (10) warranty on the interior glazing covering:
 - a. Change in light transmission of no more than 6% per ASTM D-1003.
 - b. Color stability: interior glazing shall not change color more than 6 CIE Units DELTA E by ASTM D-2244.
 - 3. Provide a ten (10) year warranty on the exterior glazing covering:
 - a. Change in light transmission of no more than 6% per ASTM D-1003.
 - b. Color stability: exterior glazing shall not change color more than 6 CIE Units DELTA E by ASTM D-2244.
 - 4. Blue light spectrum (400-470nm) measured in accordance with ASTM E-1175 shall not decrease by no more than 6% after ten years in comparison with the original value.
- C. In addition, submit installer's written warranty agreeing to repair installation workmanship, defects and leaks within one year from date of delivery.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis of design Product
 - 1. The design and performance criteria of this job are based on the UniQuad Translucent Window– pre-fabricated, pre-assembled glazing, system as manufactured by Kingspan Light + Air | Architectural Daylighting.
- B. Approved Manufacturers
 - 1. Other manufacturers may bid this project provided they comply with all requirements of the specification and submit evidence of compliance with all performance criteria specified herein. This evidence must include proof of conformance and test reports per section 1.5. Any exceptions taken from this specification must be noted on the approval request. If no exceptions are noted and approval is given, product performance will be as specified.
 - 2. Listing manufacturers names in this specification does not constitute approval of their products or relieve them of compliance with all the performance and design requirements contained herein. Other manufacturers which may provide products complying with the specifications are as follows:
 - a. Major Industries
 - b. Duo-Gard Industries.

2.2 TRANSLUCENT WINDOW PERFORMANCE AND APPEARANCE

- A. Glazing construction for longevity and resistance to buckling and pressure
 - 1. Translucent glazing must be constructed of tight cell sizes not exceeding 0.18". Wide cells of size greater than 0.18" shall not be acceptable.
- B. Translucent glazing assemblies – Unitized Double Glazed
 - 1. Design, engineer, manufacture, and installation of unitized double-glazed translucent window system. An assembly of two independent insulated glazing panes in one integrated assembly, incorporated into a complete aluminum frame system that has been tested and warranted by the manufacturer as a single source system. Design shall provide for the replacement of the exterior glazing, independently of the interior glazing without exposing the building's interior or compromising the weather tightness of interfering with the normal working functions of the building. Single pane glazing systems are not acceptable.
 - 2. Overall glazing assembly thickness shall be a minimum 2.75", with two glazing panes and concealed interlocking connector. Thickness of the exterior and interior glazing shall be minimum 8mm thick each.
- C. Thermal and Solar Performance
 - 1. To ensure Energy Code compliance, product U-Values must be listed in the NFRC Product Directory and have a Certified Product Directory (CPD) number.
 - a. Basis of Design CPD Number: UQTW
 - 2. Center of glazing U-Value per NFRC 100: Maximum .25.
 - 3. System U-Value per NFRC 100 and 700: Maximum .30.
 - 4. Visible Light Transmission – Center of Glass (VT%) 20% max Per ASTM E-972 and NFRC 202.
 - 5. Solar Heat Gain Coefficient -Center of glass (SHGC) 0.40 max, per NFRC 201.
 - 6. Haze measurement minimum of 90% per ASTM D-1003.
 - 7. Standard exterior glazing color: As Selected by Architect from Manufacturer's Full range.
 - 8. Standard interior glazing color: As Selected by Architect from Manufacturer's Full range.
- D. Translucent Glazing Joint System
 - 1. Water penetration: no water penetration of the glazing joint connection length at test pressure of 6.24 PSF [Optional: 15 PSF] per ASTM E-331.
 - 2. Air Infiltration: pass requirements of NFRC 400 at 1.57 PSF and 6.24 PSF.
 - 3. Air Exfiltration: pass requirements of NFRC 400 at 1.57 PSF and 6.24 PSF.
 - 4. Free movement of the glazing shall be allowed to occur without damage to the weather tightness of the completed system.
 - 5. The glazing joint shall comply with the deflection limitation of IBC Table 1604.3 for exterior walls with flexible finishes – L/120 per IBC.
- E. Flammability
 - 1. Exterior Glazing
 - a. Class CC1 fire rating classification per ASTM D-635. Square foot and separation limitations provided in IBC Table 2607.4, any light transmitting plastic of a CC2 fire classification rating is specifically dis-allowed.
 - b. Class A interior flame spread per ASTM E-84
 - c. Flame spread no greater than zero (0) and smoke density no greater than 110 per ASTM E-84.
 - d. Minimum self-ignition temperature of 1120° per ASTM 1929.

2. Interior Glazing
 - a. Class CC1 fire rating classification per ASTM D-635. Square foot and separation limitations provided in IBC Table 2607.4, any light transmitting plastic of a CC2 fire classification rating is specifically dis-allowed.
 - b. Class A interior flame spread per ASTM E-84
 - c. Flame spread no greater than zero (0) and smoke density no greater than 110 per ASTM E-84.
 - d. Minimum self-ignition temperature of 1120° per ASTM 1929.
- F. Impact Resistance
 1. Minimum Impact loading of 500 ft. lbs. per ASTM E-695.
 2. Must comply with standard specification for performance of exterior windows or curtain walls when impacted by windborne debris at level D and after cyclic wind loading at the specified design load (ASTM E1996-02).
- G. Weatherability
 1. The light transmission shall not decrease more than 6% as measured by ASTM D-1003 over 10 years, or after exposure to temperature of 300° for 25 minutes (thermal aging performance standard).
 2. The weathering performance should be justified by successful testing of the glazing's performance after exposure to actual Florida weather conditions for approximately 10 years in comparison to a new glazing assembly. This performance must be demonstrated by providing independent lab test reports for the exposed and a new panel assembly for the following tests; test results must show that there is no deterioration in performance for the 10 year's exposed panels versus new:
 - a. Uniform static air pressure per ASTM E-330 at negative load of -105 PSF and positive load of 130 PSF.
 - b. Impact loading of 500 ft.lbs. per ASTM E-695.
 - c. Cyclic static air pressure at 65 PSF and impact lever D per ASTM 1886 and ASTM E-1996.
 3. Glazing must be manufactured with a permanent, co-extruded ultra-violet protective layer. Post-applied coatings or films of dissimilar materials that need to be maintained are unacceptable.
 4. Glazing shall not become readily detached when exposed to temperatures of 300°F and 0°F for 25 minutes.
 5. Thermal aging – the interior and exterior glazing shall not change color in excess of 0.75 Delta E per ASTM D-2244 and shall not darken more than 0.3 units Delta L per ASTM D-2244 and shall allow no cracking or crazing when exposed to 300°F for 25 minutes.
 6. Glazing shall be factory sealed to restrict dirt ingress.

2.3 METAL FRAME STRUCTURE

- A. Design criteria shall be per ASCE-7 requirements.
- B. The wall light framing is designed to be self-supporting between the support constructions. The deflection of the system framing members in a direction normal to the plane of the glazing, when subjected to a uniform load deflection, shall not exceed L/120 for the unsupported span per IBC Table 1604.3. All adjacent and support construction must support the transfer of all loads included horizontal and vertical, exerted by the system. Design or structural engineering services for the

supporting structure or building components in not included in the translucent window scope of this section

- C. All window system aluminum framing exposed to the exterior shall be thermally broken.
- D. Water penetration: the translucent window system shall allow no water penetration at a minimum differential static pressure of 6.24 PSF per AAMA 501 pressure difference recommendations and as demonstrated by prior testing of typical framing sample per ASTM E-331
- E. Water test of meal frame structure shall be conducted according to procedures in AAMA 501.2.

2.4 METAL MATERIALS

- 1. Extruded aluminum shall be ANSI/ASTM B-221; 6063-T6 or 6005-T5.
- 2. Flashing:
 - a. 5005 H34 Aluminum .040" thick
 - b. Sheet metal sill flashings are to be furnished shop formed to profile - when lengths exceed 10ft, provide in nominal 10ft lengths. Field trimming of the flashing and field forming the ends is necessary to suit as-built conditions. Sheet metal ends are to overlap at least 6in to 8in, set in a full bed of sealant and riveted if required.
- B. All fasteners for aluminum framing to be stainless steel or cadmium plated steel, excluding the final fasteners to the building.
- C. All exposed ALUMINUM FINISH shall be from manufacturer standard color range:
 - 1. Options as follows:
 - a. PREMIUM PLUS 70% base resin PVDF wet paint per AAMA-2605 non-exotic, non-metallic with 20 year warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. General contractor to verify when structural support is ready to receive all work in the section and to convene a pre-installation conference at least one week prior to commencing work of this section. Attendance required of the general contractor, translucent window installer and all parties affecting and effected by the work of this section.
- B. All submitted opening sizes, dimensions and tolerances are to be field verified by the general contractor unless otherwise stipulated.
- C. Installer shall examine area of installation to verify readiness of site conditions. Notify the general contractor about any defects requiring correction. Do not work until conditions are satisfactory.

3.2 INSTALLATION

- A. Install components in strict accordance with manufacturer's instructions an approved shop drawings. Use proper fasteners, caulking and hardware for material attachments as specified.

- B. Use methods of attachment to structure allowing sufficient adjustment to accommodate tolerances.
- C. Remove all protective coverings on panels immediately after installation.

3.3 CLEANING

- A. Follow manufacturer's instructions when washing down exposed panel surfaces using a solution of mild detergent in warm water that is applied with soft, cleaning wiping cloths. Always test a small area before applying to an entire area.
- B. Follow strict panel manufacturer guidelines when removing foreign substances from panel surfaces requiring mineral spirits or any solvents that are acceptable for use. Always test a small sample to validate compliance before applying to the entire glazing surface.
- C. Installer shall leave glazing system clean at completion of installation. Final cleaning is by others upon completion of project, following manufacturer's cleaning instructions.

END OF SECTION

SECTION 088000

GLAZING

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. Glass for doors, interior borrowed lites, storefront framing, glazed and curtain walls.
 - 2. Glazing sealants and accessories.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 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 temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of the following products; 12 inches square.
 - 1. Tinted glass.
 - 2. Coated glass.
 - 3. Laminated glass.
 - 4. Insulating glass.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturers of insulating-glass units with sputter-coated, low-E coatings.
- B. Product Certificates: For glass.
- C. Product Test Reports: For insulating glass, for tests performed by a qualified testing agency.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: 5 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following:
 - 1. AGC Glass Company North America, Inc.
 - 2. Berkowitz, JE, LP.
 - 3. Cardinal Glass Industries.
 - 4. Cristacurva Glass.
 - 5. Dlubak Corporation.
 - 6. Gardner Glass Products, Inc.

7. General Glass International.
 8. Glasswerks LA, Inc.
 9. Glaz-Tech Industries.
 10. Guardian Industries Corp.
 11. Hartung Glass Industries.
 12. Northwestern Industries, Inc.
 13. Oldcastle BuildingEnvelope.
 14. Pilkington North America Inc.
 15. PPG Industries, Inc.
 16. Saint-Gobain Corporation.
 17. Schott North America, Inc.
 18. Tecnoglass S. A.
 19. Trulite Glass & Aluminum Solutions.
 20. Viracon, Inc.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
1. Obtain tinted glass from single source from single manufacturer.
 2. Obtain reflective-coated glass from single source from single manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
1. Design Wind Pressures: As indicated on Drawings.
 2. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
 - a. Wind Design Data: As indicated on Drawings.
 - b. Basic Wind Speed: As indicated on Drawings.
 - c. Importance Factor: 1.0.
 - d. Exposure Category: B.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.

3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum.
 1. Minimum Glass Thickness for Exterior Lites: 6 mm.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

- B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- D. Ceramic-Coated Spandrel Glass: ASTM C 1048, Type I, Condition B, Quality-Q3.
 - 1. Basis-of-Design Product: PPG spandrel glass.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 - 2. Spacer: Manufacturer's standard spacer material and construction.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. May National Associates, Inc.; Bondaflex Sil 290.
 - d. Pecora Corporation; 890NST.
 - e. Sika Corporation U.S.; Sikasil WS-290.
 - f. Tremco Incorporated; Spectrem 1.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets

and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type TS: Clear fully tempered float glass.
1. Minimum Thickness: 6 mm.
 2. Safety glazing required.
- B. Glass Type R: clear heat-strengthened float glass.
1. Basis-of-Design Product: Vitro; Starphire.
 2. Minimum Thickness: 6 mm.
- C. Glass Type S: Ceramic-coated spandrel glass; heat-strengthened float glass.
1. Basis-of-Design Product: Vitro spandrel glass.
 2. Glass: Clear float glass.
 3. Tint Color: As selected from manufacturer's full range.
 4. Coating Color: As selected by Architect from manufacturer's full range.
 5. Minimum Thickness: 6 mm.
 6. Coating Location: Second surface.
 7. Winter Nighttime U-Factor: 0.50 maximum.
 8. Summer Daytime U-Factor: 0.50 maximum.
 9. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.

3.9 INSULATING GLASS SCHEDULE

- A. Glass Type IS: Low-E-coated, tinted insulating glass.
1. Basis-of-Design Product: Vitro Solarban.
 2. Overall Unit Thickness: 1 inch.
 3. Minimum Thickness of Each Glass Lite: 6 mm.
 4. Outdoor Lite: Heat-strengthened Fully tempered float glass.
 5. Interspace Content: Air.
 6. Indoor Lite: Heat-strengthened float glass.
 7. Low-E Coating: Sputtered.
 8. Winter Nighttime U-Factor: 0.29 maximum.
 9. Summer Daytime U-Factor: 0.27 maximum.
 10. Visible Light Transmittance: 35 percent minimum.
 11. Solar Heat Gain Coefficient: 0.31 maximum.
 12. Safety glazing required.
- B. Glass Type IG: Low-E, tinted insulating glass.
1. Basis-of-Design Product: Vitro Graylite II + Solarban 60 Clear.
 2. Overall Unit Thickness: 1 inch.
 3. Minimum Thickness of Each Glass Lite: 6 mm.
 4. Outdoor Lite: Heat-strengthened Fully tempered float glass.
 5. Interspace Content: Air.

6. Indoor Lite: Heat-strengthened float glass.
7. Low-E Coating: Sputtered on third surface.
8. Winter Nighttime U-Factor: 0.29 maximum.
9. Summer Daytime U-Factor: 0.27 maximum.
10. Visible Light Transmittance: 7 percent.
11. Solar Heat Gain Coefficient: 0.13.
12. Safety glazing required.

END OF SECTION

SECTION 092216

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
 - 1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.033 inch.
 - b. Depth: As indicated on Drawings.
 - 2. Dimpled Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.025 inch.
 - b. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
 - 1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure

above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - 2) MBA Building Supplies; FlatSteel Deflection Track.
 - 3) Steel Network Inc. (The); VertiClip SLD Series.
- D. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.033 inch.
 - 2. Depth: As indicated on Drawings.
- E. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch-wide flanges.
 - 1. Depth: 2-1/2 inches.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and 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.

3.4 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.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- 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 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. 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. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. 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 inches o.c.
- E. Z-Furring Members:
 - 1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
 - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Do not attach hangers to steel roof deck.
 5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. 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.

END OF SECTION

SECTION 092900

GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size sample in 12-inch-long length for each trim accessory indicated.
- C. Samples for Initial Selection: For each type of trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated
- B. At all walls scheduled to have GWB finish, provide abuse resistant GWB full height. Contractor Option: Provide standard GWB above 8'-0" AFF except at Gymnasium and Cafeteria spaces.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C 1396/C 1396M.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. USG Corporation.
 - 2. Thickness: 1/2 inch.
 - 3. Long Edges: Tapered.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Gypsum.

- b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. USG Corporation.
 - 2. Thickness: 5/8 inch.
 - 3. Long Edges: Tapered.
- C. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 - 2. Thickness: 1/4 inch.
 - 3. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. USG Corporation.
 - 2. Thickness: 1/2 inch.
 - 3. Long Edges: Tapered.
- E. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. USG Corporation.
 - 2. Core: 5/8 inch, Type X.
 - 3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 - 4. Long Edges: Tapered.
 - 5. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- F. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. USG Corporation.
2. Core: As indicated.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 SPECIALTY GYPSUM BOARD

- A. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
 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. National Gypsum Company.
 - b. Quiet Solution.
 - c. CertainTeed
 2. Core: 5/8 inch, Type X.
 3. Long Edges: Tapered.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation.
 - b. Custom Building Products.
 - c. James Hardie Building Products, Inc.
 - d. National Gypsum Company.
 - e. USG Corporation.
 2. Thickness: 5/8 inch.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.

2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (control) joint.
 - d. Curved-Edge Cornerbead: With notched or flexible flanges.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels:
 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

- E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
 - b. Pecora Corporation; AC-20 FTR
 - c. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
 - d. USG Corporation; SHEETROCK Acoustical Sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 1. Wallboard Type: As indicated on Drawings.
 2. Type X: As indicated on Drawings Where required for fire-resistance-rated assembly.
 3. Flexible Type: Apply in double layer at curved assemblies.
 4. Ceiling Type: Ceiling surfaces.
 5. Abuse-Resistant Type: As indicated on Drawings.
 6. Mold-Resistant Type: As indicated on Drawings.
 7. Acoustically Enhanced Type: As indicated on Drawings.
- B. Single-Layer Application:
 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

- C. 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 instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- D. Curved Surfaces:
 - 1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
 - 2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. Curved-Edge Cornerbead: Use at curved openings.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 5: All surfaces exposed to view.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 095113

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Related Requirements:
 - 1. Division 23 - HVAC.
 - 2. Division 26 - Electrical.
- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch-square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch-long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which suspension systems will be attached.

3. Size and location of initial access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
5. Perimeter moldings.

- B. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANELS (ACT 1)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Optima Tegular Cloud w/ Axiom trim (2'x2') or comparable product by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. Chicago Metallic Corporation.
 - 4. USG Interiors, Inc.; Subsidiary of USG Corporation.

- B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type XII, FORM 2.
 - 2. Pattern: E.
- C. Color: As selected from manufacturer's full range.
- D. LR: Not less than 0.88.
- E. NRC: Not less than 0.90.
- F. CAC: Not less than 26.
- G. Edge/Joint Detail: Tegular.
- H. Thickness: 15/16 inch.
- I. Modular Size: 24 by 24 inches.
- J. Fire Class: A

2.4 ACOUSTICAL CEILING SHAPES (ACS-1 through ACS-5)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Soundscapes Shapes – Hexagon, 3’-10” x 3’-3 13/16” or comparable product by one of the following:
 - 1. CertainTeed Corp.
 - 2. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type XII, Form, 2.
 - 2. Pattern: E.
- C. Color: As indicated, and/or selected by the Architect from the Manufacturer’s full range.
- D. LR: Not less than 0.90 (for Manufacturer’s white panel)
- E. Fire Class: A.

2.5 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

- B. 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.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 - 3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
 - 4. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.
- D. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

2.6 METAL SUSPENSION SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Prelude 15/16" or comparable product by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. Chicago Metallic Corporation.
 - 4. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Wide-Face, Capped, Double-Web, Steel Suspension System:- Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch-wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Steel cold-rolled sheet.

- a. At ACT 2 locations, provide Aluminum cap material. (Add. #4)
5. Cap Finish: Painted in color as selected from manufacturer's full range.

2.7 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 that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide hemmed angled molding.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.8 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, provide one of the following:
 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
- B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook." Serpentine ceiling shall be installed in accordance with manufactures instruction.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. As indicated on reflected ceiling plans.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 099113

EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates.
 - 1. Steel.
 - 2. Galvanized metal.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel" for shop priming of metal substrates with primers specified in this Section.
 - 2. Section 099123 "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.3 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 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. VOC content.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Benjamin Moore & Co.
 2. Pratt & Lambert.
 3. Sherwin-Williams Company (The).
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

- D. Colors: As selected by Architect from manufacturer's full range.

2.3 METAL PRIMERS

- A. Primer, Alkyd, Quick Dry, for Metal: MPI #76.

2.4 SOLVENT-BASED PAINTS

- A. Alkyd, Exterior, Semi-Gloss (Gloss Level 5): MPI #94.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
 - 1. Paint the following work where exposed to view:
 - a. Exposed steel lintels at windows and doors.
 - b. Metal conduit.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 1. Alkyd System:
 - a. Prime Coat: Primer, alkyd, anticorrosive for metal, MPI #79.
 - b. Prime Coat: Shop primer specified in Section where substrate is specified.
 - c. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - d. Topcoat: Alkyd, exterior, semi-gloss (Gloss Level 5), MPI #94.
- B. Galvanized-Metal Substrates:
 - 1. Alkyd System:
 - a. Prime Coat: Primer, galvanized metal, as recommended in writing by topcoat manufacturer for exterior use on galvanized-metal substrates with topcoat indicated.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Alkyd, exterior, semi-gloss (Gloss Level 5), MPI #94.

END OF SECTION

SECTION 099123

INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete masonry units (CMU).
 - 2. Steel.
 - 3. Galvanized metal.
 - 4. Wood.
 - 5. Gypsum board.
 - 6. Plaster.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel" for shop priming of metal substrates with primers specified in this Section.
 - 2. Section 099113 "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.3 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
 - 3. VOC content.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. Pratt & Lambert.
 - 3. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. Colors: As selected by Architect from manufacturer's full range.

2.3 BLOCK FILLERS

- A. Block Filler, Latex, Interior/Exterior: MPI #4.

2.4 PRIMERS/SEALERS

- A. Primer Sealer, Latex, Interior: MPI #50.
- B. Primer, Latex, for Interior Wood: MPI #39.
- C. Primer Sealer, Alkyd, Interior: MPI #45.

2.5 METAL PRIMERS

- A. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.
- B. Primer, Alkyd, Quick Dry, for Metal: MPI #76.
- C. Primer, Galvanized, Water Based: MPI #134.

2.6 WATER-BASED PAINTS

- A. Latex, Interior, Flat, (Gloss Level 1): MPI #53.
- B. Latex, Interior, (Gloss Level 2): MPI #44.
- C. Latex, Interior, (Gloss Level 3): MPI #52.
- D. Latex, Interior, (Gloss Level 4): MPI #43.
- E. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.
- F. Latex, Interior, Gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees): MPI #114.

2.7 SOLVENT-BASED PAINTS

- A. Alkyd, Interior, Flat (Gloss Level 1): MPI #49.
- B. Alkyd, Interior, (Gloss Level 3): MPI #51.

- C. Alkyd, Interior, Semi-Gloss (Gloss Level 5): MPI #47.
- D. Alkyd, Interior, Gloss (Gloss Level 6): MPI #48.

2.8 TEXTURED COATING

- A. Primer for Textured Coating, Latex, Flat: As recommended in writing by topcoat manufacturer.

2.9 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

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. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- G. 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.
- D. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards.
 - b. Tanks that do not have factory-applied final finishes.
 2. Paint the following work where exposed in occupied spaces:
 - a. Other items as directed by Architect.
 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. CMU Substrates:
 - 1. Alkyd System:
 - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - b. Intermediate Coat: Alkyd, interior, matching topcoat.
 - c. Topcoat: Alkyd, interior, flat (Gloss Level 1), MPI #49.
 - d. Topcoat: Alkyd, interior, semi-gloss (Gloss Level 5), MPI #47.
- B. Steel Substrates:
 - 1. Latex over Alkyd Primer System:
 - a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - b. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - c. Intermediate Coat: Latex, interior, matching topcoat.
 - d. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
- C. Galvanized-Metal Substrates:
 - 1. Latex over Waterborne Primer System:
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
- D. Wood Substrates: Including wood trim doors.
 - 1. Latex over Alkyd Primer System:
 - a. Prime Coat: Primer sealer, alkyd, interior, MPI #45.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
- E. Gypsum Board Plaster Substrates:
 - 1. Latex System:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.

END OF SECTION

SECTION 114000

FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Any perceived omission, discrepancy, or ambiguity in Section 114000 Bid Documents shall be questioned by prospective bidders in writing directly to the foodservice consultant no later than ten (10) days prior to the bid date. An addendum shall be issued to clarify any such issue. Failure to seek such clarification indicates the prospective bidder understands fully the intent of the Bid Documents.

1.2 DESCRIPTION OF WORK

- A. Extent of foodservice equipment work is indicated on drawings and by provisions of this section, including schedules and equipment lists associated with either drawings or this section. The Foodservice Equipment Contractor shall be responsible for coordinating his work with other trades. The Foodservice Equipment Contractor shall be responsible for all required permits, including but not limited to, setting equipment and erection of and connection of walk-in refrigeration.
- B. Foodservice equipment must be manufactured in the United States per the Buy American Clause.**
- C. Only the walk-in cooler / freezer and the shelving contained within shall be replaced. All other kitchen equipment shall remain as is.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of foodservice equipment of types, capacities, and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Section 114000 Contractor Qualifications: Firms shall hold a Class "A" Virginia Contractor's License and be regularly engaged in the distribution of foodservice equipment and brands hereinafter specified.
- C. Fabricator's Qualifications: Where indicated units require custom fabrication, provide units fabricated by a shop which is skilled and has a minimum of 5 years of experience in similar work. Fabricate all custom equipment items in same shop. Where units cannot be fully shop-fabricated, complete fabrication work at project site. Custom fabrication shall carry both NSF and UL Custom Certification.

