



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

**MULTI-STEP BIDDING PROCESS
FOR
CONTRACTORS**

**Request For Solicitation For
Construction Services**

Stage II - Mechanical Contractors Bidders List FY09

February 5, 2009

**HVAC UPGRADES
CANNON HEALTH BUILDING**

**DEPARTMENT OF HEALTH
SALT LAKE CITY, UTAH**

DFCM Project No. 07177390

Van Boerum & Frank Associates, Inc.
330 South 300 East
Salt Lake City, Utah 84111

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Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov> or are available upon request from DFCM:

DFCM Supplemental General Conditions dated July 15, 2008
DFCM General Conditions dated May 25, 2005
DFCM Application and Certificate for Payment dated May 25, 2005

Technical Specifications:
Drawings:

The Agreement and General Conditions dated May 25, 2005 have been updated from versions that were formally adopted and in use prior to this date. The changes made to the General Conditions are identified in a document entitled Revisions to General Conditions that is available on DFCM's web site at <http://dfcm.utah.gov>

INVITATION TO BID

ONLY FIRMS PRE-QUALIFIED DURING STAGE I OF THE RFS ARE ALLOWED TO BID ON THIS PROJECT

The State of Utah - Division of Facilities Construction and Management (DFCM) is requesting bids for the construction of the following project:

HVAC UPGRADES - CANNON HEALTH BUILDING
DEPARTMENT OF HEALTH – SALT LAKE CITY, UTAH
DFCM PROJECT NO: 07177390

Project Description: Replacement of the existing ceiling diffusers, replacement of the existing air handler cooling coils, revising the chilled water piping to the coils, replacement of the air handler fans, and air balancing the air distribution system. Construction Cost Estimate: \$321,000.

Company	Contact	Fax
Ben Lomond Mechanical	Jeff Dalton	(801) 731-7844
Commercial Mechanical Sys & Srv	Norman J. Cole	(801) 977-3928
Envision Mechanical, Inc.	Ray Squier	(801) 731-8070
Harris Air Systems, Inc.	Omar Nava	(801) 467-6524
Harris Companies	Frank Dorhofer	(801) 433-2641
KOH Mechanical Contractors	Larry Hansen	(801) 254-6374
Mechanical Service & Systems, Inc.	Randy Karren	(801) 561-4673
Ralph Tye and Sons, Inc.	Doug Tye	(801) 262-1391
Rocky Mountain Mechanical	Jeff Larsen	(801) 467-1460
S.R. Mechanical, Inc.	Steven Roberts	(435) 529-7851
Tod R. Packer Heating & Air	Tod R. Packer	(801) 849-1314

The bid documents will be available at 1:00 PM on Thursday February 5, 2009 in electronic format only on CDs from DFCM at 4110 State Office Building, Salt Lake City, Utah 84114, telephone (801)538-3018 and on the DFCM web page at <http://dfcm.utah.gov>. For questions regarding this project, please contact Craig Wessman, P.E., Project Manager, DFCM, at (801) 538-3246. No others are to be contacted regarding this project.

A **MANDATORY** pre-bid meeting and site visit will be held at 11:00 AM on Tuesday, February 10, 2009 at the Cannon Health Building, 288 North 1460 West, Salt Lake City, Utah. Meet in the main lobby. All pre-qualified prime contractors wishing to bid on this project must attend this meeting.

Bids must be submitted by 2:30 PM on Monday, February 23, 2009 to DFCM, 4110 State Office Building, Salt Lake City, Utah 84114. Bids will be opened and read aloud in the DFCM Conference Room, 4110 State Office Building, Salt Lake City, Utah. Note: Bids must be received at 4110 State Office Building by the specified time. The contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

A bid bond in the amount of five percent (5%) of the bid amount, made payable to the Division of Facilities Construction and Management on DFCM's bid bond form, shall accompany the bid.

The Division of Facilities Construction & Management reserves the right to reject any or all bids or to waive any formality or technicality in any bid in the interest of the State.

DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT
MARLA WORKMAN, CONTRACT COORDINATOR
4110 State Office Bldg., Salt Lake City, Utah 84114

STAGE II - MULTI-STEP BIDDING PROCESS

ONLY FIRMS PRE-QUALIFIED DURING STAGE I OF THE RFS ARE ALLOWED TO BID ON THIS PROJECT

1. Invitational Bid Procedures

The following is an overview of the invitational bid process. More detailed information is contained throughout the document. Contractors are responsible for reading and complying with all information contained in this document.