D. Codes and Standards:

1. NSF Standards: Comply with applicable National Sanitation Foundation standards and recommended criteria. Provide each principal item of foodservice equipment with a NSF “Seal of Approval”.
2. UL Labels: Where available, provide UL labels on the completed principal item of foodservice equipment. In addition, provide UL “recognized marking” on other items with electrical components, signifying listing by UL, where available.
3. ANSI Standards: Comply with applicable ANSI standards for electric powered appliances and for plumbing fittings including vacuum breakers and air gaps to prevent siphonage in water piping.
4. NFPA Codes: Install foodservice equipment in accordance with the following National Fire Protection Codes:
 - a. NFPA 70 – National Electric Code
 - b. NFPA 96 – “Removal of Smoke & Grease-Laden Vapors from Commercial Cooking Equipment”
5. ASME Boiler Code: Construct steam generating and closed steam heated equipment to comply with American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code; Section IV for units not exceeding 15 psig or 250°F, or Section I for higher pressure/temperature units.
6. Health Code: Install foodservice equipment in accordance with local health department applicable requirements.

1.4 SUBMITTALS

- A. Product Data, Standard Manufactured Models: Submit the latest manufacturer’s specification sheet with a separate cover sheet indicating the item number, specific model number, quantity, accessories and utility information.
- B. Shop Drawings, Custom Foodservice Equipment: Provide manufacturer prepared detailed shop drawings drawn at a minimum of 1/2”=1’-0” scale consisting of plan views, elevation, sections and enlarged details as required to illustrate compliance with the drawings and specifications of Section 114000. Plot manufacturer’s shop drawings at the scale indicated on the shop drawing. Do not modify scale. Do not include any shop drawings in Equipment Brochure.
- C. Required Additional Drawings: Provide separate 1/4”=1’-0 scale floor plan with schedule, 1/4”=1’-0” scale, dimensioned plumbing rough-in drawing with schedule, 1/4”=1’-0” scale, dimensioned electrical rough-in drawing with schedule and 1/4”=1’-0” scale, dimensioned special conditions drawing indicating any floor depressions, floor block outs for floor troughs, wall blocking, wall opening locations and heights, vent collars and any other special condition requiring coordination with other Divisions. Coordinate with the Contractor to determine which building features will be present and are most appropriate for dimensioning reference on rough-ins. Dimensioned rough-ins shall employ “Baseline” dimensioning style with “Continuing” style used only for minor dimensions such as faucet spacing. Consult equipment specification sheets and shop drawings for leg locations. Avoid leg locations when placing rough-in, particularly floor drains and floor sinks. Verify locations and coordinate correction of all rough-ins prior to floor pouring.

- D. **All of the above mentioned submittals shall be presented as a single electronic PDF submittal package. Partial and non-complying submittals shall be returned or reviewed at the Consultant's/Architect's discretion.**
- E. Samples for Initial Selection: Submit manufacturer's color charts showing the full range of colors available for exposed products with color finishes.
- F. Maintenance Data: Submit the operation, maintenance, and parts data manuals, in quantities as prescribed by Division 1. O & M Manuals shall be arranged as follows:
 - 1. Manuals shall be presented in a locking 3-ring binder of suitable size to securely hold the information. A cover and spine insert shall indicate the name and address of the facility, the type of Equipment, e.g., Kitchen, Servery, Dishroom, the foodservice equipment contractors full name address, phone number and principal contact person.
 - 2. The first page(s), in a clear plastic protective sleeve(s), shall provide an index of equipment arranged alphabetically by manufacturer's name. The index shall include the manufacturer's name, an item description, e.g., "Dishwasher" and the project Item Number. Include the service agents name for each manufacturer and that agent's 24/7 service phone number.
 - 3. Separate each manufacturer's manuals from the next with an appropriately labeled index tab.
 - 4. In lieu of paper submission, the above mentioned O&M Manuals may be presented as a single electronic PDF. File shall include a copy of the plan, the equipment schedule, a cover sheet, and complete index. The index shall include the manufacturer's name, an item description, e.g., "Dishwasher" and the project Item Number. Include the service agents' name for each manufacturer and that agent's 24/7 service phone number. The PDF shall be electronically 'bookmarked' at each item that has a unique project Item Number. Electronic O&M Manual shall be page numbered, and page numbers shall correspond to the index. The approved O&M PDF shall be written to a 'thumb drive' or similar physical digital file exchange device and shall be delivered to the Owner at the equipment demonstration as described in section 3.05 of these specifications.
 - 5. Partial and non-complying O&M Manuals shall not be accepted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver foodservice equipment in factory-fabricated containers designed to protect equipment and finish until final installation. Make arrangements to receive equipment at project site, or to hold in warehouse until delivery can be made to job site.
- B. Foodservice equipment shall be stored in original containers, and in a location that provides adequate protection to equipment while not interfering with other construction operations.
- C. Handle foodservice equipment carefully to avoid damage to components, enclosures, and finish. Do not install damaged foodservice equipment; replace and return damaged components to equipment manufacturer.

1.6 PROJECT CONDITIONS

- A. Take field measurements to assure accurate fit of fabricated and buyout equipment.
- B. Check utility characteristics; provide pressure regulating valves where required for proper operation of equipment.

1.7 SPECIAL REFRIGERATION WARRANTY

- A. Warranty on Refrigeration Compressors: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. It is the intent of these specifications to designate an all-inclusive job, complete and ready for use, except all plumbing, ventilating, and electrical connections made under Division 22, 23 and 26. All equipment shall be set in place completely assembled, jointed together in a workmanlike manner and left ready for the required connections.
- B. **Foodservice equipment must be manufactured in the United States per the Buy American Clause.**
- C. All equipment shall be permanently and legibly marked, or have a permanent nameplate, with the manufacturer's name. The manufacturer's type, or model number, and the serial number shall also be permanently marked on the machine.
- D. All equipment covered by these specifications shall utilize the best and most modern practices of the Foodservice and Cooking Equipment Industry.
- E. All specially built equipment shall be made by one manufacturer and shall be uniform throughout as to method and type of construction used.
- F. No machinery or equipment covered by these specifications shall be acceptable from any manufacturers who shall not have had equipment of approximately the same type and design as that specified operating successfully for at least one year. Machines installed for test purposes shall not come within the category of successful commercial operation.
- G. Appliances shall be new, of manufacturer's current production and furnished complete with motors, driving mechanism, starters and controllers including master switches, timers, cutouts, reversing mechanism, and other electrical equipment, if and as

applicable with wiring on the appliance installed in rigid metal conduit (except that flexible conduit may be used as necessary to permit adjustment of motors with drive belts or chain) and permanently connected. Wiring and connection diagrams shall be furnished with electrically operated machines.

- H. Appliances shall be of rigid construction, free from objectionable vibration, and quiet in operation.
- I. Substitutions may be considered, subject to Owner's approval, only in accordance with the requirements of Division 1 of these specifications, for equipment items included in the Equipment Schedule. The brands and models indicated in the written specifications are deemed to be the design standard. Coordination and any corresponding costs incurred by other Divisions due to any substitutions is the responsibility of the Section 114000 contractor.

2.2 ELECTRICAL REQUIREMENTS

- A. Supply motors and heating elements for operation and electrical characteristics indicated on contract drawings or as stipulated under Foodservice Equipment Schedule.
- B. A cord of suitable length and size shall be provided for all portable items and those usually so connected. Verify characteristics of receptacles being provided under other Sections of these specifications and provide matching plug all completely wired for plug-in operation. Receptacles provided as a part of integral unit of items shall be congruent or match those above.
- C. Motors shall be of the drip-proof, splash-proof, or totally enclosed type, having a 2-hour duty cycle and ball bearings (except small timing motors which may have sleeve bearings). All motors shall have windings impregnated to resist moisture. Motors located where subject to deposits of dust, lint, or other similar matter from the machine on which installed shall be of the totally enclosed type. Motors shall have ample power to operate the machines for which designated under full load operating conditions without exceeding their nameplate ratings. Horsepower requirements on driven equipment shall be determined by the manufacturer based on normal operation at maximum capacities. The nominal rated motor horsepower shall be not less than the horsepower required for normal operation of the equipment at maximum capacity.

2.3 MATERIALS

- A. General: Unless otherwise indicated on drawings, the following requirements shall apply.
- B. Stainless Steel: AISI Type 304. Provide non-magnetic sheets, free of buckles, waves, and surface imperfections. Provide No. 4 polished finish for any surfaces which will be exposed.
- C. Galvanized Steel Sheet: ASTM A 526, except ASTM A 527 for extensive forming; ASTM A 525, G90 zinc coating, chemical treatment.

- D. Stainless Steel Tube: ASTM A 554, Type 304 with No. 4 polished finish.
- E. White Metal: Corrosion-resistant metal containing not less than 21% nickel. Make casting free from pit marks, runs, checks, burrs, and other imperfections; rough grind, polish and buff to bright luster. In lieu of white metal castings, 18-8 stainless steel die-cast or stamped may be used.
- F. Plastic Materials and Components: Except for plastic laminate, provide plastic materials and components which comply with NSF 51.
- G. Sound Deadening: Heavy-bodied resinous coating, filled with granulated cork or other resilient material, compounded for permanent, non-flaking adhesion to metal in 1/8" thick coating. Apply coating of sound deadening material to underside of tops, drainboards, dishtables, and sinks.
- H. Sealants: Provide low VOC sealant that when fully cured and washed meets requirements of Food and Drug Administration Regulation 21 CFR 177.2600 for use in areas where it comes in contact with food. Provide closed cell polyethylene backer rod as required.
- I. Gaskets: Solid or hollow (not cellular) neoprene or PVC; light gray, minimum 40 Shore A hardness, self-adhesive or prepared for either adhesive application or mechanical anchorage.
- J. Fasteners: Shall be stainless steel of a style appropriate for the task. Fasteners shall be Phillips truss head machine screws, Phillips truss head sheet metal screws or Phillips flathead machine screws. Shields and toggles shall be used where necessary to fasten to CMU and concrete. Drive pins are not acceptable foodservice attachment devices.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Rough-In Work: Examine roughed-in plumbing, mechanical and electrical services, and installation of floors, walls, columns and ceilings, and other conditions under which foodservice work is installed; verify dimensions of services and substrates before fabricating work. Notify Contractor of unsatisfactory locations and dimensions of other work, and of unsatisfactory conditions for proper installation of foodservice equipment. Do not proceed with fabrication and installation until unsatisfactory dimensions and conditions have been corrected.

3.2 INSTALLATION

- A. General: Set each item of non-mobile and non-portable equipment securely in place, level and adjust to correct height. Anchor to supporting substrate where indicated and where required for sustained operation and use without shifting or dislocation. Conceal anchorages where possible. Adjust counter tops and other work surfaces to level tolerance of 1/16" maximum offset, and maximum variation from level or indicated slope of 1/16" per ft. Height of tops and work surfaces shall not exceed 2'-10" AFF.

- B. Field Joints: Complete field-assembly joints in work (joints which cannot be completed in shop) by welding, bolting-and-gasketing, or similar methods. Grind welds smooth and restore finish. Set or trim gaskets flush, except for “T” gaskets as indicated.
- C. Closure Plates and Strips: Install, with joints coordinated with units of equipment.
- D. Cut-Outs: Provide cut-outs in foodservice equipment to run plumbing, electric, or steam lines through equipment items for final connections.
- E. Sealants and Gaskets: Install all around each unit to make joints air-tight, watertight, vermin-proof, and sanitary for cleaning purposes. In general, make sealed joints not less than 1/8" wide, and stuff backer rod to shape sealant bead properly, at 1/4" depth. Shape exposed surfaces of sealant slightly concave, with edges flush with faces of materials at joint. At internal-corner joints, apply sealant or gaskets to form a sanitary cove, of not less than 3/8" radius. Provide sealant-filled or gasketed joints up to 1/4" joint width; stainless steel closure strips for wider joints, with sealant application each side of strips. Anchor gaskets mechanically or with adhesives to prevent displacement.
- F. Piping: Install necessary piping from relief valves on kettles and steamers to exhaust in manner to avoid steam coming in contact with operating personnel, and in accordance with applicable codes. Install required piping from indirect drain connections to floor drains.
- G. Custom Sink Faucets: For single compartment sinks mount faucet over center line; for double compartment sinks center faucet over partition; for triple compartment sinks mount two faucets, one over each partition.

3.3 FIELD QUALITY CONTROLS

- A. Testing: Do not start-up foodservice equipment until service lines have been tested, balanced, and adjusted for pressure, voltage, and similar considerations; and until water and steam lines have been cleaned and treated for sanitation. Before testing, lubricate each equipment item in accordance with manufacturer's recommendations.
- B. Test each item of operational equipment to demonstrate that it is operating properly, and that controls and safety devices are functioning. Repair or replace equipment which is found to be defective in its operation, including units which are below capacity or operating with excessive noise or vibration.

3.4 CLEANING

- A. After completion of installation, and completion of other major work in foodservice areas, remove protective coverings, if any, and clean foodservice equipment, internally and externally. Restore exposed and semi-exposed finishes to remove abrasions and other damages; polish exposed-metal surfaces and touch-up painted surfaces. Replace work which cannot be successfully restored.

- B. Final Cleaning: After testing and start-up, and before time of Substantial Completion, thoroughly clean foodservice equipment, and leave in condition ready for sanitizing by foodservice personnel.
- C. Any cleaning agents that are acid based, contain bleach, or other caustic agents or chemicals not specifically approved for use on stainless steel SHALL BE STRICTLY FORBIDDEN IN ALL FOODSERVICE SPACES. Failure to observe this will result in permanent damage to stainless steel equipment and stainless steel components and will VOID manufacturers' warranties. Section 114000 shall inform the General Contractor of its responsibility to enforce this requirement.

3.5 CLOSEOUT PROCEDURES

- A. Provide services of Installer's technical representative, and manufacturer's technical representative, to instruct Owner's personnel in operation and maintenance of foodservice equipment.
- B. Schedule training with Owner, provide 7-day notice to Contractor and Architect of training date.

PART 4 - ITEMIZED EQUIPMENT SPECIFICATIONS

4.1 ITEM NO. 1A, 1B, 1C AND 2A, 2B, 2C - WALK-IN COOLER/FREEZER COMBINATION

- A. Walk-in Cooler/Freezer Combination shall be Thermokool Model No. CUSTOM, shaped as indicated on Drawing QF101, 23'-8" wide x 11'-10" deep front-to-back x 8'-6" high overall. Provide 125 diamond tread aluminum reinforced floor rated at 12000 pounds per square foot depressed flush with adjacent kitchen floor. Cooler/Freezer shall be finished in .040 stucco embossed aluminum in/out where exposed with white stucco embossed ceiling. Provide each compartment with a 36" wide x 78" high door where indicated, equipped with 1/8" diamond tread kick plates inside and out, doors and frames to 36" AFF. Provide doors with Kason Series K-77 positive latch hardware with cylinder locks finished in polished chrome. Provide 14" x 24" heated view windows in each door. Provide vinyl strip curtains at each door opening. Provide 12-gauge stainless steel threshold plate with thermostatically controlled heater for both cooler and freezer doors. Install door stops as necessary. Provide a 2" x 6" stainless steel hat channel bumper rail full length of exposed exterior wall except door and door frames, mount at 30" above finished floor and fully enclose ends and seal to walk-in wall. Trim Cooler/Freezer with matching aluminum closures to walls and ceiling. Furnish and mount four (4) additional Kason 1810LCT LED light fixtures where indicated on Drawing QF101. Coordinate connection of lights with Division 26. Provide a "Special Conditions Drawing" with submittal detailing location and size of floor depression and masonry opening. The box shall be set at a level to allow the door(s) to swing freely over the adjacent exterior floor.

- B. Provide HCFC-free air-cooled Condensing Unit Model RFO180E4SEA with matching Unit Cooler Model RL6A117ADA for the medium temperature compartment and HCFC-free air-cooled Condensing Unit Model RFO350L4SEA with matching Unit Cooler Model RL6E105DDA for the low temperature compartment. Mount Condensing Units and hang Unit Coolers where indicated on Drawing QF101. Provide low ambient kits and UL listed weather covers. Connection of refrigeration and drain lines shall be by a licensed refrigeration technician using refrigeration grade hard copper following the manufacturer's and ASHRAE guidelines under Section 114000. Wrap all condensate drain lines with heat tape where exposed to freezing temperatures. Verify distance of refrigeration line runs and adjust line size and condensing unit size to conform to manufacturer's recommendations.
- C. After all lines are connected, the entire system shall be leak tested. The complete system shall be pressurized to 150 psig with refrigerant and dry nitrogen (or dry CO₂). An electronic type leak detector shall be used to identify leaks. Pressure shall be held for a minimum of 12 hours and then rechecked. Coordinate test observation with the owner's representative on site.
- D. A good, deep vacuum pump shall be connected to both the low and high side evacuation valves with copper tube or high vacuum hoses (1/4" ID minimum). If the compressor has service valves, they shall remain closed. A deep vacuum gauge capable of registering pressure in microns shall be attached to the system for pressure readings. A shut off valve between the gauge connection and vacuum pump shall be provided to allow the system pressure to be checked after evacuation. Do not turn off vacuum pump when connected to an evacuated system before closing shut off valve. The vacuum pump shall be operated until pressure of 1,500 microns absolute pressure is reached – at which time the vacuum shall be broken with the refrigerant to be used in the system through a drier until the system pressure rises above 0 psig. Repeat this operation a second time. Open the compressor service valves and evacuate the entire system to 500 microns absolute pressure. Raise the pressure to 2 psig with the refrigerant and remove the vacuum pump.
- E. Refrigeration lines shall be insulated with Aeroflex USA Aerocel White/Gray 25/50 pipe insulation. Thickness of insulation shall be in accordance with insulation manufacturer's recommendation. Butt joints and seams shall be sealed with contact adhesive.
- F. After completion of electrical connections under Division 26, trim the Cooler/Freezer to the building, clean inside and out, test, charge and start system, install the shelving, adjust temperature to 35 degrees for the medium temperature compartment and 0 degrees for the low temperature compartment, leave ready for use.

4.2 ITEM NO. 3 – DUNNAGE RACK

- A. Dunnage Rack shall be Metro Model No. HP2248PD-L003
 - 1. Provide the following options:
 - a. Manufacturer's Standard Features

4.3 ITEM NO. 4 – SHELVING UNIT

- A. Shelving Unit shall be Walk-in Shelving shall be Metro Model No. Super Erecta Metroseal 3-L003, sized and arranged as indicated on Drawing QF101
 - 1. Provide the following options:
 - a. Manufacturer's Standard Features and
 - b. Sixteen (16) post clamps
- B. Each section shall consist of four (4) shelves and four (4) 74" posts. Install bottom shelf at 8" AFF and subsequent shelves 19" above the one beneath to surface. Install post clamps above the top shelf to adjacent front posts where possible and rear posts where not possible on front posts.

END OF SECTION

SECTION 200100

COMMON WORK RESULTS – GENERAL MECHANICAL

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 the following basic mechanical materials and methods to complement other Division 23 Sections.
 - 1. Coordination with related work specified in other Divisions.
 - 2. Coordination drawings specific to Divisions 20, and 23 requirements.
 - 3. Record document submittals specific to Divisions 20, and 23 requirements.
 - 4. Piping materials and installation instructions common to most piping systems.
 - 5. Damper requirements.
 - 6. Access panels for mechanical devices furnished under Divisions 20, and 23.
 - 7. Maintaining utility services.
 - 8. Concrete base construction requirements.
 - 9. Grout.
 - 10. Transition fittings.
 - 11. Dielectric fittings.
 - 12. Flexible connectors.
 - 13. Field-fabricated metal and wood equipment supports and anchorage.
 - 14. Installation requirements common to equipment specification sections.
 - 15. Mechanical demolition.
 - 16. Cutting and patching specific to Divisions 20, and 23 requirements.
 - 17. Painting.

1.3 HVAC MAINTENANCE AND SERVICE REQUIREMENT

- A. The Mechanical Contractor (Division 23) and HVAC Control Contractor (Division 25) shall each provide two years of preventative and regular maintenance service for all HVAC equipment and controls installed. The two-year maintenance period shall begin at the issuance of each respective project HVAC and/or HVAC Controls substantial completion. Each Contractor shall prepare and submit maintenance schedules that identify periodic maintenance tasks for each equipment type prior to substantial completion. The maintenance and service required for each piece of equipment shall be as designated by the equipment manufacturer within their published installation, operation and maintenance manuals. Each Contractor shall

provide the owner with monthly reports of maintenance tasks completed for that period. The maintenance scope of work shall include all parts and labor associated with:

1. Periodic air filter replacement for each air-moving device. The maximum operating duty period for each filter shall not be greater than three months.
 2. Fan motor belt replacement for each air-moving device.
 3. Lubrication of equipment components.
 4. All other preventative or regular maintenance service tasks identified in the HVAC equipment manufacturer's written operation and maintenance guidelines for each piece of equipment.
- B. The Contractors' maintenance and service personnel shall contact the Owner with 48 hours notice before all site visits in order to allow Owner's maintenance staff members to accompany maintenance and service personnel to witness all maintenance and service tasks and activities.

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Plenum: A plenum is an enclosed portion of the building structure that is designed to allow air movement, and thereby serve as part of an air distribution system. Supply, return, exhaust, relief and ventilation air plenums shall be limited to areas above a ceiling or below the floor. Plenums shall be limited to one fire area. Fuel-fired appliances shall not be installed within a plenum.
- G. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
 2. CPVC: Chlorinated polyvinyl chloride plastic.
 3. HDPE: High density polyethylene plastic.
 4. PE: Polyethylene plastic.
 5. PVC: Polyvinyl chloride plastic.

H. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene propylene diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.5 ACTION SUBMITTALS

- A. Product Data: For transition fittings, dielectric fittings and flexible connectors.
- B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
 1. Mechanical Access Drawings: For access panel and door locations. Reproduce architectural reflected ceiling plans and note proposed locations of ceiling and wall access doors. Where possible group together work of Divisions 20, 21, 22, 23 and 26 at a single location.
 2. Field Construction Drawings: Sheet metal installation drawing shall be used to coordinate all work of separate Sections. Locate pipe work, conduits, raceways, equipment, etc. in plan and elevation to coordinate concealed space clearances.
 3. Conflicts not resolved in field shall be submitted on minimum 1/4-inch per foot scale drawing to Architect. Drawing to describe full extent of conflict.
- B. Welding certificates.

1.7 CLOSEOUT SUBMITTALS

- A. Record Documents: Coordinate specific requirements listed below with general provisions for record documents specified in Section 017700 "Closeout Procedures."
 1. Maintain a record set of drawings on site and specifically note the following:
 - a. Hydronic Piping:
 - 1) Underground mains and branch locations measured from building columns or walls and dimensioned on record drawings.
 - 2) Underground mains and branch inverts or depth of piping below floor slab.
 - 3) Main and branch distribution piping service shut-off valves and valve tag number.
 - 4) Main and branch distribution piping deviations in locations shown on Contract Documents. Specifically identify each service with the proper Drawing symbol and dimension from building columns or walls.

- 5) Specialty items located behind finished surfaces and accessible through access doors. Where item is not accessible, provide dimensions from identifying walls and elevations above finish floor.
- 6) Pipe anchor points attached to roof support steel. Dimension from building columns or walls.

b. Ductwork and Ductwork Accessories:

- 1) Shop fabrication drawings noting coordination with work of other Sections, to be cross-referenced by drawing identification number and contract drawing number.
 - 2) Roof penetration locations for fans and other equipment.
 - 3) Ductwork accessories to be identified by highlighting where accessory requires service as follows:
 - a) Fire dampers and access doors to fusible links.
 - b) Relief or gravity backdraft dampers.
 - c) Motorized control dampers.
 - d) Automatic control system sensors.
 - e) Fan or equipment with motor or control valve.
 2. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.
 3. Submit record set of Drawings and Specifications for coordination with a single master set of “As-Built” Contract Documents.
- B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.8 CODES AND STANDARDS

- A. All work shall be done in accordance with all State, County and Local Building Regulations and Codes.
- B. All equipment and work under this Division shall also conform to the following regulations, codes, and standards.
1. OSHA
 2. NFPA
 3. SMACNA Standards for Sheet Metal Work
 4. International Electrical Code
 5. International Fire Code
 6. International Mechanical Code
 7. Model Energy Code, ASHRAE Standard 90.1 (2013)
 8. West Virginia Policy 6200

- C. These regulations are considered a part of the specifications and shall prevail should they differ with plans and specifications. Prior to bid submission, the Contractors should direct the Engineer's attention to the difference. Should the Contractor not so notify the Engineer, the Contractor shall fully comply without claim for extra costs.

1.9 DRAWINGS

- A. Drawings: Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required ductwork offsets, fittings, and accessories to meet such conditions.
- B. Design Concepts: The Drawings indicate capacities, sizes, and dimensional requirements of system components and are based on the specific types, manufacturers, and models indicated.
 - 1. Components having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, and other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. The burden of proof of equality of products is on the proposer.
 - 2. Any changes to other Sections or Contractors shall be the burden of the proposer and shall be coordinated as such with all other disciplines.
 - 3. Refer to Section 012500 "Substitution Procedures."

1.10 QUALITY ASSURANCE

- A. Products by Listed Manufacturers but not Scheduled: Equipment of higher or lower electrical characteristics, physical dimensions, capacities, and ratings than scheduled products may be furnished subject to the following conditions:
 - 1. Deviations from scheduled product are noted and highlighted in submittal of product data and shop drawings.
 - 2. No exception is taken by Architect to submitted product through standard submittal process.
 - 3. Connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased or reduced to accommodate deviations from scheduled product. These modifications shall be coordinated with affected trades at no additional cost to the owner. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.
- B. Materials exposed within plenums. Materials exposed within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke developed index of not more than 50 when tested in accordance with ASTM E 84.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel."

- D. 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.
- E. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.11 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 prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.12 SEQUENCING AND COORDINATION

- A. **Use of permanent building HVAC system prior to Substantial Completion is prohibited.**
- B. Provide information required for development of Contractor’s Construction Schedule specified in Division 01.
- C. Coordinate all variances in equipment power requirements with the Electrical Contractor prior to submission of shop drawings for that equipment. A statement of coordination shall be included with that shop drawing submittal.
- D. Coordinate mechanical equipment installation with other building components, including but not limited to: concrete bases, thrust blocks, structural supports, roof penetrations and curbs, louvers, framed openings, etc.
- E. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- F. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- G. Coordinate roof penetrations, curbs, framed openings, etc. for installation of equipment, curb types and flashing.

- H. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- I. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- J. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.
- K. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Coordinate installation of identifying devices with location of access panels and doors. Install identifying devices before installing acoustical ceilings and similar concealment.
- L. Coordinate installation work to maintain the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Planned ductwork layout, including maintenance deviance to dampers, equipment and access through ceiling.
 - 3. Planned fire protection including zone valves, flow switches, damper switches, equipment and access through ceilings.
 - 4. Clearances for installing and maintaining insulation.
 - 5. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - 6. Equipment and accessory service connections and support details.
 - 7. Exterior wall and foundation penetrations.
 - 8. Fire-rated wall and floor penetrations.
 - 9. Sizes and location of required concrete pads and bases.
 - 10. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - 11. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
 - a. Access door locations to gang together valve dampers, etc at a single location for service.
 - 13. Roof penetrations, dimensions, weights, curbing and blocking, vents, roof drains, piping curbs on roof, etc.
 - 14. Site utilities and under floor services, inverts and clearances to maintain pipe slope.

1.13 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final

location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

- B. Unless specifically noted otherwise, each Division 20, 21, 22, 23, 25 and 26 Contractor shall be responsible for reviewing all project drawings, for providing and installing all necessary access panels including, but not limited to, those shown on the Drawings, and identify required access panels on coordination drawings and submit for review by the Architect.
- C. Coordinate specific access panel requirements with the requirements specified in Section 083113 "Access Doors and Frames."
- D. Extend all grease fittings to an accessible location.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE AND FITTINGS

- A. Refer to individual Division 20, 21, 22 and 23 piping Sections for pipe 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 20, 21, 22 and 23 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. 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, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping: ASTM D 2564 for PVC Piping. Include primer according to ASTM F 656.
- H. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- I. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
 - 1. Sleeve: ASTM A 126, Class B, gray iron.
 - 2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 3. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.5 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous materials; threaded, solder-joint, plain, and weld-neck end connections that match piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Eclipse, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

- H. 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.

1. Manufacturers:

- a. Perfection Corp.
- b. Precision Plumbing Products, Inc.
- c. Sioux Chief Manufacturing Co., Inc.
- d. Victaulic Co. of America.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Anvil International.
2. ANAMET Industrial, Inc.
3. Flexicraft Industries.
4. Flex-Weld, Inc.
5. Hyspan Precision Products, Inc.
6. Mercer Rubber Co.
7. Metraflex Co.
8. Uniflex, Inc.

- B. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with keyed couplings.

- C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

- D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose. Not acceptable for potable water.

- E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose. Not acceptable for potable water.

2.7 DAMPERS

- A. All dampers including AHU dampers, exhaust fan dampers, air intake dampers shall meet ASHRAE 90.1 standards for Climate Zone 4A as follows: motorize leakage at 1 in. w.g., 10 cfm/sf; nonmotorized at 1 in. w.g., 20 cfm/sf unless more stringent requirements are listed with individual damper specifications.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B nonshrink and nonmetallic dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psig, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 20, 21, 22 and 23 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 at specified slopes.
- D. Select system components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install all piping at right angles or parallel to building walls. Diagonal runs are prohibited.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's written instructions.
- M. Verify final equipment locations for roughing-in.
- N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

- O. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 5. 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:
 - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - c. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. 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.
 6. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
 8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
 - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - b. ABS Piping: ASTM D 2235 and ASTM D 2661.
 - c. CPVC Piping: ASTM D 2846 and ASTM F 493.
 - d. PVC Pressure Piping: ASTM D 2672.
 - e. PVC Nonpressure Piping: ASTM D 2855.
 - f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.
 9. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 procedures and manufacturer's written instructions.
 - a. Plain-End Pipe and Fittings: Use butt fusion.
 - b. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.2 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 with NPS 2 or smaller threaded pipe connection.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 - 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 piping materials of dissimilar metals.

3.3 DUCTWORK SYSTEMS – COMMON REQUIREMENTS

- A. General: Division 23 Ductwork sections specify unique installation requirements.
- B. General locations and arrangements: Drawing plans and schematics indicated general locations and arrangements of ductwork. Transition ductwork, to equivalent size, rise and drop, raises or lower to accommodate space and slope of other utilities pipes and conduits. Install ductwork as indicated, unless deviations to layout are approved on coordination drawings.
- C. Install finished surface frames on walls roofs, ceilings, etc. where ductwork penetrates spaces exposed to view.
 - 1. Prime coat frames ready for field painting at walls and non-accessible ceilings.
 - 2. Match enamel paint for ceiling tee bars where penetrating lay-in ceiling.
- D. Install sleeves for ductwork penetrating walls. Size sleeves for continuous insulation at non-fire rated walls, roofs, and floors. Omit sleeves at fire and smoke walls where sleeves are a portion of a damper assembly.

3.4 MAINTAINING SERVICES

- A. Coordinate maintenance of utility services with requirements of Division 01 Section “Temporary Facilities and Controls.”
- B. Note the presence of existing underground services and exercise caution in the execution of work to avoid disturbing such facilities.

3.5 CONCRETE BASES

- A. Concrete bases are provided by General Contractor, coordinate size and location.
- B. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Anchor equipment to concrete base according to equipment manufacturer’s written instructions.

1. Install dowel rods to connect concrete base to concrete floor. Install dowel rods on 18-inch centers around the full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.6 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- 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 to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces.
- D. 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.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.10 CONNECTIONS TO EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

- A. Drawings indicate connection size and service. Coordinate with equipment installation drawings and provide all accessories and final connections as required.

3.11 MECHANICAL DEMOLITION

- A. Refer to Division 1 Section “Execution” for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing and mechanical systems, equipment, and components indicated to be removed.
- C. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- D. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
- E. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

- F. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
- G. Equipment to Be Removed: Disconnect and cap services to remove equipment.
- H. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- I. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- J. If pipe, duct, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.12 CUTTING AND PATCHING

- A. This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- C. Sizes of cut openings shall accommodate minimum clearances required for new work.
- D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- E. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
- F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- G. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work;
 - 2. Remove and replace defective work;
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents;
 - 4. Remove samples of installed Work as specified for testing;
 - 5. Install equipment and materials in existing structures;
 - 6. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
- H. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- I. Repair cut surfaces to match adjacent surfaces.

3.13 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

END OF SECTION

SECTION 200513

COMMON MOTOR AND FREQUENCY DRIVE
REQUIREMENTS FOR GENERAL MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Section includes general requirements for factory or field provided Variable Frequency Drives (VFD's).

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - a. Magnetic controllers
 - b. Multispeed controllers
 - c. Reduced-voltage controllers
 - d. Variable speed controllers

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Torque, speed, and horsepower requirements of the load.
4. Ratings and characteristics of supply circuit and required control sequence.
5. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide Variable Frequency Drives by one of the following:
 1. ABB
 2. Graham
 3. Square D Company
 4. Toshiba
 5. Reliance
 6. York

2.2 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.3 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F, unless otherwise indicated.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. 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.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Provided with Factory installed Shaft Grounding Rings
 - a. Shall be maintenance-free, circumferential, conductive micro-fiber shaft grounding ring to discharge shaft currents to ground (AEGIS-SGR or similar)
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- D. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.6 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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.

2.7 VARIABLE FREQUENCY DRIVES

- A. The variable frequency drives (VFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform. The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
- B. Specification 3 HP to 100 HP at 480 volts.
 1. Input 440/460/500 VAC +/-10 percent (capable of operation to 550 VAC), 3 phase, 48-63 Hz.
 2. Output 0 – Input Voltage, 3 phase, 0 to 500 Hz for drives up to 75 HP.
 3. Environmental operation conditions: 0 to 40 degrees C at 3 kHz switching frequency, 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing.
 4. Enclosure shall be rated Type 1.

C. All VFD's shall have the following:

1. All VFD's shall have digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (start/stop and speed adjust), for setting all parameters, and for stepping through the displays and menus.
2. The VFD shall give the user the option of either (1) displaying a fault, or (2) running at a programmable preset speed if the input reference (4-20mA or 2-10V) is lost; as selected by the user.
3. The VFD's shall utilize plain English Digital display code numbers are not acceptable. The digital display shall be a 40-character (2 line by 20 characters/line) LCD display. The LCD shall be back lit to provide easy viewing in any light condition. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
4. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs shall count down on the display to warn an operator that a restart will occur.
5. The VFD shall be capable of starting into a rotating load and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
6. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
7. The customer terminal strip shall be isolated from the line and ground.
8. The drive shall employ three current limit circuits to provide trip free operation:
 - a. The Slow Current Regulation limit circuit shall be adjustable to 125 percent (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
 - b. The Rapid Current Regulation limit shall be adjustable to 170 percent (minimum) of the VFD's variable torque current rating.
 - c. The Current Switch-off limit shall be fixed at 255 percent (minimum, instantaneous) of the VFD's variable torque current rating.
9. The overload rating of the drive shall be 11 percent of its variable torque current rating for 1 minute every 10 minutes, and 140 percent of its H torque current rating for 2 seconds every 15 second.
10. The VFD shall have input line fuses standard in the drive enclosure.
11. The VFD shall have a DC Line Reactor to reduce the harmonics to the power line.
12. The VFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise.
13. The VFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.

D. All VFD's to have the following adjustment:

1. Five (5) programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.

2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.
 3. Two programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 – 20 mA and 0-10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 6- Hz, without lowering the drive maximum frequency below 60 Hz.
 4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices.
 5. Two (2) programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power, DC Bus voltage, or Active Reference.
 6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.04 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs must be true form C type contacts; open collector outputs are not acceptable.
 7. Seven (7) programmable preset speeds.
 8. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
 9. The VFD shall Ramp or Coast to a stop, as selected by the user.
- E. The following operating information displays shall be standard on the VFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency.
 2. Motor Speed (RPM, Percent or Engineering Units).
 3. Motor Current.
 4. Calculated Motor Torque.
 5. Calculated Motor Power.
 6. DC Bus Voltage.
 7. Output Voltage.
 8. Heatsink Temperature.
 9. Analog Input Values.
 10. Keypad Reference Values.
 11. Elapsed Time Meter.
 12. kWh Meter.
- F. The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).
1. Overcurrent trip 315 percent instantaneous (225 percent RMS) of the VFD's variable torque current rating.
 2. Overvoltage trip 130 percent of the VFD's rated voltage.
 3. Undervoltage trip 65 percent of the VFD's rated voltage.
 4. Overtemperature+ 70 degrees C.

5. Ground Fault either running or at start
 6. Adaptable Electronic Motor Overload (I²t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve and external fan parameter.
- G. Speed command input shall be via:
1. Keypad.
 2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
 3. Analog input shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20 mA and 0 – 10 volts.
 4. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.
- H. Serial Communications:
1. The VFD shall have an RS-485 port as standard, BAC net MS/TP interface.
 2. The VFD shall be able to communicate with PLC's, DCS's, DDC's, and touch-screen graphic operator panels.
 3. Provide complete IO List.
- I. Door interlocked thermal magnetic circuit breaker which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type, and be padlockable in the "Off" position.
- J. Manual transfer to line power via contactors. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the "Normal mode", the bypass contactor is open and the drive output contactor is closed. In the "Test" position both contactors are open, and the bypass contactor is closed. The drive output contactor shall also open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes. Pilot lights shall be provided for indication of "Normal" operation, "Bypass" operation, and "External Fault". All pilot lights shall be push-to-test type.
- K. Service contactor (drive input contactor) which provides the ability to service the drive (electrically isolate the drive while in bypass operation without having to remove power from the motor.) The service contactor shall open when the drive is switched to bypass, and also be controlled by a switch which is mounted inside the drive enclosure so that its access is limited to service personnel only.
- L. A class20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.
- M. 4-20mA speed reference shall be via direct connection to the VFD.

- N. The VFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.

PART 3 - EXECUTION

3.1 DEMONSTRATION

- A. A factory-authorized service representative shall train owner's maintenance personnel to adjust, operate, and maintain motors and variable frequency drives.

END OF SECTION

SECTION 200517

SLEEVES AND SLEEVE SEALS FOR GENERAL MECHANICAL 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.
- B. Related Sections:
 - 1. Section 200100 "Common Work Results – General Mechanical."

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- C. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.
- D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Metraflex Company
- B. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Airex Manufacturing
 - 3. CALPICO, Inc.
 - 4. GPT; an EnPro Industries company
- B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. CALPICO, Inc.
 3. GPT; an EnPro Industries company
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.

- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Use grout to seal around the outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. 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.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout, to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade, use one of the following:
 - a. Cast-iron pipe sleeves.
 - b. Steel pipe sleeves.
 - c. Sleeve-seal fittings.
 - 2. Exterior Concrete Walls below Grade:
 - a. Cast-iron pipe sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Stack-sleeve fittings.
5. Interior Partitions:
 - a. Install sleeves for pipes passing through concrete and masonry walls, wood-framed walls, ceiling partitions and gypsum-board partitions.
 - 1) Cut sleeves to length for mounting flush with both surfaces.
 - 2) Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3) Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - b. Piping Smaller Than NPS 6: Steel pipe sleeves
 - c. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION

SECTION 200519

METERS AND GAGES FOR GENERAL MECHANICAL 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.
- B. Related Sections:
 - 1. Section 200100 "Common Work Results – General Mechanical."
 - 2. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermometers
 - 2. Liquid-in-glass thermometers
 - 3. Separable sockets
 - 4. Pressure gages
 - 5. Pressure gage fittings.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Liquid-in-Glass Thermometers:
 - a. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - b. Ernst Gage Co.
 - c. Marsh Bellofram.
 - d. Palmer Instruments, Inc.
 - e. Trerice: H. O. Trerice Co.
 - f. Weiss Instruments, Inc.
 2. Pressure Gages:
 - a. AMETEK, Inc.; U.S. Gauge Div.
 - b. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
 - c. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - d. Ernst Gage Co.
 - e. Marsh Bellofram.
 - f. Noshok, Inc.
 - g. Trerice: H. O. Trerice Co.
 - h. Weiss Instruments, Inc.
 - i. WIKA Instruments Corp.

2.2 THERMOMETERS, GENERAL

- A. Scale Range: Temperature ranges for services listed are as follows:
1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
 3. Hydronic Geothermal Water: 0 to 100 deg F, with 2-degree scale divisions.
- B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Description: ASTM E 1.
- B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Tube: Red or blue reading, organic-liquid filled with magnifying lens. Mercury is prohibited.
- E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.
- F. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 SEPARABLE SOCKETS

- A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
 - 4. Insertion Length: To extend to center of pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.

2.5 PRESSURE GAGES

- A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; liquid-filled-case type.
- B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens, liquid filled.
- C. Connector: Brass, NPS 1/4.
- D. Scale: White-coated aluminum with permanently etched markings.
- E. Accuracy: Grade B, plus or minus 2 percent of middle 50 percent of scale.
- F. Range: Comply with the following:
 - 1. Fluids under Pressure: Two times the operating pressure.

2.6 PRESSURE-GAGE FITTINGS

- A. Valves: NPS 1/4 brass or stainless-steel needle type.
- B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

- C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install in the following locations:
 - 1. See Drawings for thermometer locations.
 - 2. Outlet of each water heater.
- C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
 - 1. Install with socket extending to center of pipe.
 - 2. Fill sockets with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

- A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
- B. Install liquid-filled pressure gages in the following locations:
 - 1. Suction and discharge of each pump.
 - 2. See Drawings for additional pressure gage locations.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20, 21, 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
 - 1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.

3.5 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.
- C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 200523

GENERAL-DUTY VALVES FOR GENERAL MECHANICAL 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.
- B. Related Sections:
 - 1. Section 200100 “Common Work Results – General Mechanical.”

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze angle valves.
 - 2. Brass ball valves.
 - 3. Bronze ball valves
 - 4. Iron, single-flange butterfly valves.
 - 5. Iron, grooved-end butterfly valves.
 - 6. High-performance butterfly valves.
 - 7. Bronze swing check valves.
 - 8. Iron swing check valves.
 - 9. Iron, grooved-end swing check valves.
 - 10. Bronze gate valves.
 - 11. Iron gate valves.
 - 12. Bronze globe valves.
 - 13. Iron globe valves.
- B. Related Sections:
 - 1. Section 200553 "Identification for General Mechanical 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.
 - 5. Section 232113 “Hydronic Piping” for additional valve and accessory information.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.

- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to specific VALVE SCHEDULE articles for applications of valves.
- B. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- C. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.
 - 6. ASME B31.1 for power piping valves.
 - 7. ASME B31.9 for building services piping valves.
- D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Actuator Types:
 - 1. Gear Actuator: For valves NPS 8 and larger.
 - 2. Handlever: For valves NPS 6 and smaller.
- I. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

J. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.
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.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.

2.3 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:
 - a. American Valve Inc.
 - b. Apollo Valves; Conbraco Industries
 - c. Crane; Crane Energy Flow Solutions
 - d. Dynaquip Controls
 - e. Hammond Valve
 - f. Jomar Valve
 - g. KITZ Corporation
 - h. Legend Valve and Fitting, Inc.
 - i. Marwin Valve; Richards Industries
 - j. Milwaukee Valve Company
 - k. NIBCO Inc.
 - l. Red White Valve Corp.
 - m. Stockham; Crane Energy Flow Solutions

n. WATTS

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.

2.4 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:
 - a. American Valve, Inc.
 - b. Apollo Valves; Conbraco Industries
 - c. Crane; Crane Energy Flow Solutions
 - d. Hammond Valve
 - e. Lance Valves
 - f. Legend Valve and Fitting, Inc.
 - g. Milwaukee Valve Company
 - h. NIBCO Inc.
 - i. Red White Valve Corp.
 - j. WATTS
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABZ Valve and Controls
 - b. Apollo Valves; Conbraco Industries
 - c. Bray Controls
 - d. Center Line; Crane Energy Solutions
 - e. Cooper Cameron Valves
 - f. DeZurik
 - g. Hammond Valve
 - h. KITZ Corporation
 - i. Milwaukee Valve Company
 - j. Mueller Steam Specialty;
 - k. NIBCO, Inc.
 - l. Norriseal
 - m. Red White Valve Corp.
 - n. Spence Engineering
 - o. Stockham; Crane Energy Flow Solutions
 - p. Sure Flow Equipment Inc.
 - q. Tyco Valves and Controls
 - r. WATTS
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 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: Nickel-plated ductile iron.

2.6 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves, 175 CWP:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnell Mechanical Products
 - b. Kennedy Valve Company; a Division of McWane, Inc.
 - c. Shurjoint Piping Products USA Inc.
 - d. Tyco Fire Products LP

- e. Victaulic Company
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.

2.7 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Single-Flange, High-Performance Butterfly Valves, Class 150:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABZ Valve and Controls
 - b. Apollo Valves; Conbraco Industries
 - c. Bray Controls
 - d. Cooper Cameron Valves
 - e. DeZurik
 - f. Flowseal; Crane Energy Flow Solutions
 - g. Hammond Valve
 - h. Jamesbury; Metso
 - i. Milwaukee Valve Company
 - j. NIBCO, Inc.
 - k. Process Development & Control, Inc
 - l. Stockham; Crane Energy Flow Solutions
 - m. Tyco Valves and Controls
 - n. XOMOX; Crane Chempharma
- 2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Carbon steel.
 - h. Service: Bidirectional.

2.8 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve Inc.
 - b. Apollo Valves; Conbraco Industries
 - c. Crane; Crane Energy Flow Solutions
 - d. Hammond Valve
 - e. Jenkins Valve; Crane Energy Flow Solutions
 - f. Jomar Valve
 - g. KITZ Corporation
 - h. Macomb Group (The)
 - i. Milwaukee Valve Company
 - j. NIBCO Inc.
 - k. Powell Valves
 - l. Red White Valve Corp.
 - m. Stockham; Crane Energy Flow Solutions
 - n. WATTS
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.

2.9 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries
 - b. Crane; Crane Energy Flow Solutions
 - c. Hammond Valve
 - d. Jenkins Valve; Crane Energy Flow Solutions
 - e. KITZ Corporation
 - f. Legend Valve & Fitting, Inc.
 - g. Macomb Group (The)
 - h. Milwaukee Valve Company
 - i. NIBCO Inc.
 - j. Powell Valves

- k. Red White Valve Corp.
- l. Stockham; Crane Energy Flow Solutions
- m. Sure Flow Equipment Inc
- n. WATTS

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

2.10 IRON, GROOVED-END SWING CHECK VALVES

A. Iron, Grooved-End Swing Check Valves, 300 CWP:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International
 - b. Grinnell Mechanical Products
 - c. Shurjoint Piping Products USA Inc.
 - d. Tyco Fire Products LP
 - e. Victaulic Company
- 2. Description:
 - a. CWP Rating: 300 psig.
 - b. Body Material: ASTM A 536, ductile iron.
 - c. Seal: EPDM.
 - d. Disc: Spring operated, ductile iron or stainless steel.

2.11 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve Inc.
 - b. Apollo Valves; Conbraco Industries
 - c. Crane; Crane Energy Flow Solutions
 - d. Hammond Valve

- e. Jenkins Valve; Crane Energy Flow Solutions
- f. Jomar Valve
- g. KITZ Corporation
- h. Macomb Group (The)
- i. Milwaukee Valve Company
- j. NIBCO Inc.
- k. Powell Valves
- l. Red White Valve Corp.
- m. Stockham; Crane Energy Flow Solutions
- n. WATTS

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.

2.12 IRON GATE VALVES

A. Iron Gate Valves, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; Conbraco Industries
- b. Crane; Crane Energy Flow Solutions
- c. Flo Fab Inc.
- d. Hammond Valve
- e. Jenkins Valve; Crane Energy Flow Solutions
- f. KITZ Corporation
- g. Legend Valve & Fitting, Inc.
- h. Macomb Group (The)
- i. Milwaukee Valve Company
- j. NIBCO Inc.
- k. Powell Valves
- l. Red White Valve Corp.
- m. Stockham; Crane Energy Flow Solutions
- n. WATTS

2. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

2.13 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; Crane Energy Flow Solutions
 - b. Hammond Valve.
 - c. KITZ Corporation.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Powell Valves.
 - g. Red-White Valve Corporation.
 - h. Smith Cooper International
 - i. WATT
 - j. Zy-Tech Global Industries, 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 and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

2.14 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; Crane Energy Flow Solutions
 - b. FNW; Ferguson Enterprises, Inc.
 - c. Hammond Valve.
 - d. KITZ Corporation.
 - e. Milwaukee Valve Company.