Notification: DFCM will notify each registered pre-qualified firm (via fax or e-mail) when a project is ready for Construction Services and invite them to bid on the project.

Description of Work: A description of work or plans/specifications will be given to each contractor. If required, the plans and specifications will be available on the DFCM web page at <http://dfcm.utah.gov> and on CDs from DFCM, at 4110 State Office Building, Salt Lake City, Utah 84114.

Schedule: The Stage II Schedule shows critical dates including the mandatory pre-bid site meeting (if required), the question and answer period, the bid submittal deadline, the subcontractor list submittal deadline, etc. Contractors are responsible for meeting all deadlines shown on the schedule.

Mandatory Pre-Bid Site Meeting: If a firm fails to attend a pre-bid site meeting labeled “Mandatory” they will not be allowed to bid on the project. At the mandatory meeting, contractors may have an opportunity to inspect the site, receive additional instructions and ask questions about project. The schedule contains information on the date, time, and place of the mandatory pre-bid site meeting.

Written Questions: All questions must be in writing and directed to DFCM’s project manager assigned to this project. No others are to be contacted regarding this project. The schedule contains information on the deadline for submitting questions.

Addendum: All clarifications from DFCM will be in writing and issued as an addendum to the RFS. Addenda will be posted on DFCM’s web site at <http://dfcm.utah.gov>. Contractors are responsible for obtaining information contained in each addendum from the web site. Addenda issued prior to the submittal deadline shall become part of the bidding process and must be acknowledged on the bid form. Failure to acknowledge addenda may result in disqualification from bidding.

Submitting Bids: Bids must be submitted to DFCM 4110 State Office Building, Salt Lake City, Utah 84114 by the deadline indicated on the schedule. Bids submitted after the deadline will not be accepted. Bids will be opened at DFCM on the date, time, and place indicated on the schedule.

Subcontractors List: The firm selected for the project must submit a list of all subcontractors by the deadline indicated on the schedule contained in this document.

Pre-qualified List of Contractors: Contractors shall remain on DFCM’s list of pre-qualified contractors provided: (a) they maintain a performance rating of 3.5 or greater on each project, (b) they are not suspended for failure to comply with requirements of their contract, (c) the firm has not undergone a significant reorganization involving the loss of key personnel (site superintendents, project managers, owners, etc.) to a degree such that the firm no longer meets the pre-qualification requirements outlined in Stage I, (d) the financial viability of the firm has not significantly changed, and (e) the firm is not otherwise disqualified by DFCM. Note: If a contractor fails to comply with items (a) through (e) above,

they may be removed from DFCM's list of pre-qualified contractors following an evaluation by a review committee. Contractors will be given the opportunity to address the review committee before a decision is made. Pre-qualified contractors are ONLY authorized to bid on projects within the discipline that they were originally pre-qualified under.

2. Drawings and Specifications and Interpretations

Drawings, specifications and other contract documents may be obtained as stated in the Invitation to Bid. If any firm is in doubt as to the meaning or interpretation of any part of the drawings, specifications, scope of work or contract documents, they shall submit, in writing, a request for interpretation to the authorized DFCM representative by the deadline identified in the schedule. Answers to questions and interpretations will be made via addenda issued by DFCM. Neither DFCM or the designer shall be responsible for incorrect information obtained by contractors from sources other than the official drawings/specifications and addenda issued by DFCM.

3. Product Approvals

Where reference is made to one or more proprietary products in the contract documents, but restrictive descriptive materials of one or more manufacturer(s) is referred to in the contract documents, the products of other manufacturers will be accepted, provided they equal or exceed the standards set forth in the drawings and specifications and are compatible with the intent and purpose of the design, subject to the written approval of the Designer. Such written approval must occur prior to the deadline established for the last scheduled addendum to be issued. The Designer's written approval will be included as part of the addendum issued by DFCM. If the descriptive material is not restrictive, the products of other manufacturers specified will be accepted without prior approval provided they are compatible with the intent and purpose of the design as determined by the Designer.

4. Addenda

All clarifications from DFCM will be in writing and issued as an addendum to the RFS. Addenda will be posted on DFCM's web site at <http://dfcm.utah.gov>. Contractors are responsible for obtaining information contained in each addendum from the web site. Addenda issued prior to the submittal deadline shall become part of the bidding process and must be acknowledged on the bid form. Failure to acknowledge addenda shall result in disqualification from bidding. DFCM shall not be responsible for incorrect information obtained by contractors from sources other than official addenda issued by DFCM.

5. Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors

Contractors shall respond promptly to any inquiry in writing by DFCM to any concern of financial responsibility of the Contractor, Subcontractor or Sub-subcontractor. Failure to respond may result in suspension from DFCM's list of pre-qualified contractors.

6. Licensure

The Contractor shall comply with and require all of its Subcontractors to comply with the license laws as required by the State of Utah.

7. Permits

In concurrence with the requirements for permitting in the general conditions, it is the responsibility of the contractor to obtain the fugitive dust plan requirements from the Utah Division of Air Quality and the SWPPP requirements from the Utah Department of Environmental Quality and submit the completed forms and pay any permit fee that may be required for this specific project. Failure to obtain the required permit may result in work stoppage and/or fines from the regulating authority that will be the sole responsibility of the contractor. Any delay to the project as a result of any such failure to obtain the permit or noncompliance with the permit shall not be eligible for any extension in the Contract Time.

8. Time is of the Essence

Time is of the essence in regard to all the requirements of the contract documents.

9. Bids

Before submitting a bid, each bidder shall carefully examine the contract documents; shall visit the site of the work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the bid the cost of all items required by the contract documents including those added via addenda. If the bidder observes that portions of the contract documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the bidder shall promptly notify the DFCM Project Manager prior to the bidding deadline. Changes necessary to correct these issues will be made via addenda issued by DFCM.

The bid, bearing original signatures, must be typed or handwritten in ink on the Bid Form provided in the procurement documents and submitted in a sealed envelope at the location specified by the Invitation to Bid prior to the published deadline for the submission of bids.

Bid bond security, in the amount of five percent (5%) of the bid, made payable to the Division of Facilities Construction and Management, shall accompany bid. **THE BID BOND MUST BE ON THE BID BOND FORM PROVIDED IN THE PROCUREMENT DOCUMENTS IN ORDER TO BE CONSIDERED AN ACCEPTABLE BID.**

If the bid bond security is submitted on a form other than DFCM's required bid bond form, and the bid security meets all other legal requirements, the bidder will be allowed to provide an acceptable bid bond by the close of business on the next business day following notification by DFCM of submission of a defective bid bond security. **A cashier's check cannot be used as a substitute for a bid bond.**

10. Listing of Subcontractors

Listing of Subcontractors shall be as summarized in the "Instructions and Subcontractor's List Form", included as part of the contract documents. The subcontractors list shall be delivered to DFCM or faxed to DFCM at (801) 538-3677 within 24 hours of the bid opening. Requirements for listing additional subcontractors will be listed in the contract documents.

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements may be suspended from DFCM's list of pre-qualified contractors.

11. Contract and Bond

The Contractor's Agreement will be in the form provided in this document. The duration of the contract shall be for the time indicated by the project completion deadline shown on the schedule. The successful bidder, simultaneously with the execution of the Contractor's Agreement, will be required to furnish a performance bond and a payment bond, both bearing original signatures, upon the forms provided in the procurement documents.

The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the Contract Sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for Subcontractors will be specified in the Supplementary General Conditions.

12. Award of Contract

The Contract will be awarded as soon as possible to the lowest, responsive and responsible bidder, based on the lowest combination of base bid and acceptable prioritized alternates, provided the bid is reasonable, is in the interests of DFCM to accept and after applying the Utah Preference Laws in U.C.A. Title 63, Chapter 56. DFCM reserves the right to waive any technicalities or formalities in any bid or in the bidding. Alternates will be accepted on a prioritized basis with Alternate 1 being highest priority, Alternate 2 having second priority, etc. Alternates will be selected in prioritized order up to the construction cost estimate.

13. Right to Reject Bids

DFCM reserves the right to reject any or all Bids.

14. Withdrawal of Bids

Bids may be withdrawn on written request received from bidders within 24 hours after the bid opening if the contractor has made an error in preparing the bid.

15. DFCM Contractor Performance Rating

As a contractor completes each project, DFCM will evaluate project performance based on the enclosed "DFCM Contractor Performance Rating" form. The ratings issued on this project may affect the firm's "pre-qualified" status and their ability to obtain future work with DFCM.