- f. NIBCO INC.
- g. Powell Valves.
- h. Red-White Valve Corporation.
- i. WATT
- j. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-85, 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. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 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 check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- F. Install valve tags. Comply with requirements in Section 200553 "Identification for General Mechanical Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded, solder-joint or pressure-seal fitting valve-ends.
 - 2. For Copper Tubing, NPS 2-1/2 or larger: Flanged ends.
 - 3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded valve-ends.
 - 5. For Steel Piping, NPS 5 and Larger: Flanged ends.
 - 6. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.
- C. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or gate valves.
 - 2. Throttling Service: Ball or butterfly valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
 - 4. Hydronic Section Isolation Valves: Butterfly valves.
- D. Domestic Water Piping, Use the following types of valves:
 - 1. Swing Check Valves, NPS 2 and Smaller: Class 125, bronze.
 - 2. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, gray iron.
 - 3. NPS 2 and Smaller: Class 125, bronze.
 - 4. NPS 2-1/2 and Larger: Class 125, 250, NRS, bronze-mounted cast iron.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves (At Fixture Only): Class 125, bronze disc.
3. Ball Valves: Two piece, full port, brass or bronze with brass or bronze trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.
5. Bronze Gate Valves: Class 125, NRS.
6. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves: Class 150.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron Gate Valves: Class 125, NRS.
5. Iron Globe Valves: Class 125.

3.6 HVAC PIPING VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Brass or bronze ball valves, two piece, with brass or bronze trim, and full port.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valve: Ductile-iron disc, 200 CWP, and EPDM seat.
2. Iron, Grooved-End Butterfly Valves: 300 CWP.
3. High-Performance Butterfly Valves: Single flange, Class 150.
4. Iron, grooved-end swing check valves, 300 CWP.
5. Iron swing check valves with metal seats, Class 125.
6. Iron gate valves, NRS, Class 125.

END OF SECTION

SECTION 200529

HANGERS AND SUPPORTS FOR GENERAL MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 200100 "Common Work Results – General Mechanical."
3. Section 200516 "Expansion Fittings and Loops for General Mechanical Piping" for pipe guides and anchors.
4. Section 200548 "Vibration Controls for General Mechanical" for vibration isolation devices.
5. Section 221116 "Domestic Water Piping" for piping hangers and supports.
6. Section 221316 "Sanitary Waste and Vent Piping" for piping hangers and supports.
7. Section 232113 "Hydronic Piping" for piping hangers and supports.
8. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel." ALL welding for any structural support must be performed OUTSIDE the facility.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line Inc.
 - 2. Grinnell Corp.
 - 3. PHD Manufacturing, Inc.
- B. 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.
- C. 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.

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 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-Line, an Eaton Business.
 - c. Thomas & Betts Corporation, a Member of the ABB Group.
 - d. Unistrut; Part of Atkore International.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with intumed lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc or Hot-dipped galvanized.
8. Paint Coating: Vinyl or epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. ERICO International Corporation.
 - c. NIBCO Inc.
2. Description: Shop- or field-fabricated pipe support assembly made of steel channels, accessories, fittings and other components for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with intumed lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous thread rod, nuts and washers made of carbon steel or stainless steel.
7. Coating: Paint.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hilti, Inc.
 - 2. ITW Ramset/Red Head.
 - 3. Masterset Fastening Systems, Inc.
- B. 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.
- C. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-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.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Stainless steel
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: One or more; plastic.
 3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 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, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger, pipe clamp or shield for insulated piping.
- E. 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.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. 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.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

- a. Use thermal hanger shield insert with clamp sized to match OD of insert.
 - b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. 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: ALL field welding must be performed OUTSIDE the facility. 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: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Interior Painting"
- C. 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, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. 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.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. 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.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. 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.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. 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.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. 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.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 200548

VIBRATION CONTROLS FOR GENERAL MECHANICAL

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. Section 200100 “Common Work Results – General Mechanical.”

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Open-spring isolators.
 - 4. Pipe-riser resilient supports.
 - 5. Resilient pipe guides.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device component required.
 - a. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations and details for selecting vibration isolators and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Contractor shall provide products from a qualified vibrations control vendor/supplier. Provide vibration controls products from one of the following:
 1. Ace Mountings Co., Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line
 4. Gripple, Inc.
 5. Kinetics Noise Control, Inc.
 6. Mason Industries

7. Vibration Eliminator Co., Inc.
8. Vibration Mountings & Controls, Inc
9. Vibro-Acoustics

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Smooth pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

A. 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 steel plate for bolting to structure with an elastomeric isolator pad attached to the 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.

2.5 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.
 - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.6 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.
 - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.7 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 - 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.8 SPRING HANGERS

- A. 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. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Spring hangers are required for any suspended piece of equipment that has an operational motor, such as:
 1. Fans
 2. Pumps
 3. Water Source Heat Pumps
- D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- 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. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. 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.
- H. 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 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.

3.5 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION

SECTION 200553

IDENTIFICATION FOR GENERAL MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
 - 1. Section 200100 “Common Work Results – General Mechanical.”

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Duct labels.
 - 4. Valve tags.
 - 5. Valve schedules.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Letter Color: Red.
 - 3. Background Color: White.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (3 by 5 inch for roof mounted equipment).
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 6. Fasteners: Stainless-steel self-tapping screws.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White
 - 3. Background Color: Black
 - 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 (3 by 5 inch for roof mounted equipment).
 - 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-quarters 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.

- D. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- E. 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) and 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 according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full 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; also include 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.3 DUCT LABELS

- A. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
- B. Letter Color: White
- C. Background Color: see 3.5 Duct Label Installation.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.4 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain, beaded chain or S-hook.
 - 3. Valve-Tag Color: Safety Red.
 - 4. Letter Color: White.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 - 2. Frame: Finished hardwood.
 - 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

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 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. 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 and on both sides of 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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Fire-Suppression Piping: White letters on safety-red background.
 - 2. Domestic Water Piping: White letters on safety-green background.
 - 3. Sanitary Waste and Storm Piping: Blue letters on safety-grey background.
 - 4. Geothermal Water Piping: White letters on a safety-green background.
 - 5. Refrigerant Piping: White letters on a safety-purple background.
 - 6. Natural Gas Piping: Black Letters on a safety-yellow background.

3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For combination heating and cooling duct.
 - 2. Red: For exhaust-air ducts.
 - 3. Yellow: For return-air ducts.
 - 4. Green: For outside-air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size and with captions similar to those indicated in the following:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches round.
 - b. Hot Water: 1-1/2 inches round.
 - c. Fire Protection: 1-1/2 inches round.
 - d. Geothermal: 1-1/2 inches round.

3.7 VALVE SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.8 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 200719

GENERAL MECHANICAL 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 piping services:
 - 1. Chilled water piping.
 - 2. Heating hot water piping.
 - 3. Condensate drain piping.
 - 4. Refrigerant piping.
- B. Related Sections:
 - 1. Section 079200 "Joint Sealants" and section 078413 "Penetration Firestopping" for details of sealants and firestopping required around insulation at penetrations.
 - 2. Section 200529 "Hangers and Supports for General Mechanical Piping and Equipment" for thermal-hanger shield inserts.
 - 3. Section 220716 "Plumbing Equipment Insulation."
 - 4. Section 230713 "Duct Insulation."
 - 5. 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, equipment connections, and access panels.

6. Detail application of field-applied jackets.
 7. Detail application of linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 2. Sheet Form Insulation Materials: 12 inches square.
 3. Jacket Materials for Pipe: 12 inches long by NPS 2.
 4. Sheet Jacket Materials: 12 inches square.
 5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATION SUBMITTALS

- A. Qualification Data: For qualified installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting and certifying test results for compliance of insulation materials, sealers, attachments, cements and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality control reports.

1.5 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, by a testing and inspecting 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.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

- a. One 10-foot section of NPS 2 straight pipe.
- b. One each of a 90-degree threaded, welded, and flanged elbow.
- c. One each of a threaded, welded, and flanged tee fitting.
- d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
- e. Four support hangers including hanger shield and insert.
- f. One threaded strainer and one flanged strainer with removable portion of insulation.
- g. One threaded reducer and one welded reducer.
- h. One pressure temperature tap.
- i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 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.

1.7 COORDINATION

- A. All insulation must be **CONTINUOUS** at each clevis-type and/or trapeze-type pipe hanger. Provide thermal shield inserts as required for continuous insulation, jacket and vapor barrier.
- B. Coordinate sizes and locations of supports, hangers and insulation shields specified in Section 200529 "Hangers and Supports for General Mechanical Piping and Equipment."
- C. 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.

- D. Coordinate installation and testing of heat tracing.

1.8 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 insulation 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. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 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
- F. 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 I with factory-applied FSK jacket. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville, a Berkshire Hathaway company.

- c. Knauf Insulation.
- d. Owens Corning.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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. 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. 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. 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. 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. 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. 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 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. 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. 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.
 - d. Speedline Corporation.
 - 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, adhesive shall 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Vimasco Corporation.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.

C. Breather Mastic: Water based; suitable for indoor use on above ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Mon-Eco Industries, Inc.
 - e. Vimasco Corporation.
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-A03316C, Class I, Grade A and shall be compatible with insulation materials, jackets and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Vimasco Corporation.
2. For indoor applications, sealants shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
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.

2.6 SEALANTS

A. Insulation 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 when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. 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. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. 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: 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.”

C. 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. 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.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as 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
 - b. P.I.C. Plastics, Inc
 - c. Proto Corporation
 - d. Speedline Corporation
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
- C. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products
 - b. ITW Insulation Systems; Illinois Tool Works, Inc.
 - c. RPR Products, Inc.
 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 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.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240.

- a. Factory cut and rolled to size.
- b. Material, finish and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
- 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.

2.9 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. ABI, Ideal Tape Division
 - b. Avery Dennison Corporation, Specialty Tapes Division
 - c. Compac Corporation
 - d. 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. ABI, Ideal Tape Division
 - b. Avery Dennison Corporation, Specialty Tapes Division
 - c. Compac Corporation
 - d. 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.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Compac Corporation
 - b. Ideal Tape Division
 - c. Venture Tape
 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, provide one of 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.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Company.
 - b. Insul-Tect Products Co.
 - c. McGuire Manufacturing.
 - d. Plumberex.
 - e. Truebro; a brand of IPS Corporation.
 - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Truebro
 - b. Zurn Industries, LLC
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

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.
- 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. **Do not cut or notch insulation at hangers, supports or anchors. Provide an insulation pipe hanger insert at each hanger, support or anchor. Apply insulation inserts at time of pipe installation to ensure proper pipe slope and alignment.**
- K. 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 insert 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 or shield.
- L. Apply adhesives, mastics and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation material more than 75 percent of its nominal thickness.

- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. 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 used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts and nuts. Fill joints, seams and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation or one pipe diameter, whichever is thicker. Fill joints, seams and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

- above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word “union.” Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches and transmitters on insulated pipes. 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 centerline 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.
 6. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 7. Where vapor barriers are indicated, seal longitudinal seams, end joints and protrusions with vapor-barrier mastic and joint sealant.
 8. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 9. 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.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of performed 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 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 installation.

3.7 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.

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 performed 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 installation.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. 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.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 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.
 - 1. Add a UV retardant coating to all exterior insulation to minimize ultraviolet degradation.
 - a. Provide a product similar to K-FLEX 374.
- 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 define 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 duct system, selection from materials listed is Contractor’s option, but shall be consistent throughout the project.
- 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. Chilled Water Supply and Return, 55 Deg F and below:

1. NPS 4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
 - b. Flexible Elastomeric: 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. Mineral Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - C. Condensate and Equipment Drain Water below 70 Deg F:
 1. All Pipe Sizes: 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.
 - D. Refrigerant Piping:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - E. Refrigerant Tubing:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- 3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE
- A. Chilled Water Supply and Return, 55 Deg F and below:
 1. NPS 4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
 - b. Flexible Elastomeric: 1-1/2 inch thick.
 - B. Refrigerant Piping:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 2 inches thick.
 - b. Mineral Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
 - C. Refrigerant Tubing:
 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Flexible Elastomeric: 2 inches thick.
- b. Mineral Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.15 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. Domestic cold, domestic hot and sanitary waste and vent piping exposed at lavatories:
 - 1. PVC 30 mils thick.
 - 2. Manufactured protective shielding pipe cover.

3.16 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 located within a piping vestibule:
 - 1. PVC, White: 20 mils thick.
- D. Exposed Piping (ALL):
 - 1. Aluminum, Smooth or Corrugated with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION

SECTION 221124

FACILITY NATURAL GAS 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. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, 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.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressures within Buildings: Primary pressure is 0.5 psig or less.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.

- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.11 COORDINATION

- A. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.

- e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
- 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- 6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 - 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 - 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 - 5. Striker Plates: Steel, designed to protect tubing from penetrations.
 - 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.

7. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type L (ASTM B 88M, Type B).
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
 2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
 - a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
- D. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type L (ASTM B 88M, Type B).
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
 2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads complying with ASME B1.20.3.
 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 4. Corrugated stainless-steel tubing with polymer coating.
 5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
 6. End Fittings: Zinc-coated steel.
 7. Threaded Ends: Comply with ASME B1.20.1.
 8. Maximum Length: 72 inches (1830 mm.)
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
1. Copper-alloy convenience outlet and matching plug connector.
 2. Nitrile seals.
 3. Hand operated with automatic shutoff when disconnected.
 4. For indoor or outdoor applications.
 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig (862 kPa).

2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig (862 kPa).
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated brass.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig (4140 kPa).
 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.

- d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
- 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig (4140 kPa).
 - 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig (4140 kPa).
 - 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Bronze Plug Valves: MSS SP-78.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Plug: Bronze.
 - 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Operator: Square head or lug type with tamperproof feature where indicated.

6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

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. Actaris.
 - b. American Meter Company.
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - e. Invensys.
 - f. Maxitrol Company.
 - g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig (34.5 kPa).

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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. Canadian Meter Company Inc.
 - b. Eaton Corporation; Controls Div.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 - e. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
 9. Maximum Inlet Pressure: 5 psig (34.5 kPa).

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 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. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International Ltd.
 - e. Matco-Norca, Inc.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 250 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 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. Capitol Manufacturing Company.
 - b. Central Plastics Company.

- c. Matco-Norca, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 250 psig.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig (1035 kPa).
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe

with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 200517 "Sleeves and Sleeve Seals for General Mechanical Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 200517 "Sleeves and Sleeve Seals for General Mechanical Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 200518 "Escutcheons for General Mechanical Piping."

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. 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.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 200548 "Vibration Controls for General Mechanical."
- B. Comply with requirements for pipe hangers and supports specified in Section 200529 "Hangers and Supports for General Mechanical Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
 2. (NPS 1-1/4) (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 3. (NPS 1-1/2 and NPS 2) (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 4. (NPS 2-1/2 to NPS 3-1/2) (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
 5. (NPS 4) (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
- D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
 2. (NPS 1/2 and NPS 5/8) (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
 3. (NPS 3/4 and NPS 7/8) (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
 4. (NPS 1) (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
- E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
 2. (NPS 1/2) (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
 3. (NPS 3/4) (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.

- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.9 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel.
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex.
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
 - 3. Annealed-temper, copper tube with wrought-copper fittings and brazed flared joints.
 - 4. Aluminum tube with flared fittings and joints.
 - 5. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
 - 3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, full-port, bronze ball valves with bronze trim.

3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes (DN 50) and smaller shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes (DN 65) and larger shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION

SECTION 230100

COMMON SPECIFICATIONS - GENERAL HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Reference and comply with all Division 20 – General Mechanical specifications. All division 20 specifications are applicable to Division 23 – Heating, Ventilating and Air Conditioning. Division 20 specifications may complement other Division 23 – Heating, Ventilating and Air Conditioning specifications.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 230130

HVAC AIR-DISTRIBUTION SYSTEM CLEANING

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 cleaning new and existing HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
- C. Cleaning Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.
- C. Systems and Components to Be Cleaned:
 - 1. Air devices for supply and return air.
 - 2. Air-terminal units.
 - 3. Ductwork:

- a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
 - b. Return-air ducts to the air-handling unit.
 - c. Exhaust-air ducts.
4. Air-Handling Units:
 - a. Interior surfaces of the unit casing.
 - b. Coil surfaces compartment.
 - c. Condensate drain pans.
 - d. Fans, fan blades, and fan housings.
5. Filters and filter housings.
- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- E. Particulate Collection:
 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- F. Control odors and mist vapors during the cleaning and restoration process.
- G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- I. Clean all air-distribution devices, registers, grilles, and diffusers.
- J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
 1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
 2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
 3. Clean evaporator coils, reheat coils, and other airstream components.
- K. Duct Systems:
 1. Create service openings in the HVAC system as necessary to accommodate cleaning.

2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- M. Mechanical Cleaning Methodology:
1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
 - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
 2. Cleaning Mineral-Fiber Insulation Components:
 - a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
 - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
 - c. Fibrous materials that become wet shall be discarded and replaced.
- N. Coil Cleaning:
1. Measure static-pressure differential across each coil.
 2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
 3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
 4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
 5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
 6. Rinse thoroughly with clean water to remove any latent residues.

3.4 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Additional Verification:
 - 1. Perform surface comparison testing or NADCA vacuum test.
 - 2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- E. Verification of Coil Cleaning:
 - 1. Measure static-pressure differential across each coil.
 - 2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of the differential measured when the coil was first installed.
 - 3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.
- F. Prepare a written cleanliness verification report. At a minimum, include the following:
 - 1. Written documentation of the success of the cleaning.
 - 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 - 3. Surface comparison test results if required.
 - 4. Gravimetric analysis (nonporous surfaces only).
 - 5. System areas found to be damaged.

3.5 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 "Metal Ducts." Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts."
- D. Replace damaged insulation according to Section 230713 "Duct Insulation."

- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The Testing, Adjusting and Balancing (TAB) agent shall directly represent the Building Owner. The TAB agent shall be under contract with the Contractor and shall be paid from project funds.
- B. Work indicated in this section and on Project Drawings shall be performed in its entirety by this Contractor. If the Contractor excludes any work from his bid, the bid will be rejected.
- C. The TAB agent shall be qualified to perform the desired services and perform testing, adjusting, and balancing procedures, or qualified to perform approved certification according to the procedures contained in the Associated Air Balance Council (AABC) national standards, the National Environmental Balancing Bureau (NEBB) procedural standards, and the Environmental Engineering Consultants (EEC) standards for testing, adjusting and balancing.
- D. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-air-volume systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - 3. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Condensing units.
 - c. Heat-transfer coils.
 - 4. Sound tests.
 - 5. Duct leakage tests.
 - 6. Control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- E. BAS: Building automation system.
- F. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- G. NC: Noise criteria.
- H. NEBB: National Environmental Balancing Bureau.
- I. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- J. RC: Room criteria.
- K. Report Forms: Test data sheets for recording test data in logical order.
- L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- N. TAB: Testing, adjusting, and balancing.
- O. TABB: Testing, Adjusting, and Balancing Bureau.
- P. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- Q. TDH: Total dynamic head.
- R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

- S. Test: A procedure to determine quantitative performance of systems or equipment.
- T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at project site with the Owner's and Architect's representatives after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit 4 copies of documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB Reports: Submit four copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm. Submit two copies to the Owner and two copies to the Architect for approval.
 - A. If the Architect requires corrections to the TAB report, then the Contractor will make the corrections and resubmit the complete corrected reports to the Architect and Owner within thirty (30) days, with a cover letter addressing the corrections.
 - B. Sample Report Forms: Submit two sets of sample TAB report forms with Qualification Data.

- C. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.
- D. Warranties specified in this Section.
- E. Submit TAB report in Microsoft Excel or Word or compatible file format burned to a CD, in addition to paper copies, when final corrections are made.

1.6 QUALITY ASSURANCE

- A. TAB Firm and Specialists Qualifications: Certified by AABC, NEBB or TABB.
- B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.", or TAB firm's forms approved by Architect.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and HVAC Contractor to operate HVAC systems and equipment to support and assist TAB activities. TAB work schedule shall conform to HVAC and Control Contractor's work schedules.
- B. Coordinate the efforts of factory-authorized Geothermal Wellfield flushing and purging Contractors to operate systems and equipment to support and assist TAB activities. TAB work schedule shall conform to HVAC and those Contractor's work schedules.
- C. West Virginia Department of Education (WVDE) shall be notified a minimum of 2 weeks before TAB work begins.
- D. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- E. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

1.9 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
- B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
- C. Other contractors, if approved by Architect, shall provide a guarantee equal to that of AABC or NEBB.
- D. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they 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 curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. 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.
- C. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
- b. Piping is complete with terminals installed.
- c. Water treatment is complete.
- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning per the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. TAB contractor shall not perform adjusting and balancing until systems are complete and ready for operation. This includes the building control system.
- B. TAB procedures shall be performed in the presence of the Owner's representatives.
- C. 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.
- D. 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. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 200719 "General Mechanical Piping Insulation."
- E. 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.
- F. 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. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.

- b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 6. After testing, adjusting, and balancing is completed, TAB Contractor shall replace the adjustable sheaves furnished with units with fixed sheaves of appropriate size. The fixed sheaves shall be furnished and installed by the TAB Contractor. Turn adjustable sheaves over to the Owner. No Exceptions. This work is mandated by West Virginia Department of Education Policy 6200.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.

6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Verify initial pressure setting in bladder expansion tanks.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for geothermal hydronic systems.

B. Adjust the variable-flow geothermal hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

- 1) Position valves for full flow through coils.
- 2) Measure flow by main flow meter, if installed.
- 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

- 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
- 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
- 3) Convert pressure to head and correct for differences in gage heights.
- 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
- 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed in each geothermal wellfield row to design water flows.
 - a. Measure flow at wellfield row.
 - b. Adjust each wellfield row to design flow.
 - c. Re-measure each wellfield row after all have been adjusted.
4. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
5. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
6. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
7. Prior to verifying final system conditions, determine the system differential-pressure set point.
8. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
9. Mark final settings and verify that all memory stops have been set.
10. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.

- c. Mark final settings.
- 11. Verify that memory stops have been set.
- D. For systems with diversity:
 - 1. Determine diversity factor.
 - 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 - 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 - 4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 - 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.10 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.11 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 6. Capacity: Calculate in tons of cooling.
 7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.12 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
1. Measure and record entering- and leaving-water temperatures.
 2. Measure and record water flow.
 3. Record relief valve pressure setting.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- B. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.

3.14 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents. Note air pressures and device positions and correlate with airflow measurements. Note the speed of response to input changes.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.15 TOLERANCES

- A. Set HVAC system's airflow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 to minus 10 percent.
2. Air Outlets and Inlets: Plus 10 to minus 10 percent.

- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.16 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for 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 biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fan 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.

- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Pipe and valve sizes and locations.
 4. Terminal units.
 5. Balancing stations.
 6. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Refrigerant expansion valve and refrigerant types.
- i. Refrigerant suction pressure in psig.
- j. Refrigerant suction temperature in deg F.

G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.
- d. Air temperature differential in deg F.
- e. Entering-air static pressure in inches wg.
- f. Leaving-air static pressure in inches wg.
- g. Air static-pressure differential in inches wg.
- h. Low-fire fuel input in Btu/h.
- i. High-fire fuel input in Btu/h.
- j. Manifold pressure in psig.
- k. High-temperature-limit setting in deg F.
- l. Operating set point in Btu/h.
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For geothermal water coils of condensing units include the following:
1. Unit Data:
 - a. System identification.
 - b. Location and zone.
 - c. Area served.
 - d. Coil make and size.

- e. Flowmeter type.
- 2. Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F
 - b. Leaving-water temperature in deg F
 - c. Water pressure drop in feet of head or psig
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm
 - g. Water pressure differential in feet of head or psig
 - h. Required net positive suction head in feet of head or psig
 - i. Pump rpm.
 - j. Impeller diameter in inches
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig
 - b. Pump shutoff pressure in feet of head or psig
 - c. Actual impeller size in inches
 - d. Full-open flow rate in gpm
 - e. Full-open pressure in feet of head or psig
 - f. Final discharge pressure in feet of head or psig
 - g. Final suction pressure in feet of head or psig
 - h. Final total pressure in feet of head or psig
 - i. Final water flow rate in gpm
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- M. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.

- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.18 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Measure sound levels at two locations.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner and Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner and Architect.
3. Owner and Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.19 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

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.
- B. Related Sections:
 - 1. Section 200719 “General Mechanical Piping Insulation.”
 - 2. Section 233113 “Metal Ducts” for duct liners.

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 insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application of linkages of control devices.

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, 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 200529 “Hangers and Supports for General Mechanical Piping and Equipment.”
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- 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 “Duct Insulation Schedule, General,” and “Indoor 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville, a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.

- c. Knauf Insulation.
- d. Owens Corning.

2.2 FIRE-RATED SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, non-asbestos, biosoluble, patented inorganic fire resistant blanket encapsulated with a scrim-reinforced foil, blanket thickness of 1.5 inches for kitchen exhaust grease duct applications, tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction. Provide two layers of 1.5 inch thick insulation.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M.
 - b. CertainTeed Corporation.
 - c. Johns Manville; a Berkshire Hathaway company.

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. Flexible Elastomeric 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. K-Flex USA.
 - 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. 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. 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."
- 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. 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, adhesive shall 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. 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, 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.