Stage II PROJECT SCHEDULE

**PROJECT NAME: HVAC UPGRADES - CANNON HEALTH BUILDING
DEPARTMENT OF HEALTH – SALT LAKE CITY, UTAH
DFCM PROJECT #: 07177390**

Event	Day	Date	Time	Place
Stage II Bidding Documents Available	Thursday	February 5, 2009	1:00 PM	DFCM 4110 State Office Building SLC, UT and the DFCM web site*
Mandatory Pre-bid Site Meeting	Tuesday	February 10, 2009	11:00 AM	Main Lobby Cannon Health Building 288 North 1460 West Salt Lake City, UT
Deadline for Submitting Questions	Thursday	February 12, 2009	4:00 PM	Craig Wessman - DFCM E-mail cwessman@utah.gov Fax (801) 538-3267
Addendum Deadline (exception for bid delays)	Wednesday	February 18, 2009	2:00 PM	DFCM web site*
Prime Contractors Turn in Bid and Bid Bond	Monday	February 23, 2009	2:30 PM	DFCM 4110 State Office Building SLC, UT
Subcontractors List Due	Tuesday	February 24, 2009	2:30 PM	DFCM 4110 State Office Building SLC, UT Fax 801-538-3677
Substantial Completion Date	Thursday	April 30, 2009		

* **NOTE: DFCM's web site address is <http://dfcm.utah.gov>**



Division of Facilities Construction and Management

BID FORM

NAME OF BIDDER _____ DATE _____

To the Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

The undersigned, responsive to the "Invitation to Bid" and in accordance with the Request for Bids for the HVAC UPGRADES - CANNON HEALTH BUILDING – DEPARTMENT OF HEALTH – SALT LAKE CITY, UTAH - DFCM PROJECT NO. 07177390 and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: _____

BASE BID: For all work shown on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the sum of:

_____ DOLLARS (\$ _____)
(In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO. 1: For all work shown on the Drawings and described in the Specifications and Contract Documents to replace the east air handler fans with a new fan array, I/we agree to perform for the sum of:

_____ DOLLARS (\$ _____)
(In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO. 2: For all work shown on the Drawings and described in the Specifications and Contract Documents to replace the west air handler fans with a new fan array, I/we agree to perform for the sum of:

_____ DOLLARS (\$ _____)
(In case of discrepancy, written amount shall govern)

I/We guarantee that the Work will be Substantially Complete by **April 30, 2009**, should I/we be the successful bidder, and agree to pay liquidated damages in the amount of **\$125.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor’s Agreement.

This bid shall be good for 45 days after bid opening.

Enclosed is a 5% bid bond, as required, in the sum of _____

BID FORM
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The undersigned Contractor's License Number for Utah is _____.

Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract. The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within time set forth.

Type of Organization: _____
(Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws:

Respectfully submitted,

Name of Bidder

ADDRESS:

Authorized Signature

BID BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed, (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the STATE OF UTAH, hereinafter referred to as the "Obligee," in the amount of \$ _____ (5% of the accompanying bid), being the sum of this Bond to which payment the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted to Obligee the accompanying bid incorporated by reference herein, dated as shown, to enter into a contract in writing for the _____ Project.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that if the said principal does not execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the principal, then the sum of the amount stated above will be forfeited to the State of Utah as liquidated damages and not as a penalty; if the said principal shall execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the Principal, then this obligation shall be null and void. It is expressly understood and agreed that the liability of the Surety for any and all defaults of the Principal hereunder shall be the full penal sum of this Bond. The Surety, for value received, hereby stipulates and agrees that obligations of the Surety under this Bond shall be for a term of sixty (60) days from actual date of the bid opening.

PROVIDED, HOWEVER, that this Bond is executed pursuant to provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals on the date indicated below, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

DATED this _____ day of _____, 20_____.

Principal's name and address (if other than a corporation):

By: _____

Title: _____

Principal's name and address (if a corporation):

By: _____

Title: _____

(Affix Corporate Seal)

Surety's name and address:

By: _____

Attorney-in-Fact (Affix Corporate Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this ____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.
My Commission Expires: _____
Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

**Division of Facilities Construction and Management****INSTRUCTION AND SUBCONTRACTORS LIST FORM**

The three low bidders, as well as all other bidders that desire to be considered, are required by law to submit to DFCM within 24 hours of bid opening a list of **ALL** first-tier subcontractors, including the subcontractor's name, bid amount and other information required by Building Board Rule and as stated in these Contract Documents, based on the following:

DOLLAR AMOUNTS FOR LISTING

PROJECTS UNDER \$500,000: ALL FIRST-TIER SUBS \$20,000 OR OVER MUST BE LISTED
PROJECTS \$500,000 OR MORE: ALL FIRST-TIER SUBS \$35,000 OR OVER MUST BE LISTED

- Any additional subcontractors identified in the bid documents shall also be listed.
- The DFCM Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law.
- List subcontractors for base bid as well as the impact on the list that the selection of any alternate may have.
- Bidder may not list more than one subcontractor to perform the same work.
- If there are no subcontractors for the job that are required to be reported by State law (either because there are no subcontractors that will be used on the project or because there are no first-tier subcontractors over the dollar amounts referred to above), then you do not need to submit a sublist. If you do not submit a sublist, it will be deemed to be a representation by you that there are no subcontractors on the job that are required to be reported under State law. At any time, DFCM reserves the right to inquire, for security purposes, as to the identification of the subcontractors at any tier that will be on the worksite.

LICENSURE:

The subcontractor's name, the type of work, the subcontractor's bid amount, and the subcontractor's license number as issued by DOPL, if such license is required under Utah Law, shall be listed. Bidder shall certify that all subcontractors, required to be licensed, are licensed as required by State law. A subcontractor includes a trade contractor or specialty contractor and does not include suppliers who provide only materials, equipment, or supplies to a contractor or subcontractor.

'SPECIAL EXCEPTION':

A bidder may list 'Special Exception' in place of a subcontractor when the bidder intends to obtain a subcontractor to perform the work at a later date because the bidder was unable to obtain a qualified or reasonable bid under the provisions of U.C.A. Section 63A-5-208(4). The bidder shall insert the term 'Special Exception' for that category of work, and shall provide documentation with the subcontractor list describing the bidder's efforts to obtain a bid of a qualified subcontractor at a reasonable cost and why the bidder was unable to obtain a qualified subcontractor bid. The Director must find that the bidder complied in good faith with State law requirements for any 'Special Exception' designation, in order for the bid to be considered. If awarded the contract, the Director shall supervise the bidder's efforts to obtain a qualified subcontractor bid. The amount of the awarded contract may not be adjusted to reflect the actual amount of the subcontractor's bid. Any listing of 'Special Exception' on the sublist form shall also include amount allocated for that work.

GROUNDS FOR DISQUALIFICATION:

The Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law. Director may withhold awarding the contract to a particular bidder if one or more of the proposed subcontractors are considered by the Director to be unqualified to do the Work or for such

INSTRUCTIONS AND SUBCONTRACTORS LIST FORM
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other reason in the best interest of the State of Utah. Notwithstanding any other provision in these instructions, if there is a good faith error on the sublist form, at the sole discretion of the Director, the Director may provide notice to the contractor and the contractor shall have 24 hours to submit the correction to the Director. If such correction is submitted timely, then the sublist requirements shall be considered met.

CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:

Subsequent to twenty-four hours after the bid opening, the contractor may change its listed subcontractors only after receiving written permission from the Director based on complying with all of the following criteria.

- (1) The contractor has established in writing that the change is in the best interest of the State and that the contractor establishes an appropriate reason for the change, which may include, but not is not limited to, the following reasons: the original subcontractor has failed to perform, or is not qualified or capable of performing, and/or the subcontractor has requested in writing to be released.
- (2) The circumstances related to the request for the change do not indicate any bad faith in the original listing of the subcontractors.
- (3) Any requirement set forth by the Director to ensure that the process used to select a new subcontractor does not give rise to bid shopping.
- (4) Any increase in the cost of the subject subcontractor work is borne by the contractor.
- (5) Any decrease in the cost of the subject subcontractor work shall result in a deductive change order being issued for the contract for such decreased amount.
- (6) The Director will give substantial weight to whether the subcontractor has consented in writing to being removed unless the Contractor establishes that the subcontractor is not qualified for the work.

EXAMPLE:

Example of a list where there are only four subcontractors:

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONTRACTOR LICENSE #
ELECTRICAL	ABCD Electric Inc.	\$350,000.00	123456789000
LANDSCAPING	"Self" *	\$300,000.00	123456789000
CONCRETE (ALTERNATE #1)	XYZ Concrete Inc	\$298,000.00	987654321000
MECHANICAL	"Special Exception" (attach documentation)	Fixed at: \$350,000.00	(TO BE PROVIDED AFTER OBTAINING SUBCONTRACTOR)

* Bidders may list "self", but it is not required.

PURSUANT TO STATE LAW - SUBCONTRACTOR BID AMOUNTS CONTAINED IN THIS SUBCONTRACTOR LIST SHALL NOT BE DISCLOSED UNTIL THE CONTRACT HAS BEEN AWARDED.