2.5 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. 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 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. Metal Jacket:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. ITW Insulation Systems; Illinois Tool Works, Inc.
 - c. RPR Products, Inc.
 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240.
 - a. Factory cut and rolled to size.
 - b. Material, finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.8 TAPES

- A. Comply with requirements in “Duct Insulation Schedule, General,” and “Indoor Duct and Plenum Insulation Schedule” articles for where insulating materials shall be applied.
 1. Width: 4 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.

2.9 SECUREMENTS

- A. Bands:
 1. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
 1. 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. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
- C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories and finishes with smooth, straight and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, 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. 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 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.
 1. 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.
 2. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 3. 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” for firestopping and fire-resistive joint sealers.
- 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 adhesive and insulation pins.
1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

- b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch outward-clinching staples, 1 inch o.c. install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic and sealant at joints, seams and protrusions.
 - a. Repair punctures, tears and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18 foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface to be insulated. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.

- e. Cut excess portion of pins extending beyond speed washers. Cover exposed pins and washers with tape matching insulation facing.
- 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch outward-clinching staples, 1 inch o.c. install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic and sealant at joints, seams and protrusions.
 - a. Repair punctures, tears and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18 foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface to be insulated. 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 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.
- B. Where metal jackets are indicated, install with 2 inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

1. Overlap perimeter and longitudinal joints 3 inches to 4 inches on both layers. If required, tape seams using minimum 3 inch wide aluminum foil adhesive tape.
2. Filament tape may be used as a temporary securing measure during application of duct wrap. Finish installation using 1/2 inch wide by 0.015 inch steel banding on exterior layer of wrap, spacing 10-1/2 inches o.c. and within 1-1/2 inches of all overlapped seams.
3. For duct widths greater than 24 inches, weld insulation pins to bottom of horizontal ducts on a 12 inch by 10-1/2 inch maximum grid spacing. Impale duct wrap insulation over pins and secure with speed clips.
4. At access doors: Install duct wrap to manufacturer's requirements.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed work.

C. Do not field paint aluminum or stainless steel jackets.

3.10 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 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 two locations for each duct system defined in the "Duct Insulation Schedule, General" article.

D. All insulation applications will be considered defective work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.

- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round, supply-, and outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- B. Concealed, rectangular, supply-, and outdoor-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 2. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
- C. Exposed, round, supply-, and outdoor-air duct insulation is specified in Section 233113 “Metal Ducts.”
- D. Exposed, rectangular, supply-, and outdoor-air duct insulation is specified in Section 233113 “Metal Ducts.”

END OF SECTION

SECTION 232113 - HYDRONIC 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. Copper tube and fittings.
 - 2. Steel pipe and fittings.
 - 3. Joining materials.
 - 4. Transition fittings.
 - 5. Dielectric fittings.
 - 6. Bypass chemical feeder.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe and tube.
 - 2. Fittings.
 - 3. Joining materials.
 - 4. Transition fittings.
 - 5. Bypass chemical feeder.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.
- C. Preconstruction Test Reports:
 - 1. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

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

- B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on water quality.

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 unless otherwise indicated:
 - 1. Chilled-Water Piping: 150 psig at 73 deg F.
 - 2. Makeup-Water Piping: 80 psig at 73 deg F.
 - 3. Condensate-Drain Piping: 150 deg F.
 - 4. Blowdown-Drain Piping: 180 deg F.
 - 5. Air-Vent Piping: 180 deg F.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- C. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- D. Wrought Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A234, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. National Fittings, Inc.
 - c. Nexus Valve, Inc.
 - d. Smith-Cooper International.
 - e. Victaulic Company.
 - 2. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47, Grade 32510 malleable iron; ASTM A53, Type F, E, or S, Grade B fabricated steel; or ASTM A106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 3. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.4 JOINING MATERIALS

- A. 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 otherwise 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.

- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Matco-Norca.
 - d. WATTS.
 - e. Wilkins.
 - f. Zurn Industries, LLC.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. WATTS.
 - e. Wilkins.
 - f. Zurn Industries, LLC.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 150 psig.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell G-Fire by Johnson Controls Company.
 - c. Matco-Norca.
 - d. Precision Plumbing Products.
 - e. Victaulic Company.
2. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

2.6 BYPASS CHEMICAL FEEDER

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:
 - 1. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be either of the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 - 2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- C. Makeup-Water Piping, Copper: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered.
- D. Condensate-Drain Piping, Copper: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- F. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. 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.
- C. Install piping to permit valve servicing.
- D. Install piping at indicated slopes.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.

- G. Install piping to allow application of insulation.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- K. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- N. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."
- O. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- Q. Install shutoff valve immediately upstream of each dielectric fitting.
- R. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results - Mechanical."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results - Mechanical."

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 pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

- D. 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.
- E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration Controls for HVAC."
- B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting and coupling.
- E. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
 - 1. pH: 9.0 to 10.5.
 - 2. "P" Alkalinity: 100 to 500 ppm.
 - 3. Boron: 100 to 200 ppm.
 - 4. Chemical Oxygen Demand: Maximum of 100.
 - 5. Corrosion Inhibitor: One of the following, to be coordinated with Owner:
 - a. Sodium Nitrate: 1000 to 1500 ppm.
 - b. Molybdate: 200 to 300 ppm.
 - c. Chromate: 200 to 300 ppm.
 - d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
 - e. Chromate Plus Molybdate: 50 to 100 ppm each.
 - 6. Soluble Copper: Maximum of 0.20 ppm.
 - 7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
 - 8. Total Suspended Solids: Maximum of 10 ppm.
 - 9. Ammonia: Maximum of 20 ppm.
 - 10. Free Caustic Alkalinity: Maximum of 20 ppm.
 - 11. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
 - c. Nitrate Reducers: 100 organisms/mL.
 - d. Sulfate Reducers: Maximum of zero organisms/mL.
 - e. Iron Bacteria: Maximum of zero organisms/mL.
- B. Install bypass chemical feeders in each hydronic system where indicated.
 - 1. Install in upright position with top of funnel not more than 48 inches above the floor.
 - 2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.

3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- B. Perform the following tests on hydronic piping:
 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
 1. Open manual valves fully.

2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

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.

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 calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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.

1.6 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to 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 HYDRONIC SPECIALTY VALVES

- A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General Duty Valves for HVAC Piping."
- B. Triple-Duty Valve:
 - 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. Griswold Controls.
 - d. Taco.
 - e. Tour & Andersson; available through Victaulic Company.
 - f. Victaulic Company.
 - 2. Angle or straight pattern.
 - 3. 175-psig pressure rating, cast-iron body.
 - 4. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
 - 5. Brass gage ports with integral check valve and orifice for flow measurement.
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 - 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. Griswold Controls.
 - d. Taco.
 - e. Tour & Andersson; available through Victaulic Company.
 - f. Victaulic Company.
 - 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 3. Ball: Brass or stainless steel.
 - 4. Plug: Resin.
 - 5. Seat: PTFE.
 - 6. End Connections: Threaded or socket.
 - 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.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

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. Griswold Controls.
 - d. Taco.
 - e. Tour & Andersson; available through Victaulic Company.
 - f. Victaulic Company.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

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. Spence Engineering Company, Inc.
 - e. Watts; a Watts Water Technologies company.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.2 AIR-CONTROL DEVICES

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; a Xylem brand.
 - d. Taco, 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; a Xylem brand.
 - d. Taco, 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. TACO Comfort Solutions, Inc.
 - e. WATTS.
2. Tank: Pre-charged, horizontal, welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Heavy duty Butyl rubber, 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. -Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air and Dirt Separators:

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. TACO Comfort Solutions, Inc.
2. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 350 deg F maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Sediment Separator: Carbon steel internal deflector screen on the inside of the tank body to direct sediment down to dome style collection cap on the bottom of the unit. Collection cap shall include threaded blow down connection to allow for sediment to be regularly cleaned out of the unit
5. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Keckley Company.
 - b. Metraflex Company (The).
 - c. Titan Flow Control, Inc.
 - d. WATTS.
2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
5. CWP Rating: 125 psig.

B. Basket Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Keckley Company.
 - b. Metraflex Company (The).
 - c. Titan Flow Control, Inc.
 - d. WATTS.
2. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
5. CWP Rating: 125 psig.

2.4 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.

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 calibrated-orifice, balancing 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 pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. 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.
- B. Install tangential air and dirt separator in pump suction. Install blowdown piping with full-port ball valve; extend full size to nearest floor drain.
- C. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

END OF SECTION

SECTION 232123

HYDRONIC PUMPS

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. Close-coupled, end-suction centrifugal pumps.

1.3 DEFINITIONS

- A. EPDM: Ethylene propylene diene monomer.
- B. HI: Hydraulic Institute.
- C. NBR: Nitrile rubber or Buna-N.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of pump.
 - 1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
 - 2. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Bell & Gossett.
 - 3. TACO Comfort Solutions, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 013310 "Delegated Design Requirements," to design vibration isolation.

2.3 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

- A. Source Limitations: Obtain pumps from single source from single manufacturer.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and flanged connections.
 - 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - 3. Pump Shaft Sleeve: Bronze or Type 304 stainless steel.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket. Include water slinger on shaft between motor and seal.

- D. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
1. Enclosure: Totally enclosed, fan cooled.
 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in the National Electric Code.
 4. Variable-speed motor.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch perforations and 51 percent open area.
4. Type 304 stainless steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
4. Brass valve disc with EPDM rubber seat.
5. Type 304 stainless steel valve stem.
6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
7. Brass gauge ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 STARTUP SERVICE

A. A factory-authorized service representative shall perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.

- b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in correct direction.
- 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
- 6. Start motor.
- 7. Open discharge valve slowly.

3.2 DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Video training sessions and provide electronic copy of video to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 - 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 4. Obtain Owner sign-off that training is complete.
 - 5. Owner training shall be held at Project site.

END OF SECTION

SECTION 232300

REFRIGERANT AND CONDENSATE 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. Refrigerant pipes, fittings and insulation.
- 2. Refrigerant piping valves and specialties.
- 3. Condensate pipes, fittings and insulation.
- 4. Refrigerants

B. Related Sections:

- 1. Section 200719 "General Mechanical Piping Insulation" for refrigerant and condensate piping insulation requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.

- 1. Include pressure drop, based on manufacturer's test data, for the following:
 - a. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.

B. Shop Drawings:

- 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
- 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4-inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
- D. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 2. Suction Lines for Heat-Pump Applications: 535 psig.
 3. Hot-Gas and Liquid Lines: 535 psig.
 4. Condensate water piping: 80 psig at 150 deg F.

2.2 REFRIGERANT COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.

- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8.
- E. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 450 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 REFRIGERANT PRE-MANUFACTURED LINE KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or similar:
 - 1. JMF Company
 - 2. Mueller Industries
 - 3. Streamline
- B. Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with refrigerant or nitrogen, sealed, and with both lines insulated. Provide in standard lengths for installation without joints, except at equipment connections.
- C. End Fittings:
 - 1. Factory installed Flare fittings with Brass nuts.
 - 2. Capped, plain end fittings for use with brazed connections.
 - 3. Factory installed threaded brass connection with sealed port.

2.4 REFRIGERANT VALVES AND SPECIALTIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
 - 2. Danfoss Electronics, Inc.
 - 3. Emerson Electric Company; Alco Controls Div.
 - 4. Henry Valve Company.
 - 5. Sporlan Valve Company.

B. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

C. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

D. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

E. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

F. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.

6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- G. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- H. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Adjustable
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in parts per million (ppm).
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 240 deg F.
- L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Rated Flow: 20 tons .
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 240 deg F.
- M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Rated Flow: 20 tons.
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 240 deg F.
- N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or flare.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.
- O. Receivers: Comply with AHRI 495.
1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
 2. Comply with UL 207; listed and labeled by an NRTL.
 3. Body: Welded steel with corrosion-resistant coating.
 4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 5. End Connections: Socket or threaded.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.5 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

2.6 CONDENSATE COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. DWV Copper Tubing: ASTM B 306, Type DWV.

E. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO, Inc.
 - b. Viega, LLC
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.

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.

G. Wrought-Copper Unions: ASME B16.22.

2.7 PIPE JOINT CONSTRUCTION

A. 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.

- B. 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/A5.8M.
- C. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

2.8 CONDENSATE VALVES AND SPECIALTIES

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- 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, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Dielectric Unions:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING SCHEDULE FOR REFRIGERANT R-410A

- A. Hot-Gas and Liquid Lines from Outdoor Condensing Unit to the Indoor Evaporator Units shall be the following:
 - 1. Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 2. Copper, Type ACR, annealed Pre-manufactured, insulated refrigerant line kits with brazed joints or brass, threaded fittings

3.2 PIPING SCHEDULE FOR CONDENSATE PIPING

- A. Condensate piping, aboveground and indoors, NPS 2 and smaller, shall be one of the following:
 - 1. Type L or type DWV drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
- B. Condensate piping, aboveground and outdoors, NPS 2 and smaller, shall be one of the following:
 - 1. Type L or type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

3.3 REFRIGERANT VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves (as required by Manufacturer) upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top. Install 2-way solenoid valves for heat pump applications.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.

- 3. Hot-gas bypass valves.
- 4. Compressor.

- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- 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 adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install condensate piping at a uniform pitch of 1/4" per 1'-0" downward in direction of flow.
- K. Increase condensate pipe sizes using eccentric reducer fitting installed with level side up.
- L. Refer to Section 250923 "Direct Digital Control (DDC) System for HVAC" and Section 250993 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- M. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- N. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

- O. Install refrigerant piping in protective conduit where installed belowground.
- P. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- Q. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- R. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- S. Insulate refrigerant piping according to Section 200719 "General Mechanical Piping Insulation."
- T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- U. Identify refrigerant piping, condensate piping and all valves according to Section 200553 "Identification for General Mechanical Piping and Equipment."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 200517 "Sleeves and Sleeve Seals for General Mechanical Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 200517 "Sleeves and Sleeve Seals for General Mechanical Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 200518 "Escutcheons for General Mechanical Piping."

3.5 PIPE 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 pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Condensate Piping - Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Pressure-Treated Lumber is **NOT** an acceptable support for exterior refrigerant piping and conduit. Pipe support shall consist of a rubber based with an integral 14 gauge galvanized metal channel.
 - 1. Provide B-Line "Dura-Block" DB Series (or similar).
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
 - 9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.
- E. Support multifloor vertical runs at least at each floor.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.8 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233113

METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealant and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 233716 "Fabric Air-Distribution Devices" for fabric ducts.

1.3 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.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

NOTE: DO NOT FABRICATE OR INSTALL DUCTWORK BEFORE SHOP DRAWINGS ARE REVIEWED BY ARCHITECT.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Mechanical Equipment.
 - d. Mechanical Piping.
 - e. Speakers.
 - f. Sprinklers.
 - g. Access panels.

- h. Perimeter moldings.
 - i. Moveable partition structural elements.
- B. Welding certificates.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated. Construct ducts of galvanized sheet steel unless otherwise indicated.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
 - 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
 - 3. **Where specified for specific applications, all joints shall be welded.**
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-

support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. **Where specified for specific applications, all joints shall be welded.**

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND 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. Construct ducts of galvanized sheet steel unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 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.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

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:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
- 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
- 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. 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).

- b. 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."
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC.
 - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. 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).
 - b. 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. 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 aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
 - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - 3. Butt transverse joints without gaps, and coat joint with adhesive.
 - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 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: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 11. Sealant 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. 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.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant 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. 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.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM 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.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts 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 Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with Section 230130 "HVAC Air-Distribution System Cleaning."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 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."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint exterior of metal ducts that are in exposed installations. Apply one coat of flat, latex paint over a compatible galvanized-steel primer. Color(s) shall be selected by Architect.
- B. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.
- C. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - b. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - d. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean duct systems before testing, adjusting, and balancing. Comply with Section 230130 "HVAC Air-Distribution System Cleaning."
- B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

3.9 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
- B. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg.
 3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Pressure Class: Positive 2-inch wg after Terminal Unit.
 4. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
- C. Return Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.

F. Liner: All liner shall be 1 inch thick unless noted otherwise on drawings.

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch and 2 inches thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch and 2 inches thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick.
4. Supply Fan Plenums: Fibrous glass, Type II, 1 inch and 2 inches thick.
5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 1 inch thick.
6. Transfer Ducts: Fibrous glass, Type I, or Flexible Elastomeric, 1 inch thick.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - b. Velocity 1000 to 1500 fpm:

- 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 1.0 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.
 - 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 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry, high-efficiency.
 - b. Rectangular Main to Round Branch: Conical spin in.
 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: Conical tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Iris balancing dampers.
5. Control dampers.
6. Fire dampers.
7. Flange connectors.
8. Turning vanes.
9. Remote damper operators.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

- e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- 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 SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Cesco Products; a division of MESTEK, Inc.
 - 3. Flex-Tek Group.
 - 4. Greenheck Fan Corporation.
 - 5. Nailor Industries Inc.
 - 6. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 0.05-inch- thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Galvanized steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.

2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage minimum.
 - b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Galvanized steel.
8. Screen Type: Bird.
9. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Cesco Products; a division of MESTEK, Inc.
 3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Ruskin Company.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 0.05-inch- thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- F. Blades:
 1. Multiple, 0.025-inch- thick, roll-formed aluminum.
 2. Maximum Width: 6 inches.
 3. Action: Parallel.
 4. Balance: Gravity.
 5. Eccentrically pivoted.
- G. Blade Seals: Neoprene.
- H. Blade Axles: Galvanized steel.
- I. Tie Bars and Brackets:
 1. Material: Galvanized steel.
 2. Rattle free with 90-degree stop.

- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
 - 1. Flange on intake.
 - 2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a Mestek Architectural Group company.
 - b. Flexmaster U.S.A., Inc.
 - c. Flex-Tek Group.
 - d. McGill AirFlow LLC.
 - e. Nailor Industries Inc.
 - f. Ruskin Company.
 - g. Trox USA Inc.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 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.
- B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a Mestek Architectural Group company.
 - b. McGill AirFlow LLC.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 - e. Trox USA Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with 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. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Nonferrous metal.
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: Aluminum.

C. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.6 IRIS BALANCING DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Continental Fan Manufacturing, Inc.
 2. Fantech.
 3. Ruskin Company.
- B. General: Factory fabricated with required hardware and accessories. Calibrated control lever moves segmented blades that form an adjustable aperture.
- C. Construction: Iris dampers shall be constructed of minimum 22 gage galvanized steel, and shall include integraldifferential pressure air measuring ports. Differential pressure ports shall be factory calibrated and iris dampers shall be supplied with their corresponding performance curve for balancing accuracy.
- D. Accuracy: Airflow measurement shall be within $\pm 6\%$ of design airflow.

2.7 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Cesco Products; a division of MESTEK, Inc.
 3. Flex-Tek Group.
 4. Greenheck Fan Corporation.
 5. McGill AirFlow LLC.
 6. Nailor Industries Inc.
 7. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
 2. 0.094-inch- thick, galvanized sheet steel.
 3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 6 inches.
 2. Parallel-blade design.
 3. Galvanized-steel.
 4. 0.0747-inch- thick dual skin.
 5. Blade Edging: Closed-cell neoprene.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Molded synthetic.
2. 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.
3. Thrust bearings at each end of every blade.

2.8 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Cesco Products; a division of MESTEK, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 3 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 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.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.9 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CL WARD & Family Inc.

2. Ductmate Industries, Inc.
3. Hardcast, Inc.
4. Nexus PDQ.
5. Ward Industries; a brand of Hart & Cooley, Inc.

- B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.10 TURNING VANES

- A. 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.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Vane Construction: Double wall.

2.11 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pottorff.
 2. Ventfabrics, Inc.
 3. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Copper.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed.
- F. Wall-Box Cover-Plate Material: Stainless steel.

2.12 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Cesco Products; a division of MESTEK, Inc.
 3. Ductmate Industries, Inc.
 4. Flexmaster U.S.A., Inc.
 5. Greenheck Fan Corporation.
 6. McGill AirFlow LLC.
 7. Nailor Industries Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inchbutt 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: Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.
 - d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 4. Factory set at 3.0- to 8.0-inch wg.
 5. Doors close when pressures are within set-point range.
 6. Hinge: Continuous piano.
 7. Latches: Cam.
 8. Seal: Neoprene or foam rubber.
 9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.13 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.

2. Ductmate Industries, Inc.
 3. Flame Gard, Inc.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.14 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, 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 wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. 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.
- 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.
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd.
 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.

- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd.
 - 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.15 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Flex-Tek Group.
 - 3. McGill AirFlow LLC.
- B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1, but not less than 4.5.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.16 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.
- 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 and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Install iris balancing dampers in round air ducts to be balanced to 50 cfm or less.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install fire dampers according to UL listing.
- I. Connect ducts to ALL fan-operated equipment with flexible duct connectors.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.

5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream and downstream from turning vanes.
 9. Control devices requiring inspection.
 10. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- M. Label access doors according to Section 200553 "Identification for General Mechanical Piping and Equipment" to indicate the purpose of access door.
- N. Install flexible connectors to connect ducts to equipment.
- O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Connect terminal units to supply ducts directly.
- Q. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- R. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- S. Install duct test holes where required for testing and balancing purposes.
- T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- 3.2 FIELD QUALITY CONTROL
- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire 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

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

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. Rectangular and square ceiling diffusers.
2. Adjustable bar grilles.
3. Fixed face grilles.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Products; a Mestek company.
 - 2. Krueger.
 - 3. Nailor Industries Inc.
 - 4. Price Industries.
 - 5. Titus.

2.2 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers [S1]:
 - 1. Devices shall be specifically designed for variable-air-volume flows.
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Size: 24 by 24 inches.
 - 5. Face Style: Plaque.
 - 6. Mounting: Surface and T-bar.
 - 7. Pattern: Fixed.
 - 8. Maximum 25 NC.
 - 9. Accessories:
 - a. Molded insulation blanket.

2.3 REGISTERS AND GRILLES

- A. Fixed Face Grille [R1]:
 - 1. Material: Steel.
 - 2. Finish: Baked enamel, white.
 - 3. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
 - 4. Core Construction: Integral.
 - 5. Frame: 1-1/4 inches.
 - 6. Mounting: Countersunk screw.
 - 7. Maximum 25 NC.

2.4 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 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.
- D. All surface-mounted diffusers, registers, and grilles installed in conjunction with a fire damper in a rated assembly shall be steel.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 235216

CONDENSING BOILERS

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 gas-fired, water-tube floor-mounted condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Where "prorated" is indicated, the boiler manufacturer will cover the indicated percentage of cost of replacement parts. With "prorated" type, covered cost decreases as age of equipment increases.
 - 1. Warranty Period for Floor-Mounted Water-Tube Condensing Boilers:
 - a. Heat Exchanger and Tank: Free from defects in material and workmanship.
 - b. Warranty Coverage: Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10- 10 percent 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.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency in accordance with Table 6.8.1-6 and other requirements in Ch. 6 of ASHRAE/IES 90.1.
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 431, Subpart E, Appendix N.
- E. Mounting Base: For securing boiler to concrete base.

2.2 FLOOR-MOUNTED, WATER-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bryan Boilers; Bryan Steam LLC.
 - 2. Hydrotherm, Inc./Mestek, Inc.
 - 3. Lochinvar, LLC.
 - 4. Thermal Solutions, LLC.
 - 5. Viessmann Manufacturing Co. (US) Inc.
- B. Description: Factory-fabricated, -assembled, and -tested, water-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.
- C. Heat Exchanger: Stainless steel primary and secondary heat exchangers.

- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas-premixing valve.
- F. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
 - a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.
- I. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Powder-coated protective finish.
 - 4. Insulation: Minimum 1-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.

2.3 TRIM - FOR HOT-WATER BOILERS

- A. Include devices sized to comply with ASME B31.9.
- B. Aquastat Controllers: Operating, firing rate, and high limit with automatic reset.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gauge: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. High and low gas-pressure switches.
- F. Alarm bell with silence switch.
- G. Boiler Air Vent: Automatic.
- H. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.4 CONTROLS

- A. Boiler operating controls shall include the following devices and features:
1. Control transformer.
 2. Set-Point Adjust: All set points shall be adjustable.
 3. Electric, factory-fabricated and factory-installed panel to control burner-firing rate, to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 130 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 90 deg F.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm, low-water-level alarm.
 - b. Control: On/off operation, hot-water-supply temperature set-point adjustment.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are shown on Drawings and specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a raceway.
 4. Field power interface shall be to fused disconnect switch.

5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.6 CONDENSATE-NEUTRALIZATION UNITS

- A. Description: Factory-fabricated and -assembled condensate-neutralizing capsule assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.
- B. Capsule features:
 1. All corrosion-resistant material.
 2. Suitable for use on all natural gas and propane boilers.
 3. Includes initial charge of neutralizing agent.
 4. Neutralizing agent to be easily replaceable when exhausted.
 5. Inlet and outlet pipe connections.
- C. Capsule Configuration:
 1. Low-profile design for applications where boiler condensate drain is close to the floor.
 2. Easily removed and opened for neutralizing agent replacement.
 3. Multiple units may be used for larger capacity.

2.7 SOURCE QUALITY CONTROL

- A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- B. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- C. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500.
- D. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- E. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting:
 - 1. Install floor-mounted boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 PIPING CONNECTIONS

- A. Comply with requirements for hydronic piping specified in Section 232113 "Hydronic Piping."
- B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.

- E. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.
- F. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- G. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve, and union or flange at each connection.

3.4 DUCT CONNECTIONS

- A. Boiler Venting:
 - 1. Install flue-venting piping and room air combustion kit.
 - 2. Field fabricate and install boiler vent and combustion-air intake.
 - 3. Connect boiler vent full size to boiler connections.
 - 4. Comply with all boiler manufacturer's installation instructions.

3.5 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch** high.

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.7 STARTUP SERVICE

- A. A factory-authorized service representative shall perform startup service. Test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.

2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Performance Tests:

1. Inspect component assemblies and equipment installations, including connections, and conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions and provide electronic copy of video to Owner.
1. Instructor shall be factory trained and certified.
 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 4. Obtain Owner sign-off that training is complete.
 5. Owner training shall be held at Project site.

END OF SECTION

SECTION 236423

AIR-COOLED, SCROLL WATER CHILLERS

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 packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.3 DEFINITIONS

- A. BCS: Building control system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. DDC: Direct digital control.
- D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.
- E. GFI: Ground fault interrupt.
- F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- G. I/O: Input/output.
- H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
- J. SCCR: Short-circuit current rating.
- K. TEAO: Totally enclosed air over.

- L. TENV: Totally enclosed nonventilating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Performance at AHRI standard conditions and at conditions indicated.
 - 3. Performance at AHRI standard unloading conditions.
 - 4. Minimum evaporator flow rate.
 - 5. Refrigerant capacity of water chiller.
 - 6. Oil capacity of water chiller.
 - 7. Fluid capacity of evaporator.
 - 8. Characteristics of safety relief valves.
 - 9. Force and moment capacity of each piping connection.
- B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Size and location of piping and wiring connections.
 - 5. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates: For certification required in "Quality Assurance" Article.
- B. Installation instructions.
- C. Source quality-control reports.
- D. Startup service reports.
- E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- B. Spare Parts List: Recommended spare parts list with quantity for each.
- C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

- D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Tool kit to include the following:
 - 1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
 - 2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
 - 3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size shall be at least 1 inch high.
 - 4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.
- B. Touchup Paint: 32 oz. container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.8 QUALITY ASSURANCE

- A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.
 - 1. Extended warranties include, but are not limited to, the following:
 - a. Complete chiller including refrigerant and oil charge.
 - b. Parts and labor.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
- C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- F. Comply with NFPA 70.
- G. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
- H. Operation Following Loss of Normal Power:
 - 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
 - 2. See drawings for equipment served by backup power systems.
 - 3. Provide means and methods required to satisfy requirement even if not explicitly indicated.
- I. Outdoor Installations:
 - 1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.
 - 2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Global Corporation.
 - 2. Trane.
 - 3. YORK; brand of Johnson Controls International plc, Building Solutions North America.

2.3 MANUFACTURED UNITS

- A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, remote evaporator, condenser with fans, electrical power, controls, and indicated accessories.

2.4 CABINET

- A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, and compressors to base to provide a single-piece unit.
- B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
- C. Casing: Galvanized steel.
- D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.

2.5 COMPRESSOR-DRIVE ASSEMBLIES

- A. Compressors:
 - 1. Description: Positive-displacement direct drive with hermetically sealed casing.
 - 2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
 - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
 - 3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
 - 4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
 - a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.
 - 5. Vibration Isolation: Mount individual compressors on vibration isolators.

- a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

B. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

C. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.6 REFRIGERATION

A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.

B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

C. Refrigerant Circuit: Each circuit shall include an electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

D. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.7 EVAPORATOR

A. Brazed-plate or shell-and-tube design. Evaporator assembly shall be pre-packaged for remote installation inside the building.

B. Shell and Tube:

1. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.

5. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping. Furnish flange adapters to mate to flanged piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

C. Brazed Plate:

1. Direct-expansion, single-pass, brazed-plate design.
2. Type 304 or 316 stainless-steel construction.
3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. Furnish flange adapters to mate to flanged piping.
5. Inlet Strainer: Factory-furnished, 20-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

D. Flow Switch: Factory-furnished and -installed, thermal-type flow switch wired to chiller operating controls.

E. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.

2.8 AIR-COOLED CONDENSER

A. Coil(s) with integral subcooling on each circuit.

B. Copper Tube with Plate Fin Coils:

1. Construct coils of copper tubes mechanically bonded to aluminum fins.
2. Coating: None.

C. Aluminum Microchannel Coils:

1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
2. Single- or multiple-pass arrangement.
3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

D. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

F. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

G. Fan Guards: Removable steel safety guards with corrosion-resistant coating.

2.9 INSULATION

A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 3/4 inch.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
6. Field-Applied Insulation:
 - a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
 - b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
 - c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
 - d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.10 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

- D. Wiring shall be numbered and color-coded to match wiring diagram.
- E. Factory wiring shall be located outside of an enclosure in a raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight conduit.
- F. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 42,000 A.
- G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
 - 1. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- H. Each motor shall have overcurrent protection.
- I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- K. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- L. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
- M. Service Receptacle:
 - 1. Unit-mounted, 120-V GFI duplex receptacle.
 - 2. Power receptacle from chiller internal electrical power wiring.
- N. Indicate the following for water chiller electrical power supply:
 - 1. Current, phase to phase, for all three phases.
 - 2. Voltage, phase to phase and phase to neutral for all three phases.
 - 3. Three-phase real power (kilowatts).
 - 4. Three-phase reactive power (kilovolt amperes reactive).
 - 5. Power factor.
 - 6. Running log of total power versus time (kilowatt hours).

2.11 CONTROLS

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

- C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
 - 1. Date and time.
 - 2. Operating or alarm status.
 - 3. Operating hours.
 - 4. Outside-air temperature if required for chilled-water reset.
 - 5. Temperature and pressure of operating set points.
 - 6. Chilled-water entering and leaving temperatures.
 - 7. Refrigerant pressures in evaporator and condenser.
 - 8. Saturation temperature in evaporator and condenser.
 - 9. No cooling load condition.
 - 10. Elapsed time meter (compressor run status).
 - 11. Antirecycling timer status.
 - 12. Percent of maximum motor amperage.
 - 13. Current-limit set point.
 - 14. Number of compressor starts.
 - 15. Alarm history with retention of operational data before unit shutdown.
 - 16. Superheat.
- E. Control Functions:
 - 1. Manual or automatic startup and shutdown time schedule.
 - 2. Capacity control based on evaporator leaving-fluid temperature.
 - 3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
 - 4. Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on **return-water** temperature.
 - 5. Current limit and demand limit.
 - 6. External water chiller emergency stop.
 - 7. Antirecycling timer.
 - 8. Automatic lead-lag switching.
- F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
 - 1. Low evaporator pressure or high condenser pressure.
 - 2. Low chilled-water temperature.
 - 3. Refrigerant high pressure.
 - 4. High or low oil pressure.
 - 5. High oil temperature.
 - 6. Loss of chilled-water flow.
 - 7. Control device failure.
- G. Building Control System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
 - 1. Hardwired I/O Points:

- a. Monitoring: On/off status, common trouble alarm.
 - b. Control: On/off operation, chilled-water discharge temperature set-point adjustment.
- 2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.
- H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.12 ACCESSORIES

- A. Factory-furnished vibration isolators for field installation.

2.13 MATERIALS

- A. Steel:
 - 1. ASTM A36 for carbon structural steel.
 - 2. ASTM A568 for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240 for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653.
- D. Aluminum: ASTM B209.
- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb.
 - c. ASTM B3359 for cross hatch adhesion of 5B.
 - 2. Application: Immersion.
 - 3. Thickness: 1 mil.
 - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.14 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- C. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
 - 1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

- A. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.
- B. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Maintain clearances required by governing code.
- E. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- F. Install separate devices furnished by manufacturer and not factory installed.
 - 1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

- A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to chillers, allow space for service and maintenance.
- D. Evaporator Fluid Connections:
 - 1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector thermometer, and plugged tee with pressure gage.
 - 2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve.

3.4 ELECTRICAL POWER CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch (13 mm) high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.
- C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch (13 mm) high.

3.6 STARTUP SERVICE

- A. A factory-authorized service representative shall perform startup service.

- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
 - 7. Verify proper motor rotation.
 - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
 - 9. Verify and record performance of chilled-water flow and low-temperature interlocks.
 - 10. Verify and record performance of water chiller protection devices.
 - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
- E. Prepare a written startup report that records results of tests and inspections.

3.7 DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video training sessions and provide electronic copy of video to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 - 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 4. Obtain Owner sign-off that training is complete.
 - 5. Owner training shall be held at Project site.

END OF SECTION

SECTION 237416

PACKAGED, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes packaged, rooftop air conditioning units (RTUs) with the following components:
 - 1. Casings.
 - 2. Fans, drives, and motors.
 - 3. Coils.
 - 4. Refrigerant circuit components.
 - 5. Air filtration.
 - 6. Gas furnaces.
 - 7. Dampers.
 - 8. Electrical power connections.
 - 9. Controls.
 - 10. Roof curbs.
 - 11. Accessories.

1.3 DEFINITIONS

- A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.4 ACTION SUBMITTALS

- A. Product Data: For each RTU.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.

5. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated.
 - b. Include certified fan-sound power ratings.
 - c. Include fan construction and accessories.
 - d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each packaged, rooftop air-conditioning units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include a detailed BACnet points list that lists the point name, function and if it is read, write or read/write.

C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. Source quality-control reports.
- D. System startup reports.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.
 - 2. Gaskets: One set for each access door.
 - 3. Fan Belts: One set for each belt-driven fan.
 - 4. Filters: One set of filters for each unit.

1.8 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: five years from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Global Corporation.
 - 2. Trane.

3. YORK; brand of Johnson Controls International plc, Building Solutions North America.

2.3 UNIT CASINGS

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Double-Wall Construction:
 1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 2. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
 3. Floor Plate: G90 galvanized steel, minimum 18 gauge thick.
 4. Casing Insulation:
 - a. Materials: Injected polyurethane foam insulation.
 - b. Casing Panel R-Value: Minimum R-8.
 - c. Insulation Thickness: 1 inch.
 - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. Static-Pressure Classifications:
 1. For Unit Sections Upstream of Fans: Minus 2-inch wg.
 2. For Unit Sections Downstream and Including Fans: 3-inch wg.
- E. Panels and Doors:
 1. Panels:
 - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
 2. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.

- b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
- 3. Locations and Applications:
 - a. Fan Section: Doors and inspection and access panels.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panels.
 - d. Damper Section: Inspection and access panels.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
- F. Condensate Drain Pans:
 - 1. Location: Each type of cooling coil.
 - 2. Construction:
 - a. Double-wall, stainless steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - 3. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - b. Minimum Connection Size: NPS 1.
 - 4. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 - 6. Width: Entire width of water producing device.
 - 7. Depth: A minimum of 2 inches deep.
 - 8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
 - 9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.
 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
 5. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
 6. Shaft Lubrication Lines: Extended to a location outside the casing.
 7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch- wide by 0.028-inch- thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drives, Direct: Factory-mounted, direct drive.
- D. Drives, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
 2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
 3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
- E. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed motors.
- F. Relief-Air Fan: Forward curved, shaft mounted on permanently lubricated motor.

G. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: Open, dripproof.
4. Enclosure Materials: Cast iron.
5. Efficiency: Premium efficient as defined in NEMA MG 1.
6. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
7. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 10 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Stainless steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

C. Outdoor-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 10 fins per inch.

3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Stainless steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

a. Working Pressure: Minimum 300 psig.

D. Hot-Gas Reheat Refrigerant Coil:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 10 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Stainless steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.
8. Suction-discharge bypass valve.

2.6 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: Hermetic, variable speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- C. Refrigeration Specialties:
 1. Refrigerant: R-410A.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Brass service valves installed in compressor suction and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Hot-gas reheat solenoid valve modulating with a replaceable magnetic coil.
 11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.7 AIR FILTRATION

- A. Panel Filters: MERV 13, minimum.
 - 1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
 - 2. Filter Unit Class: UL 900.
 - 3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 - 4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

2.8 GAS FURNACES

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
- B. CSA Approval: Designed and certified by and bearing label of CSA.
- C. Burners: Stainless steel.
 - 1. Rated Minimum Turndown Ratio: 30 to 1.
 - 2. Fuel: Natural gas.
 - 3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 - 4. Gas Control Valve: Modulating.
 - 5. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
- D. Heat-Exchanger and Drain Pan: Stainless steel.
- E. Venting, Gravity: Gravity vented with vertical extension.
- F. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve with vertical extension.
- G. Safety Controls:
 - 1. Gas Manifold: Safety switches and controls complying with ANSI standards.

2.9 DAMPERS

- A. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.
- B. Barometric relief dampers.

C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24 V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

2.10 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.11 CONTROLS

- A. Unit shall be provided with a unit controller as required to satisfy safety controls related to the operations of the refrigerant circuit, hot gas reheat, gas furnace / electric coil, airflow dampers, supply and exhaust fans and related ECM motor controllers or VFDs. Unit controller shall have volatile-memory backup. Factory installed terminal strip shall be provided for interface with the Building Automation System.
- B. Factory Installed Unit Controller Requirements:
 - 1. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
 - b. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
 - c. Cycle condenser fans to maintain maximum hot-gas pressure.
 - d. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - e. Gas furnace / electric coil airflow proving.
 - f. Gas furnace / electric coil high-temperature shutdown.
- C. Factory Installed Terminal Strip Requirements:
 - 1. Supply Fan Operation:
 - a. Enable
 - b. Signal
 - c. Feedback
 - d. Fault
 - 2. Exhaust Fan Operation:
 - a. Enable
 - b. Signal
 - c. Feedback
 - d. Fault
 - 3. Refrigerant Circuit Operation:
 - a. Enable
 - b. Variable capacity
 - c. Staged capacity
 - 4. Hot-Gas Reheat-Coil Operation:
 - a. Variable capacity
 - 5. Gas Furnace / Electric Coil Operation:
 - a. Enable

- b. Variable capacity
- 6. Energy Wheel Operation:
 - a. Enable
 - b. Signal
 - c. Feedback
 - d. Fault
- 7. Damper Operation:
 - a. Modulating damper control
 - b. Damper position
- 8. Clogged Filter Switch
 - a. Closed relay
- 9. Phase and Brown Out Protection
 - a. Closed relay
 - b. Closed relay

2.12 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: 2 inches.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C916, Type I.
- B. Curb Dimensions: Height of 24 inches.

2.13 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Low-ambient kit using staged or variable-speed condenser fans for operation down to 35 deg F.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Factory- or field-installed demand-controlled ventilation.
- E. Safeties:
 - 1. Smoke detector.
 - 2. Condensate overflow switch.
 - 3. Phase-loss protection.
 - 4. High and low pressure control.
 - 5. Gas furnace or electric coil airflow-proving switch.
- F. Coil guards of painted, galvanized-steel wire.
- G. Hail guards of galvanized steel, painted to match casing.
- H. Door switches to disable heating or reset set point when open.
- I. Vertical vent extensions to increase the separation between the outdoor-air intake and the flue-gas outlet.
- J. Door switches to disable heating or reset set point when open.
- K. Outdoor air intake weather hood with moisture eliminator and airflow measurement station.

2.14 MATERIALS

- A. Steel:
 - 1. ASTM A36 for carbon structural steel.
 - 2. ASTM A568 for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240 for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653.
- D. Aluminum: ASTM B209.

2.15 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with existing roof construction." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 1. Install ducts to termination at top of roof curb.
 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
 4. Install return-air duct continuously through roof structure.
- D. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 260553 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.
 3. Locate nameplate where easily visible.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. A factory-authorized service representative shall perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean condenser coil and inspect for construction debris.
 - 10. Clean furnace flue and inspect for construction debris.
 - 11. Connect and purge gas line.
 - 12. Remove packing from vibration isolators.
 - 13. Inspect operation of barometric relief dampers.
 - 14. Verify lubrication on fan and motor bearings.
 - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 16. Adjust fan belts to proper alignment and tension.
 - 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 19. Operate unit for an initial period as recommended or required by manufacturer.
 - 20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 21. Calibrate thermostats.
 - 22. Adjust and inspect high-temperature limits.
 - 23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
 - 24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.

- b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
- 25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
- 26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
- 27. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on electric heating coil.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.
- C. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.
- D. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- E. Prepare written report of the results of startup services.

3.6 DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain units. Video training sessions and provide electronic copy of video to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 - 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

4. Obtain Owner sign-off that training is complete.
5. Owner training shall be held at Project site.

END OF SECTION

SECTION 237433

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling 100 percent outdoor air.

1.3 DEFINITIONS:

- A. ECM: Electronically commutated motor.
- B. ISCOP: Integrated Seasonal Coefficient of Performance.
- C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.
- D. MRC: Moisture Removal Capacity.

1.4 ACTION SUBMITTALS

- A. Product Data: For each dedicated outdoor-air unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - 5. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 6. Include certified coil-performance ratings with system operating conditions indicated.
 - 7. Include filters with performance characteristics.
 - 8. Include heat exchangers with performance characteristics.

9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each dedicated outdoor-air unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For dedicated outdoor-air-unit supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranty.
- B. Source quality-control reports.
- C. Startup service reports.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fan Belts: One set for each belt-driven fan.
 2. Filters: Two sets for each unit.
 3. Gaskets: One set for each access door.

1.8 WARRANTY

- A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Dedicated Outdoor-Air-Handling Units: Two years from date of Substantial Completion.
2. Warranty Period for Compressors: Five years from date of Substantial Completion.
3. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.
4. Warranty Period for Rotary Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.
- G. Delegated Design: Engage a qualified professional engineer, as defined in Section 013310 "Delegated Design Requirements," to design vibration isolation.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Carrier Global Corporation.
 2. Trane.
 3. YORK; brand of Johnson Controls International plc, Building Solutions North America.
- B. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

2.3 UNIT CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.
- C. Double-Wall Configuration:
 - 1. Outside Casing Wall: Galvanized steel, minimum 14 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 2. Inside Casing Wall: Galvanized steel, solid, minimum 14 gauge thick.
 - 3. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
 - 4. Roof: Standing seam or membrane; sloped to drain water.
 - 5. Casing Insulation:
 - a. Materials: Polyurethane foam insulation.
 - b. Casing Panel R-Value: Minimum R-13.
 - c. Insulation Thickness: 2 inches.
 - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- D. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- E. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus 3 inches wg.
 - 2. For Unit Sections Downstream and Including Fans: 4 inches wg.
- F. Doors:
 - 1. Doors:
 - a. Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
 - 2. Locations:
 - a. Fan Section.
 - b. Access Section.

- c. Gas-Fired Burner Section.
- d. Damper Section.
- e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

G. Condensate Drain Pans:

- 1. Location: Each refrigerant coil and rotary heat exchanger.
- 2. Construction:
 - a. Single-wall, stainless steel sheet.
- 3. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
- 4. Drain Connection:
 - a. Located on one end of pan, at lowest point of pan.
 - b. Terminated with threaded nipple.
 - c. Minimum Connection Size: NPS 1.
- 5. Slope: Minimum 0.125-inch/ft. slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
- 6. Length: Extend drain pan downstream from leaving face.
- 7. Width: Entire width of water-producing device.
- 8. Depth: A minimum of 2 inches deep.
- 9. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans and Relief-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours in accordance with ABMA 9.
 - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

- a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
5. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
6. Mounting: For internal vibration isolation. Factory mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
7. Shaft Lubrication Lines: Extended to a location outside the casing.
8. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch- wide by 0.028-inch- thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drive, Direct: Factory-mounted direct drive.
- D. Drive, Belt: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
 2. Belts: Oil resistant, nonsparking and nonstatic; in matched sets for multiple-belt drives.
 3. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; 0.146 inch thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
- E. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated electronically commutated motors.
- F. Motors:
 1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 3. Enclosure Type: Open, dripproof.
 4. Motor Pulleys: Adjustable pitch for use with 5 hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 6. Mount unit-mounted disconnect switches on exterior of unit.
- G. Variable-Frequency Motor Controller: Comply with Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils are not to act as structural component of unit.

B. Supply-Air Refrigerant Coils:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 10 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

C. Hot-Gas Reheat Refrigerant Coils:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: Maximum 8 fins per inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Stainless steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.
8. Coating: None.
9. Suction-discharge bypass valve.

D. Condenser Refrigerant coils:

1. Tube Material: Copper.
2. Fin Material: Aluminum.
3. Fin and Tube Joint: Mechanical bond.

4. Coating: None.

2.6 REFRIGERATION CIRCUIT COMPONENTS

- A. Compressors: Hermetic, variable-speed scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigerant: R-410A.
- C. Refrigeration Specialties:
 1. Expansion valve with replaceable thermostatic element.
 2. Refrigerant filter/dryer.
 3. Manual-reset high-pressure safety switch.
 4. Automatic-reset low-pressure safety switch.
 5. Minimum off-time relay.
 6. Automatic-reset compressor motor thermal overload.
 7. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 8. Brass service valves installed in discharge and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
 11. Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.
 12. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.

2.7 AIR FILTRATION

- A. Panel Filters:
 1. Description: Pleated factory-fabricated, self-supported disposable air filters with holding frames.
 2. Filter Unit Class: UL 900.
 3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 4. Filter-Media Frame: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.
 5. Prefilters: 2" thick, MERV-6 minimum.
 6. Filters: 4" thick, MERV-13 minimum.
- B. Mounting Frames:
 1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
 2. Cartridge filters arranged for flat orientation, removable from access plenum.

3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.8 ROTARY HEAT EXCHANGER

A. Casing:

1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearings.

B. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.

C. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency controller. Provide permanently lubricated wheel bearings.

D. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
3. Control energy recovery to permit air economizer operation.
 - a. Bypass dampers to assist energy recovery control.
4. Pilot-Light Indicator: Display rotor rotation and speed.
5. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
6. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
7. Defrost cycle.

2.9 INDIRECT-FIRED GAS FURNACE HEATING

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.

B. CSA Approval: Designed and certified by and bearing label of CSA.

C. Burners:

1. Heat-Exchanger Material: Stainless steel.
2. Fuel: Natural gas.

3. Ignition: Electronically controlled electric spark with flame sensor.
 4. Gas Control Valve: Electronic modulating.
 5. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
- D. Venting, Gravity: Gravity vented.
- E. Heat-Exchanger Drain Pan: Stainless steel.
- F. Safety Controls:
1. Gas Manifold: Safety switches and controls complying with ANSI standards.
 2. Vent Flow Verification: Differential pressure switch to verify open vent.
 3. High Limit: Thermal switch or fuse to stop burner.
 4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
 5. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
 6. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.10 DAMPERS

- A. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1 inch wg and 8 cfm/sq. ft. at 4 inches wg.
- B. Electronic Damper Operators:
1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 2. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
 - a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24 V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

2.11 ELECTRICAL POWER CONNECTIONS

- A. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 4, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface to be NEMA KS 1, heavy-duty, nonfused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 1. NEMA KS 1, heavy-duty, nonfusible switch.
 2. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.

- J. Convenience Outlets: One 20 A duplex GFCI receptacle per location with junction box located on outside casing wall.
- K. Control Relays: Auxiliary and adjustable time-delay relays.

2.12 CONTROLS

- A. Unit shall be provided with a unit controller as required to satisfy safety controls related to the operations of the refrigerant circuit, hot gas reheat, gas furnace / electric coil, airflow dampers, supply and exhaust fans and related ECM motor controllers or VFDs. Unit controller shall have volatile-memory backup. Factory installed terminal strip shall be provided for interface with the Building Control System (BCS).
- B. Factory Installed Unit Controller Requirements:
 - 1. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
 - b. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
 - c. Cycle condenser fans to maintain maximum hot-gas pressure.
 - d. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - e. Gas furnace / electric coil airflow proving.
 - f. Gas furnace / electric coil high-temperature shutdown.
- C. Factory Installed Terminal Strip Requirements:
 - 1. Supply Fan Operation:
 - a. Enable
 - b. Signal
 - c. Feedback
 - d. Fault
 - 2. Exhaust Fan Operation:
 - a. Enable
 - b. Signal
 - c. Feedback
 - d. Fault
 - 3. Refrigerant Circuit Operation:
 - a. Enable
 - b. Variable capacity
 - c. Staged capacity
 - 4. Hot-Gas Reheat-Coil Operation:

- a. Variable capacity
- 5. Gas Furnace / Electric Coil Operation:
 - a. Enable
 - b. Variable capacity
- 6. Energy Wheel Operation:
 - a. Enable
 - b. Signal
 - c. Feedback
 - d. Fault
- 7. Damper Operation:
 - a. Modulating damper control
 - b. Damper position
- 8. Clogged Filter Switch
 - a. Closed relay
- 9. Phase and Brown Out Protection
 - a. Closed relay
 - b. Closed relay

2.13 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-resistant coating, watertight gaskets, and factory-installed wood nailer; complying with National Roofing Contractors Association manuals for the specific type of roofing applicable to the Project.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: 2 inches.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service air velocity.

- B. Curb Dimensions: Height of 24 inches.

2.14 INTAKE AND RELIEF OPENINGS

- A. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.
- B. Materials: Match material and finish of casing exterior.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.15 MATERIALS

- A. Steel:
 - 1. ASTM A36 for carbon structural steel.
 - 2. ASTM A568 for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240 for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653.
- D. Aluminum: ASTM B209.

2.16 SOURCE QUALITY CONTROL

- A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.
- B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.
- C. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- D. Damper Leakage and Air Performance:
 - 1. Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510.
- E. Refrigerant Coils: Factory tested to minimum 300 psig internal pressure and to minimum 300 psig internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine equipment pads for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Equipment Mounting:
 - 1. Install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 200548 "Vibration Controls for General Mechanical."
- B. Air-handling units shall not be used for temporary heating and ventilating unless expressly approved by Owner. If used during construction, see SMACNA's "IAQ Guidelines for Occupied Buildings under Construction" for procedures to protect HVAC system.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
- F. Comply with requirements for gas-fired furnace installation in NFPA 54.
- G. Install separate devices furnished by manufacturer and not factory installed.
- H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to units, allow space for service and maintenance.
- C. Connect piping to units mounted on vibration isolators with flexible connectors.
- D. Geothermal Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- E. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant and Condensate Piping." Install shutoff valve and union or flange at each supply and return connection.
- F. Condensate Piping: Comply with applicable requirements in Section 232300 "Refrigerant and Condensate Piping." Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- G. Hydronic Piping Connections:
 - 1. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
 - 2. Install shutoff valve and union or flange on each supply connection, and install balancing valve and union or flange on each return connection.
- H. Duct Connections:
 - 1. Comply with requirements in Section 233113 "Metal Ducts."
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Conductors and Cables."
- B. Ground equipment in accordance with Section 260600 "Grounding and Bonding."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260519 "Conductors and Cables."

3.6 STARTUP SERVICE

- A. A factory-authorized service representative shall perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Inspect units for visible damage to furnace combustion chamber.
 - 3. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 4. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
 - 5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 - 6. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
 - 7. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 - 8. Inspect casing insulation for integrity, moisture content, and adhesion.
 - 9. Verify that clearances have been provided for servicing.
 - 10. Verify that controls are connected and operable.
 - 11. Verify that filters are installed.

12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.
25. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Relief-air flow.
 - c. Outdoor-air flow.

- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.7 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

- A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.

3.10 Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain units. Video training sessions and provide electronic copy of video to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 - 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 4. Obtain Owner sign-off that training is complete.
 - 5. Owner training shall be held at Project site.

END OF SECTION

SECTION 238219

FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Ductless fan coil units and accessories.
 - 2. Ducted fan coil units and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Coil Unit Filters: Furnish one spare filter for each filter installed.
 - 2. Fan Belts: Furnish one spare fan belt for each unit installed.

1.7 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

- A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period: Five years from date of Substantial Completion.
 - 3. Warranty Period (Compressor Only): 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation; a unit of United Technologies Corp.
 - 2. Trane Inc.
 - 3. YORK; a Johnson Controls company.
- B. Fan Coil Unit Configurations: Row split.
 - 1. Number of Heating Coils: One with two-pipe system.
 - 2. Number of Cooling Coils: Three with two-pipe system.
- C. Coil Section Insulation: 1-inch- thick, foil-faced glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
 - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel.
- F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
 - 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
 - 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 - 3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
- H. MERV Rating: 8 when tested according to ASHRAE 52.2.
 - 1. Pleated Cotton-Polyester Media: 90 percent arrestance.
- I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

- J. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 - 1. Motors: Comply with requirements in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
- K. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 - 1. Motors: Comply with requirements in Section 200513 "Common Motor and Frequency Drive Requirements for General Mechanical Equipment."
- L. Unit shall be provided with a unit controller as required to satisfy safety controls related to the operations of the unit. Unit controller shall have volatile-memory backup. Factory installed terminal strip shall be provided for interface with the Building Control System (BCS) to control the operation of the unit.
- M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FAN COIL UNITS

- A. Install fan coil units level and plumb.
- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
- B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP AND TRAINING

- A. A factory-authorized service representative shall test and inspect components, assemblies, and equipment installations, including connections. The following tests and inspections shall be performed:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain fan coil units. Video training sessions and provide electronic copy of video to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 - 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 4. Obtain Owner sign-off that training is complete.
 - 5. Owner training shall be held at Project site.

3.5 STARTUP SERVICE

- A. A factory-authorized service representative shall perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 2. Verify that clearances have been provided for servicing.
 3. Verify that controls are connected and operable.
 4. Verify that filters are installed.
 5. Check piping connections for tightness.
 6. Clean coils and inspect for construction debris.
 7. Inspect and adjust vibration isolators.
 8. Verify bearing lubrication.
 9. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 10. Adjust fan belts to proper alignment and tension.
 11. Start unit.
 12. Calibrate controls.
 13. Adjust and inspect high-temperature limits.
 14. Verify operational sequence of controls.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.6 DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain units. Video training sessions and provide electronic copy of video to Owner.
1. Instructor shall be factory trained and certified.
 2. Train personnel in operation and maintenance and to obtain maximum efficiency in system operation.
 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 4. Obtain Owner sign-off that training is complete.
 5. Owner training shall be held at Project site.

END OF SECTION

SECTION 250100

COMMON SPECIFICATIONS - GENERAL HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Reference and comply with all Division 20 – General Mechanical specifications. All Division 20 specifications are applicable to Division 25 – Integrated Automation and HVAC Control. Division 20 specifications may complement other Division 25 – Integrated Automation and HVAC Control specifications.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 250993

SEQUENCE OF OPERATIONS FOR HVAC DDC

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 control sequences for DDC for HVAC systems, subsystems, and equipment.
- B. Related Requirements:
 - 1. Section 250923 "Direct Digital Control (DDC) System for HVAC" for control equipment.

1.3 DEFINITIONS

- A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).
- B. Binary Output: On/off output signal or contact closure.
- C. Digital Output: Data output that must be interpreted digitally.
- D. AHU: Air Handling Unit
- E. DDC: Direct digital control.
- F. VAV: Variable air volume.
- G. Building Automation System BAS, Building Management System (BMS) used interchangeably.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
 - 2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.
- B. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.5 DESCRIPTION OF WORK

- A. Sequence of Operation is hereby defined as the manner and method by which controls function. Requirements for each type of control system operation are specified in this section.
- B. The BAS Contractor (Division 25) is responsible for ensuring all mechanical equipment complies with the specified sequences. The Equipment Manufacturer (Division 23) is responsible for ensuring all equipment specified to be provided with a Manufacturer's standalone controller and an ASHRAE 135 (BACnet) communication interface must be programmed by the factory, or in the field, with the specified sequences. All programming modifications shall be done by a certified Manufacturer's Representative. The ASHRAE 135 (BACnet) communication interface shall be provided with enough readable and writable data points to allow for future modifications to the specified sequences by the BAS Contractor.
- C. Operating equipment, devices and system components required for control systems are specified in other Division Controls Sections of these specifications.
- D. For all graphics and sequences of operation, use final room names and number, which are not necessarily those shown on project drawings.
- E. Include text of each Sequence of Operation as part of BAS graphics. The sequences shall include project set points.
- F. Point List: Provide complete point list in spread sheet form for all data in/out points per apparatus, indicate alarm, time of day programs, graphic screen appearance, etc. Provide template for approval prior to producing.
- G. Provide graphic screen showing all electric meters, natural gas flow meters and all water flow meters (primary chilled water, terminal chilled water and domestic water).
- H. Provide graphic screen for each HVAC device showing temperatures, pressures, status, output, and adjustable set points.
- I. All variables listed in sequences to include time, temperature, pressures, flows are to be adjustable from operator control terminal.
- J. BAS Contractor shall provide 5 custom graphic screens as required by Owner/Architect.
- K. BAS Contractor shall provide an additional 25 Owner/Architect requested, customized graphic modifications with dynamic data point information. Coordinate specific points required with Owner or Architect prior to installation and closeout. These requested graphic modifications are in addition to the five custom graphic screens listed above.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 TIME SCHEDULES

3.2 TIME SCHEDULES

- A. All schedules shall be coordinated with and verified by Owner prior to final implementation.
- B. All schedules shall be fully adjustable by the Owner at the user interface.
- C. Owner shall have the ability to override all schedules, both globally and individually.
- D. Each piece of equipment shall have its own adjustable schedule.
- E. The Owner's designated staff shall be fully instructed on the operation of the system. When this instruction is complete and the system has been fully tested and is operational, the following schedules shall be implemented:
 - 1. Gymnasium: Occupied Mode 7:00am through 3:30pm Monday through Friday; Unoccupied Mode all other times.
 - 2. Cafeteria: Occupied Mode 7:00am through 12:30pm Monday through Friday; Unoccupied Mode all other times.
 - 3. Kitchen Area: Occupied Mode 6:00am through 2:00pm Monday through Friday; Unoccupied Mode all other times.
 - 4. Administration Areas: Occupied Mode 7:00am through 4:00pm Monday through Friday; Unoccupied Mode all other times.
 - 5. Classroom Areas: Occupied Mode 7:00am through 3:30pm Monday through Friday; Unoccupied Mode all other times.

3.3 DEHUMIDIFICATION

- A. If space humidity exceeds setpoint (60%) then automatic dehumidification mode for dedicated outdoor air systems and rooftop air handling units will be automatically initiated by the microprocessor controller. Dehumidification mode shall be activated for 48 hours (adj.).
- B. Run cooling coils "wild" and modulate heat to maintain discharge temperature. After 48 hours, if humidity level is not satisfactory, then operator input is required to continue dehumidification cycle until space humidity point is achieved.
- C. When dehumidification cycles are satisfied the control system shall be returned to normal mode.
- D. Alarms:
 - 1. The microprocessor controller shall monitor units with humidity sensors and send an alarm to the Operator Interface when any unit exceeds setpoint. The alarm shall be displayed on

the graphics screen and printed out. All alarms shall be recorded to a hard drive file for future reference.

- a. High Humidity

E. Graphics:

1. The Operator Interface shall include a graphic picture of the unit(s) in alarm condition. A separate screen shall indicate boilers, chiller, and associated pumps.

3.4 CHILLED WATER SYSTEMS

- A. Constant Speed Chilled Water Pumps: When the outside air temperature rises above the cooling lockout set point 55 (Adj.) and cooling demand is on, the microprocessor controller shall start the lead pump for continuous operation. Pumps shall alternate to the lag pump every 7 days and during the Unoccupied Mode. The controller shall monitor pump status. If one of the two operating pumps should fail the controller shall start the lag pump and send an alarm to the Operator Interface. The chilled water system shall have 3-way control valves at all unit ventilators, fan coil units and air handling units. A water flow transmitter shall monitor the chilled water flow to the chiller. When the outside air temperature falls below the lockout temperature the chillers shall be locked out and the pump shall continue to run for 5 minutes and then stop. A power monitor transmitter shall monitor the building input voltage. If the building power loses a phase or drops to a brown out condition, the controller shall stop the pumps and send an alarm to the Operator Interface. When the voltage returns to normal the pump and chiller will re-start.

B. Chillers:

1. The chiller plant control system will initiate a “soft start” mode whenever the system chilled water temperature exceeds the specified chilled water system setpoint by 20°F (adj) at system start-up. The chiller plant control application will add cooling capacity during soft start mode only if return water temperature is not declining at a rate of at least 0.5°F (adj) per minute. This prevents the unnecessary operation of the chiller and limits system electrical demand during chilled water loop pull down.
2. When the chilled water system is enabled the chiller plant control system will send an Enable signal to the lead chiller and lead chilled water pump. Chillers shall alternate to the lag chiller every 7 days and during the Unoccupied Mode. The controller shall monitor chiller status. If one of the chillers should fail the controller shall start the lag chiller and send an alarm to the Operator Interface.
3. The chiller plant control system will control chiller setpoints to maintain the system supply water temperature setpoint.
4. Failure Recovery: Upon sensing a chiller failure the chiller plant control system will shut down the failed chiller immediately and send a chiller failure alarm to the Operator Interface.

C. Alarms:

1. The microprocessor controller shall monitor the chillers and chiller pumps and send the following alarms to the Operator Interface:
 - a. Pump P-1A Failure

- b. Pump P-1B Failure
 - c. Chiller 1 Failure
 - d. Chiller 1 – High Chilled Water Temperature, Setpoint 50 deg. F (adj.).
 - e. Chiller 1 – Low Chilled Water Temperature, Setpoint 44 deg. F (adj.).
 - f. Chiller 1 – Low Chilled Water Flow.
 - g. Chiller 1 Failure
 - h. Chiller 1 – High Chilled Water Temperature, Setpoint 50 deg. F (adj.).
 - i. Chiller 1 – Low Chilled Water Temperature, Setpoint 44 deg. F (adj.).
 - j. Chiller 1 – Low Chilled Water Flow.
- 2. The alarms shall be displayed on the graphics screen and printed out.
 - 3. All alarms shall be recorded to a hard drive file for future reference.

D. Graphics:

- 1. The Operator Interface graphics shall include a graphic picture of the chiller/pump system.
- 2. The data shall be dynamic and include all water temperatures, pump status, and alarm indication. Include outside air indication on all chilled water and pump graphic screens.
- 3. The graphic shall include a control panel screen.
- 4. The operator shall adjust all set points as listed in the above sequence from this screen.
- 5. The graphic shall include a control panel screen to adjust alternate hours for pump Lead / Lag operation.
- 6. Each setpoint shall have a deadband. The operator shall be able to adjust the deadband from the screen.

3.5 HEATING HOT WATER SYSTEMS

- A. Constant Speed Heating Hot Water Pumps: When the outside air temperature falls below the heating lockout set point 60 (Adj.) and heating demand is on, the microprocessor controller shall start the lead pump for continuous operation. Pumps shall alternate to the lag pump every 7 days and during the Unoccupied Mode. The controller shall monitor pump status. If one of the two operating pumps should fail the controller shall start the lag pump and send an alarm to the Operator Interface. The heating hot water system shall have 3-way control valves at all unit ventilators, fan coil units, heaters and air handling units. A water flow transmitter shall monitor the heating hot water flow to the boilers. When the outside air temperature rises above the lockout temperature the boiler shall be locked out and the pump shall continue to run for 5 minutes and then stop. A power monitor transmitter shall monitor the building input voltage and amperage. If the building power loses a phase or drops to a brown out condition, the controller shall stop the pumps and send an alarm to the Operator Interface. When the voltage returns to normal the pump and boiler will restart.

B. Boilers:

- 1. When the outside air temperature falls below the Heating Setpoint of 60 deg. F (Adj.), the BCS shall enable the lead boiler. Boilers shall alternate to the lag boiler every 7 days and during the Unoccupied Mode. The controller shall monitor boiler status. If one of the boilers should fail the controller shall start the lag boiler and send an alarm to the Operator Interface.
- 2. The operating control for each boiler shall open the combustion air motorized damper. After the damper is open the boiler shall become operational.

3. Boiler burner shall modulate to maintain the system supply water temperature setpoint. If the lead boiler cannot maintain the hot water supply temperature, the lag boiler shall be commanded on.
4. The supply water temperature shall be scheduled in accordance with outdoor air temperature through the BCS. A sensor in the common boiler header shall modulate the burner(s) to maintain the boiler water reset schedule:
 - a. At 45 deg. F OA, 130 deg. F HWS (Adj.).
 - b. At 60 deg. F OA, 90 deg. F HWS (Adj.).
5. Provide flow monitoring stations for Heating Water Supply flow.
6. Provide the following temperature sensors:
 - a. Main Boiler Supply, Main Boiler Return, Hot Water Supply at each boiler and Hot Water Return at each boiler.

C. Alarms:

1. The microprocessor controller shall monitor the boiler and the heating pumps and send the following alarms to the Operator Interface:
 - a. Pump P-2A Failure
 - b. Pump P-2B Failure
 - c. Boiler 1 Failure
 - d. Boiler 2 Failure
 - e. High Heating Water Supply Temperature, Setpoint 135 deg. F (adj.).
 - f. Low Heating Water Return Temperature, Setpoint 85 deg. F (adj.).
2. The alarms shall be displayed on the graphics screen and printed out.
3. All alarms shall be recorded to a hard drive file for future reference.

D. Graphics:

1. The Operator Interface graphics shall include a graphic picture of the boiler/pump system.
2. The data shall be dynamic and include all water temperatures, pump status, and alarm indication. Include outside air indication on all heating water and pump graphic screens.
3. The graphic shall include a control panel screen.
4. The operator shall adjust all set points as listed in the above sequence from this screen.
5. The graphic shall include a control panel screen to adjust alternate hours for boiler Lead / Lag operation.
6. The graphic shall include a control panel screen to adjust alternate hours for pump Lead / Lag operation.
7. Each setpoint shall have a deadband. The operator shall be able to adjust the deadband from the screen.

3.6 SINGLE-ZONE ROOFTOP UNITS

- A. Unit shall be automatically switched to the Occupied or Unoccupied Cycle from the Front End Workstation via the occupancy schedule. Occupied or Unoccupied status shall have an override

capability from the Front End Workstation. An occupied override button shall be provided at the wall mounted thermostat and shall provide a 1-hour increment of occupied operation.

B. Fan Control:

1. Occupied: During the Occupied Cycle the microprocessor controller shall send a signal to start the supply fan for continuous fan operation. After a time delay (Adj.) the controller shall open the outside air damper to its design position as listed on schedule. The supply fan status shall be monitored through the controller. If the supply fan stops during normal operation, then a fan failure alarm shall be sent to the workstation.
2. Unoccupied: During the Unoccupied Cycle, the supply fan shall remain off. If the space temperature falls below the night heating set point 65 (Adj.) or above the night cooling set point 85 (Adj.), then the controller shall cycle the supply fan to maintain night temperatures. The outside air damper shall remain closed.
3. Morning Warm-Up: When Morning Warm-Up Cycle begins, the supply fan shall start. The outside air damper shall remain closed. The gas-fired heater shall be engaged until the return air temperature rises above 70 deg.F (Adj.) and the Morning Warm-Up Cycle shall end. The unit shall resume normal operation when the Occupied Cycle begins.
4. Morning Cool-Down: When the Morning Cool-Down Cycle begins, the supply fan shall start. The outside air damper shall remain closed. DX cooling shall be energized to maintain 55 deg.F. supply air set point during Cool-Down Cycle. When the return air temperature drops to 75 deg.F. (Adj.) the Cool-Down Cycle shall end. The unit shall resume normal operation when the Occupied Cycle begins. Use Economizer sequence when available (Outside Air Temperature Permitting).
5. Snow Day: Unit shall control same as the unoccupied period. Snow day shall be reset at midnight to regularly scheduled occupancy mode.
6. Optimization: The Morning Warm-Up and Cool Down Cycles shall be capable of optimizing start-up and cycle duration times.
7. Shelter In Place: During the Shelter in Place Mode the supply fan shall remain off and outside air damper closed. When Shelter In Place has been cleared, the RTU's shall re-start on a staggered schedule.

C. Outdoor Air Introduction and Ventilation Control:

1. The Design Outside Air value shall be balanced while the Supply Fan is operating at its Design speed to provide a constant Supply Air and Outside Air flow rate during the occupied mode.
2. The outside air damper shall close if the supply fan stops.

D. System and Space Static Pressure:

1. The Power exhaust fan shall modulate speed to satisfy space static pressure. Space static pressure shall be maintained a slight positive to the outdoors (0.05 inches W.C.).

E. DX Cooling/Outside Air Dampers:

1. A Space Temperature Sensor shall send a signal to the Microprocessor Controller.
2. When the Supply Fan is running, the controller shall energize DX Cooling to maintain the Space Temperature Set Point of 75 deg F.(Adj.).
3. When the Outside Air Temperature falls below the Cooling lockout Set Point, the DX Cooling shall remain Off.

4. When the Outside Air Temperature and Humidity fall below the Economizer Set Point (Adj.), the Microprocessor Controller shall modulate the Outside Air Damper and the Return Air Damper, to maintain the Space Temperature Set Point. Excess air shall be relieved through the unit barometric relief damper.
5. The Microprocessor Controller shall receive a signal from a Mixed Air Temperature Sensor.
6. During the Economizer Cycle the Controller shall override and modulate close the Outside Air Damper and modulate open the Return Air Damper to maintain a Mixed Air Low Limit Set Point of 45 deg. F (Adj.). Outside Air and Return Air Damper shall not modulate below minimum OA CFM setpoint position during the occupied mode.
7. If the Mixed Air Temperature falls below the Mixed Air Set Point Alarm (Mixed Air Set Point –5) a Low Mixed Temperature Alarm shall be sent to the Workstation.
8. If the Supply Fan stops, the Outside Air Damper shall close and the Return Air Damper shall open.
9. When the Outside Temperature and Humidity rises above the Economizer Set Point, Outside Air Damper and Relief Air Damper shall modulate to OA CFM setpoint position during the occupied mode.
10. Outside Air Damper shall close and the Return Air Damper shall open during unoccupied mode.
11. If the Space Temperature rises above the Space Temperature Cool Set Point Alarm (Cool Set Point + 10) a High Cooling Temperature Alarm shall be sent to the Workstation.

F. Gas Heat

1. A Space Temperature Sensor shall send a signal to the Microprocessor Controller
2. When the Supply Fan is running and on a call for Heat, the Controller shall modulate the gas valve to maintain the Space Temperature Set Point (Adj.).
3. If the Space Temperature falls below the Space Temperature Heat Set Point Alarm (Heat Set Point-10) a Low Heating Temperature Alarm shall be sent to the Workstation.

G. Dehumidification Cycle:

1. When the Return Air Relative Humidity rises above the High Humidity Set Point of 65% RH (Adj.) a high humidity alarm shall be sent to the workstation and the dehumidification cycle shall be initiated.
2. The Controller shall energize all stages of DX Cooling.
3. The controller shall energize the Hot Gas Reheat Valve.
4. When the Return Air Relative Humidity falls below the Normal Humidity Set point of 55% RH (Adj.), a humidity return to normal alarm shall sound at the workstation.
5. The controller shall disable the dehumidification cycle.
6. The unit shall return to normal operation.

H. Alarms:

1. The microprocessor controller shall monitor the rooftop air handling unit and send the following alarms to the Front-End Workstation:
 - a. Supply Fan Failure
 - b. DX Cooling Failure
 - c. Gas Heating Failure.

- d. Low Limit Thermostat Alarm
 - e. Low Mixed Air Temp Alarm
 - f. High and Low Discharge Air Temperature.
 - g. High and Low Space Temperature.
- 2. The alarms shall be displayed on the graphic screen and printed out.
 - 3. All alarms shall be recorded to a hard drive file for future reference.

I. Graphics:

- 1. The Front-End Workstation shall include a graphic picture of the above Rooftop DX air handling unit. The data on this graphic shall be dynamic and include all Inputs and Outputs as on the drawings.
- 2. The graphic shall also include a control panel screen.
- 3. The operator shall adjust all set points as listed in the above sequence from this screen, including 5 degree Dead Band between Heating and Cooling Setpoints.
- 4. Fan run time shall also be included on the control panel screen.
- 5. Include outside air damper indication on all RTU graphic screens.

3.7 DEDICATED OUTSIDE AIR SYSTEMS (DOAS)

A. Fan Control:

- 1. The unit shall be a constant volume unit which continuously operates. Unit to be manually switched to occupied or unoccupied sequence from the Operator Interface only and once set will operate in selected mode until changed.
- 2. The supply fan and exhaust fan shall be interlocked to operate together. If one fan fails, the other fan shall immediately turn off.
- 3. Occupied Mode: During the Occupied Cycle the Microprocessor Controller shall send a signal to open the outside air damper and start the supply and exhaust fans for continuous fan operation. The supply fan and return fan status shall be monitored with adjustable current sensors. If either fan fails to start or stops during normal operation, then a Fan Failure Alarm shall be sent to the Operator Interface and the outside air damper shall close.
- 4. Unoccupied Mode: During the Unoccupied Cycle, the supply fan shall remain off. If the space temperature falls below the Night Heating Set Point 55 (Adj.) or above the Night Cooling Set Point 80 (Adj.), then the Controller shall cycle the supply fan to maintain night temperatures.
 - a. An override button at the space thermostats shall switch the unit to the Occupied Mode when pushed. Time shall be adjustable at the Operator Interface and shall initially be set for 1 hour.
- 5. Morning Warm-Up Mode: The warm-up mode is activated 30 minutes (adjustable) prior to occupied mode. During the warm-up mode the supply fan shall start for continuous operation. The outside air dampers shall remain closed. The heating coil gas valve shall modulate as required to maintain a 90 deg. F supply air set point during Morning Warm-Up. When the return air temperature rises above 72 deg. F (Adj.) the Morning Warm-Up Cycle shall end. The Unit shall resume normal operation when the Occupied Cycle begins.
- 6. Morning Cool-Down Mode: The cool-down mode is activated 30 minutes (adjustable) prior to occupied mode. During the cool-down mode the supply fan shall start for

continuous operation. The outside air dampers shall remain closed. The cooling coil shall stage on as required to maintain 55 deg. F supply air set point during cool-down cycle. When the return air temperature drops to 74 deg. F (Adj.) the cool-down cycle shall end. The unit shall resume normal operation when the Occupied Cycle begins.

7. Optimization: The Morning Warm-Up and Cool Down Cycles shall be capable of optimizing start-up and cycle duration times.
8. Phase Protection: A Power Monitor Transmitter shall monitor the Building input voltage. If the Building Power loses a Phase or drops to a brown out condition, then the Controller shall stop the Unit Fans and send an alarm to the Operator Interface. When the voltage returns to normal, the DOAS will re-start on a staggered schedule.
9. Shelter in Place: During the Shelter in Place Mode the Supply and Exhaust Fans shall remain off and outside/exhaust dampers closed. When Shelter in Place has been cleared, the DOAS shall re-start on a staggered schedule.

B. Temperature Control:

1. Cooling: When the fan is running and on a call for cooling, the Controller shall cycle stages of cooling to maintain the cooling mode unit leaving dewpoint temperature setpoint.
2. Heating: When the fan is running and on a call for heat, the Controller shall modulate the gas valve and combustion air flow rate for the heating coil to maintain the heating mode unit leaving dewpoint temperature setpoint.

C. Energy Recovery (Enthalpy Wheel):

1. Enthalpy wheel will operate as required to maximize the heat transfer between the supply air and exhaust air.
2. The unit controller shall reduce wheel rotation speed in frost control mode to prevent frost formation.

D. Dehumidification:

1. When humidity exceeds high limit setpoint (60% adj.), the dehumidification mode shall be activated and a high humidity alarm sent to the Operator Interface. The unit shall continue to operate in Dehumidification Mode until humidity setpoint (50% adj.) is satisfied.
 - a. The BCS shall start the DX Cooling and start Hot Gas Reheat Coil.
 - b. The Supply Air Sensor shall modulate the Hot Gas Reheat Coil to maintain discharge air dew point.
 - c. When the Humidity falls below the Humidity Set Point, a Humidity return to normal alarm shall sound at the Operator Interface.
 - d. The BCS shall disable the Dehumidification Cycle.
 - e. The Cooling shall return to normal and the Hot Gas Reheat Coil shall turn off.

E. Communications:

1. Building Control System (Section 250923) Contractor shall provide hard-wired communications to the terminal strip in the unit as required to operate the unit per the sequence of operation as listed in this Section.
 - a. Refer to Section 250995 “Direct Digital Control (DDC) Points List” for minimum points required.

- b. Refer to Section 237433 “Dedicated Outdoor-Air Units” for additional connection requirements.
 - 2. Building Control System (Section 250923) Contractor shall provide a 0 to 10 volt signal to the unit for the following:
 - a. Discharge Air Temperature Reset
 - 3. BacNet interface will be for monitoring of the unit only – safety operation of the unit shall be conducted by unit manufacturer-provided controls. Refer to Section 237433 “Dedicated Outdoor-Air Units.”
- F. Alarms: The Microprocessor Controller shall monitor the units and send the following alarms to the Operator Interface. The alarms shall be displayed on the graphics screen and printed out. All alarms shall be recorded to a hard drive file for future reference.
 - 1. Supply fan failure.
 - 2. Exhaust fan failure.
 - 3. Cooling failure.
 - 4. Heat failure.
 - 5. Heat wheel failure.
 - 6. Change filter (based on time).
 - 7. High discharge air temperature.
 - 8. Low discharge air temperature.
 - 9. Low limit stat fan stop.
 - 10. Low limit sensor O.A. damper override.
- G. Graphics: The Operator Interface shall include a graphic picture of the DOAS units. The data on this graphic shall be dynamic and include all Inputs and Outputs as listed on the Input/Output Schedule on the Drawings. The Graphic shall also include a control panel screen. The Operator shall adjust all setpoints as listed in the above Sequence from this screen. Each Setpoint shall also have a dead-band the Operator can adjust from this screen. Include outside air indication on all DOAS unit graphic screens.

3.8 SINGLE-ZONE VARIABLE AIR VOLUME ROOFTOP UNITS

- A. Unit shall be automatically switched to the Occupied or Unoccupied Cycle from the Front End Workstation via the occupancy schedule. Occupied or Unoccupied status shall have an override capability from the Front End Workstation. An occupied override button shall be provided at the wall mounted thermostat and shall provide a 1-hour increment of occupied operation.
- B. Fan Control:
 - 1. Occupied: During the Occupied Cycle the microprocessor controller shall send a signal to start the supply fan for continuous fan operation. After a time delay (Adj.) the controller shall open the outside air damper to its design position as listed on schedule. The supply fan status shall be monitored through the controller. If the supply fan stops during normal operation, then a fan failure alarm shall be sent to the workstation.
 - 2. Unoccupied: During the Unoccupied Cycle, the supply fan shall remain off. If the space temperature falls below the night heating set point 65 (Adj.) or above the night cooling set

point 85 (Adj.), then the controller shall cycle the supply fan to maintain night temperatures. The outside air damper shall remain closed.

3. Morning Warm-Up: When Morning Warm-Up Cycle begins, the supply fan shall start. The outside air damper shall remain closed. The gas-fired heater shall be engaged until the return air temperature rises above 70 deg.F (Adj.) and the Morning Warm-Up Cycle shall end. The unit shall resume normal operation when the Occupied Cycle begins.
4. Morning Cool-Down: When the Morning Cool-Down Cycle begins, the supply fan shall start. The outside air damper shall remain closed. DX cooling shall be energized to maintain 55 deg.F. supply air set point during Cool-Down Cycle. When the return air temperature drops to 75 deg.F. (Adj.) the Cool-Down Cycle shall end. The unit shall resume normal operation when the Occupied Cycle begins. Use Economizer sequence when available (Outside Air Temperature Permitting).
5. Snow Day: Unit shall control same as the unoccupied period. Snow day shall be reset at midnight to regularly scheduled occupancy mode.
6. Optimization: The Morning Warm-Up and Cool Down Cycles shall be capable of optimizing start-up and cycle duration times.
7. Shelter In Place: During the Shelter in Place Mode the supply fan shall remain off and outside air damper closed. When Shelter In Place has been cleared, the RTU's shall re-start on a staggered schedule.

C. Outdoor Air Introduction and Ventilation Control:

1. The Design Outside Air value shall be balanced while the Supply Fan is operating at its Design speed to provide a constant Supply Air and Outside Air flow rate during the occupied mode.
2. The outside air damper shall close if the supply fan stops.

D. System and Space Static Pressure:

1. The Power exhaust fan shall modulate speed to satisfy space static pressure. Space static pressure shall be maintained a slight positive to the outdoors (0.05 inches W.C.).

E. DX Cooling/Outside Air Dampers:

1. A Space Temperature Sensor shall send a signal to the Microprocessor Controller.
2. When the Supply Fan is running, the controller shall energize DX Cooling to maintain the Space Temperature Set Point of 75 deg F.(Adj.).
3. When the Outside Air Temperature falls below the Cooling lockout Set Point, the DX Cooling shall remain Off.
4. When the Outside Air Temperature and Humidity fall below the Economizer Set Point (Adj.), the Microprocessor Controller shall modulate the Outside Air Damper and the Return Air Damper, to maintain the Space Temperature Set Point. Excess air shall be relieved through the unit barometric relief damper.
5. The Microprocessor Controller shall receive a signal from a Mixed Air Temperature Sensor.
6. During the Economizer Cycle the Controller shall override and modulate close the Outside Air Damper and modulate open the Return Air Damper to maintain a Mixed Air Low Limit Set Point of 45 deg. F (Adj.). Outside Air and Return Air Damper shall not modulate below minimum OA CFM setpoint position during the occupied mode.
7. If the Mixed Air Temperature falls below the Mixed Air Set Point Alarm (Mixed Air Set Point -5) a Low Mixed Temperature Alarm shall be sent to the Workstation.

8. If the Supply Fan stops, the Outside Air Damper shall close and the Return Air Damper shall open.
9. When the Outside Temperature and Humidity rises above the Economizer Set Point, Outside Air Damper and Relief Air Damper shall modulate to OA CFM setpoint position during the occupied mode.
10. Outside Air Damper shall close and the Return Air Damper shall open during unoccupied mode.
11. If the Space Temperature rises above the Space Temperature Cool Set Point Alarm (Cool Set Point + 10) a High Cooling Temperature Alarm shall be sent to the Workstation.

F. Gas Heat

1. A Space Temperature Sensor shall send a signal to the Microprocessor Controller
2. When the Supply Fan is running and on a call for Heat, the Controller shall modulate the gas valve to maintain the Space Temperature Set Point (Adj.).
3. If the Space Temperature falls below the Space Temperature Heat Set Point Alarm (Heat Set Point-10) a Low Heating Temperature Alarm shall be sent to the Workstation.

G. Dehumidification Cycle:

1. When the Return Air Relative Humidity rises above the High Humidity Set Point of 65% RH (Adj.) a high humidity alarm shall be sent to the workstation and the dehumidification cycle shall be initiated.
2. The Controller shall energize all stages of DX Cooling.
3. The controller shall energize the Hot Gas Reheat Valve.
4. When the Return Air Relative Humidity falls below the Normal Humidity Set point of 55% RH (Adj.), a humidity return to normal alarm shall sound at the workstation.
5. The controller shall disable the dehumidification cycle.
6. The unit shall return to normal operation.

H. Alarms:

1. The microprocessor controller shall monitor the rooftop air handling unit and send the following alarms to the Front-End Workstation:
 - a. Supply Fan Failure
 - b. Change filter (based on time).
 - c. DX Cooling Failure
 - d. Gas Heating Failure.
 - e. Low Limit Thermostat Alarm
 - f. Low Mixed Air Temp Alarm
 - g. High and Low Discharge Air Temperature.
 - h. High and Low Space Temperature.
2. The alarms shall be displayed on the graphic screen and printed out.
3. All alarms shall be recorded to a hard drive file for future reference.

I. Graphics:

1. The Front-End Workstation shall include a graphic picture of the above Rooftop DX air handling unit. The data on this graphic shall be dynamic and include all Inputs and Outputs as on the drawings.
2. The graphic shall also include a control panel screen.
3. The operator shall adjust all set points as listed in the above sequence from this screen, including 5 degree Dead Band between Heating and Cooling Setpoints.
4. Fan run time shall also be included on the control panel screen.
5. Include outside air damper indication on all RTU graphic screens

3.9 FAN COIL UNITS

A. Cooling:

1. A Space Temperature Sensor shall send a signal to the BCS.
2. When the Supply Fan is running and on a call for cooling, the controller shall modulate the chilled water control valve to maintain the Space Temperature Set Point 74 deg.F (Adj.).
3. If the Temperature rises above the Set Point Alarm (Set Point + 5), a High Cooling Temperature Alarm shall be sent to the Operator Interface.
4. If the supply fan stops, the chilled water control valve shall close to the coil.

B. Heating:

1. A Space Temperature Sensor shall send a signal to the BCS.
2. When the Supply Fan is running and on a call for heat, the controller shall modulate the hot water control valve to maintain the Space Temperature Set Point 70 deg.F (Adj.).
3. If the Temperature falls below the Set Point Alarm (Set Point – 10), a Low Heating Temperature Alarm shall be sent to the Operator Interface.
4. If the supply fan stops, the hot water control valve shall close to the coil.

C. Alarms:

1. The microprocessor controller shall monitor the air handling unit and send the following alarms to the Operator Interface:
 - a. Supply Fan Failure
 - b. Change filter (based on time).
 - c. Cooling Valve Failure
 - d. Heating Valve Failure
 - e. High Limit Thermostat Alarm
 - f. Low Limit Thermostat Alarm

D. Graphics:

1. The Operator Interface shall include a graphic picture of the fan coil unit. The data on this graphic shall be dynamic and include all Inputs and Outputs.
2. The graphic shall also include a control panel screen.
3. The operator shall adjust all set points as listed in the above sequence from this screen, including 5 degree deadband.
4. Fan run time shall also be included on the control panel screen.
5. Include Occupied/Unoccupied on all graphic screens.

3.10 EXHAUST FANS

- A. Exhaust Fans shall remain off during the Unoccupied, Warm-Up and Cool-Down Modes. Motor operated dampers on EFs that have them shall have a return spring for closure.
- B. Exhaust Fans greater than 300 CFM shall have a motor operated damper.
- C. When the Shelter in Place Mode is activated, all exhaust fans shall shut down. When Shelter in Place has been cleared, the equipment shall go through normal start-up.
- D. A Power Monitor Transmitter shall monitor the building input voltage. If the building power loses a phase or drops to a brown out condition, the controller shall stop the fans, close the intakes, and send an alarm to the Operator Interface. When voltage returns to normal, the fans shall restart and the intakes shall open.
- E. Alarms: The microprocessor control shall monitor fan and motorized damper operation and send the following alarms to the BCS Operator Interface. The alarms shall display on the graphics screen and print out.
 - 1. Fan status, Start/Stop.
 - 2. Fan failure.
 - 3. Damper failure.
 - 4. High temperature in rooms with temperature-controlled fans.
- F. Graphics: The Operator Interface shall include a graphics picture of each fan and damper. The data on this graphic shall be dynamic and selectable. When selected, the fan's detailed information shall be pulled up in a control screen. The operator shall adjust all setpoints from this screen.
 - 1. Exhaust Fans shall be on the same graphics screen and shall have individual status displayed.

3.11 COOLER AND FREEZER TEMPERATURE

- A. Cooler and Freezer temperatures shall be monitored by room temperature sensors. Proper time delay alarming shall be programmed to prevent nuisance alarming when the Cooler or Freezer door is open.
- B. Status (ON/OFF) of the Cooler and Freezer compressors shall be monitored.
- C. Alarms:
 - 1. High Temperature
 - 2. Low Temperature
- D. Graphics:
 - 1. The Operator Interface shall include a graphic picture of the cooler and freezer with dynamic graphic of each space temperature and the status of each compressor (ON/OFF).

3.12 CONTROL VALVE EXERCISE

- A. For any control valve that has been idle for a period of 7 days (Adj.), the controller shall modulate that valve open and closed two full strokes to exercise the valve.

3.13 BUILDING MODE – SCHOOL CANCELLATION

- A. Provide a master override button on the main controls screen to place the building into Unoccupied Mode in the event of a school cancellation. This override shall automatically terminate at the commencement of the next regularly scheduled Occupied Mode (or its associated Warm Up / Cool Down Mode).

3.14 BUILDING MODE – PARTIAL OCCUPATION

- A. Cooling:
 - 1. During periods of time when building is partially occupied, such as evening classes, special events, or summer classes, the system shall be in partial occupied mode.
 - 2. Areas occupied shall be enabled to operate in occupied mode as previously described.
 - 3. Other areas of the building shall be in unoccupied mode as previously described.
- B. Heating:
 - 4. During periods of time when building is partially occupied, such as evening classes and special events, the system shall be in partial occupied mode.
 - 5. Areas occupied shall be enabled to operate in occupied mode as previously described.
 - 6. Other areas of the building shall be in unoccupied mode previously described.
- C. Alarms:
 - 1. High Temperature
 - 2. Low Temperature
- D. Graphics:
 - 1. The Operator Interface shall include a graphic picture of the overall building with each unit indicated and its mode of operation (occupied or unoccupied) shown.

3.15 BUILDING MODE – NO CLASSROOM OR ASSEMBLY AREA VENTILATION

- A. Cooling:
 - 1. During periods of time when the building is minimally occupied, such as summer, certain units, such as the AHU for the main office area, will continue to run in occupied mode with ventilation. Other areas, including classrooms and assembly areas shall have outside air dampers closed and operate at setup temperature to be determined by Owner.
- B. Alarms:

1. High Temperature
2. Low Temperature
3. High Humidity

C. Graphics:

1. The Operator Interface shall include a graphic picture of the overall building with each unit indicated and its mode of operation (occupied or unoccupied) shown.

3.16 SPECIAL EVENT MODE

- A. When a special event is scheduled and additional cooling is required, occupied cooling setpoint shall be reduced during the unoccupied mode so that the space will be “pre-cooled” to accommodate additional load.
- B. As a minimum, the units serving the gymnasium and the cafeteria shall be provided with this mode of programming. Additional spaces requiring this programming shall be coordinated with the Owner.
- C. Graphics: The Operator Interface shall include a graphic picture of each unit entitled “Special Event”, with setpoint adjustment and duration of event that the sequence will serve.

3.17 SHELTER-IN-PLACE

- A. A two-position selector switch shall be located in the Principal’s Office and in the Mechanical Room. The selector shall be labeled “NORMAL – SIP” and be monitored by the DDC system.
- B. In the NORMAL position, equipment shall operate under standard sequences as described in this section.
- C. In the SIP position, all air intakes, relief vents, air conditioning units, exhaust fans, central boiler and chiller plants, and air handling units shall be shut down. All outdoor air dampers shall be closed, including combustion air dampers. Pumps that were operating immediately before the SIP alarm shall continue to run.
- D. An alarm shall be initiated through the DDC system.
- E. Graphics: The Operator Interface shall include a graphic picture verifying that all requirements of the SIP event have been met.

3.18 OUTSIDE AIR TEMPERATURE AND HUMIDITY

- A. Monitor OA temperature and humidity.
- B. Use in comparative enthalpy calculation with RA temperature and humidity for economizer operation.

3.19 CARBON MONOXIDE DETECTORS

- A. The following spaces, as a minimum, shall have carbon monoxide (CO) levels monitored by the Building Control System:
 - 1. Rooms indicated on DWGs.
- B. A High CO Level Alarm shall be sent to the BCS when a CO level of 15 ppm (Adj.) or higher is detected.

3.20 BUILDING STATIC PRESSURE

- A. During the Occupied Mode, the BAS shall monitor the Building Static and Outdoor Air Static Pressure sensors and calculate the Differential Static Pressure in the building.
 - 1. Provide a High Building Static Pressure Alarm when the reading is greater than 0.1” w.c.
 - 2. Provide a Low Building Static Pressure Alarm when the reading is lower than 0.02” w.c.

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
 - 2. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. VFC: Variable frequency controller.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THW-2, Type THHN-2-THWN-2, and Type XHHW-2.
- C. Multi-conductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.
- D. VFC Cable:
 - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.

2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
3. Comply with UL requirements for cables in Classes I and II, Division 2 hazardous location applications.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

- F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire mesh, strain relief device at terminations to suit application.
- G. VFC Output Circuits: Type TC-ER cable with dual tape shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Conductors.
 - 2. Connectors.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost 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.

- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL 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. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 2. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
- C. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To New Concrete: Bolt to concrete inserts.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. 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.
 - 4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 5. To Light Steel: Sheet metal screws.
 - 6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
 - 1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
 - 3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Setscrew or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. RTRC: Comply with UL 1684A and NEMA TC 14.
- F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.

- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Hinged type or flanged-and-gasketed type unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep as required for application.
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of reinforced concrete or fiberglass as required for application.
1. Standard: Comply with SCTE 77.
 2. Color of Frame and Cover: Green.
 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."
 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC or RNC, Type EPC-40-PVC.
 2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
 3. Underground Conduit: Type EPC-40-PVC, concrete encased.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms (lower than 3'-0").
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
- C. Minimum Raceway Size: 3/4-inch trade size. 1-inch for communication and security.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. 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. Secure raceways to reinforcement at maximum 10-foot intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from ENT to GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 1. Use EMT, IMC, or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.”

END OF SECTION

SECTION 260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND 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.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- E. Sleeves for Rectangular Openings:
1. Material: Galvanized sheet steel.
 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant 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. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 4 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Retain paragraph below if retaining self-adhesive products in Part 2. See Editing Instruction No. 1 in the Evaluations.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.5 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- H. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied.

- b. Colors for 208/110-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- B. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, 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.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label. Circuit description must be updated with Final Room Name and Number changes issued during construction.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.

- d. Switchboards.
 - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Enclosed switches.
 - g. Enclosed circuit breakers.
 - h. Enclosed controllers.
 - i. Variable-speed controllers.
 - j. Push-button stations.
 - k. Power transfer equipment.
 - l. Contactors.
 - m. Remote-controlled switches, dimmer modules, and control devices.
 - n. Battery-inverter units.
 - o. Power-generating units.
 - p. Monitoring and control equipment.
3. Identify junction boxes above ceilings with hand written circuit identification.

END OF SECTION

SECTION 260923

LIGHTING CONTROL DEVICES

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. Time switches.
 - 2. Photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Lighting contactors.
- B. Related Requirements:
 - 1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
 - 3. Astronomic Time: All channels.
 - 4. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

- B. Electromechanical-Dial Time Switches: Comply with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 - 3. Astronomic time dial.
 - 4. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 - 5. Skip-a-day mode.
 - 6. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with DPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 3. Time Delay: Thirty-second minimum, to prevent false operation.
 - 4. Lightning Arrester: Air-gap type.
 - 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

- A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 - 4. Power Pack: 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. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 7. Bypass Switch: Override the "on" function in case of sensor failure.

- B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 - 4. Dual technology.

2.5 LIGHTING CONTACTORS

- A. Description: Electrically operated and mechanically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- B. Security Interface: Provide hardware interface to enable activation of the security system to turn off the lighting contactors controlling new and existing interior night lights.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

END OF SECTION

SECTION 262416

PANELBOARDS

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. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing. Coordinate Final Room Names and Numbers with room names and numbers issued during construction.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Two spares for each type of panelboard cabinet lock.
 2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

- A. Comply with NEMA PB 1.
- B. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Square D.
2. Siemens.

2.2 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
4. Directory Card: Inside panelboard door, mounted in transparent card holder.

- B. Incoming Mains Location: Top and bottom.

- C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.4 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Mains: Circuit breaker.

- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: Circuit breaker or lugs only.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- E. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and $I^2 t$ response.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

3.5 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 262726

WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.

1.3 Isolated-ground receptacles.

- A. Tamper-resistant receptacles.
- B. Weather-resistant receptacles.
- C. Snap switches and wall-box dimmers.
- D. Wall-switch and exterior occupancy sensors.
- E. Communications outlets.
- F. Cord and plug sets.
- G. Floor service outlets and poke-through assemblies.

1.4 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.7 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
 - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.

2.2 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Pilot-Light Switches, 20 A:
 - 1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- C. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

2.3 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable toggle switch; with single-pole or three-way switching. Comply with UL 1472.
- C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.4 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.5 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

- F. Dimmers:
 - 1. Install dimmers within terms of their listing.
 - 2. Verify that dimmers used for fan speed control are listed for that application.
 - 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Square D.
 - 2. Siemens.

2.2 FUSIBLE SWITCHES

- A. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

2.3 NONFUSIBLE SWITCHES

- A. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

2.4 SHUNT TRIP SWITCHES

- A. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- B. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- C. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- D. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight red ON pilot light.
 - 3. Isolated neutral lug; 200 percent rating.
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5. Form C alarm contacts that change state when switch is tripped.
 - 6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.

3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- D. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.6 MOLDED-CASE SWITCHES

- A. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

2.7 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 265119

LED LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. Recessed Fixtures: Comply with NEMA LE 4.
- D. Bulb shape complying with ANSI C79.1.
- E. Lamp base complying with ANSI C81.61.
- F. CRI of 80. CCT of 4100 K.
- G. Rated lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: 277 V ac.
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.2 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.3 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.

4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
 - E. Flush-Mounted Luminaire Support:
 1. Secured to outlet box.
 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 3. Trim ring flush with finished surface.
 - F. Wall-Mounted Luminaire Support:
 1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
 2. Do not attach luminaires directly to gypsum board.
 - G. Ceiling-Mounted Luminaire Support:
 1. Ceiling mount with two 5/32-inch-diameter aircraft cable supports adjustable to length indicated on drawings.
 2. Ceiling mount with pendant mount with 5/32-inch-diameter aircraft cable supports adjustable in length.
 3. Ceiling mount with hook mount.
 - H. Suspended Luminaire Support:
 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
 - I. Ceiling-Grid-Mounted Luminaires:
 1. Secure to any required outlet box.
 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of two locations, spaced near corners of luminaire.
 - J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- 3.3 IDENTIFICATION
- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Luminaire will be considered defective if it does not pass operation tests and inspections.

END OF SECTION