CONTRACTOR'S AGREEMENT

FOR:

THIS CONTRACTOR'S AGREEMENT, made and entered into this ____ day of _____, 20__, by and between the DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT, hereinafter referred to as "DFCM", and _____, incorporated in the State of _____ and authorized to do business in the State of Utah, hereinafter referred to as "Contractor", whose address is _____.

WITNESSETH: WHEREAS, DFCM intends to have Work performed at _____
_____.

WHEREAS, Contractor agrees to perform the Work for the sum stated herein.

NOW, THEREFORE, DFCM and Contractor for the consideration provided in this Contractor's Agreement, agree as follows:

ARTICLE 1. SCOPE OF WORK. The Work to be performed shall be in accordance with the Contract Documents prepared by _____ and entitled "_____"

The DFCM General Conditions ("General Conditions") dated May 25, 2005 and Supplemental General Conditions dated July 15, 2008 ("also referred to as General Conditions") and on file at the office of DFCM and available on the DFCM website, are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

The Contractor Agrees to furnish labor, materials and equipment to complete the Work as required in the Contract Documents which are hereby incorporated by reference. It is understood and agreed by the parties hereto that all Work shall be performed as required in the Contract Documents and shall be subject to inspection and approval of DFCM or its authorized representative. The relationship of the Contractor to the DFCM hereunder is that of an independent Contractor.

ARTICLE 2. CONTRACT SUM. The DFCM agrees to pay and the Contractor agrees to accept in full performance of this Contractor's Agreement, the sum of _____ DOLLARS AND NO CENTS (\$_____.00), which is the base bid, and which sum also includes the cost of a 100%

CONTRACTOR'S AGREEMENT
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Performance Bond and a 100% Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

ARTICLE 3. TIME OF COMPLETION AND DELAY REMEDY. The Work shall be Substantially Complete by _____. Contractor agrees to pay liquidated damages in the amount of \$_____ per day for each day after expiration of the Contract Time until the Contractor achieves Substantial Completion in accordance with the Contract Documents, if Contractor's delay makes the damages applicable. The provision for liquidated damages is: (a) to compensate the DFCM for delay only; (b) is provided for herein because actual damages can not be readily ascertained at the time of execution of this Contractor's Agreement; (c) is not a penalty; and (d) shall not prevent the DFCM from maintaining Claims for other non-delay damages, such as costs to complete or remedy defective Work.

No action shall be maintained by the Contractor, including its or Subcontractor or suppliers at any tier, against the DFCM or State of Utah for damages or other claims due to losses attributable to hindrances or delays from any cause whatsoever, including acts and omissions of the DFCM or its officers, employees or agents, except as expressly provided in the General Conditions. The Contractor may receive a written extension of time, signed by the DFCM, in which to complete the Work under this Contractor's Agreement in accordance with the General Conditions.

ARTICLE 4. CONTRACT DOCUMENTS. The Contract Documents consist of this Contractor's Agreement, the Conditions of the Contract (DFCM General Conditions, Supplementary and other Conditions), the Drawings, Specifications, Addenda and Modifications. The Contract Documents shall also include the bidding documents, including the Notice to Contractors, Instructions to Bidders/Proposers and the Bid/Proposal, to the extent not in conflict therewith and other documents and oral presentations that are documented as an attachment to the contract.

All such documents are hereby incorporated by reference herein. Any reference in this Contractor's Agreement to certain provisions of the Contract Documents shall in no way be construed as to lessen the importance or applicability of any other provisions of the Contract Documents.

ARTICLE 5. PAYMENT. The DFCM agrees to pay the Contractor from time to time as the Work progresses, but not more than once each month after the date of Notice to Proceed, and only upon Certificate of the A/E for Work performed during the preceding calendar month, ninety-five percent (95%) of the value of the labor performed and ninety-five percent (95%) of the value of materials furnished in place or on the site. The Contractor agrees to furnish to the DFCM invoices for materials purchased and on the site but not installed, for which the Contractor requests payment and agrees to safeguard and protect such equipment or materials and is responsible for safekeeping thereof and if such be stolen, lost or destroyed, to replace same.

Such evidence of labor performed and materials furnished as the DFCM may reasonably require shall be supplied by the Contractor at the time of request for Certificate of Payment on account. Materials for which payment has been made cannot be removed from the job site without DFCM's written approval. Five percent (5%) of the earned amount shall be retained from each monthly payment. The retainage, including any additional retainage imposed and the release of any retainage, shall be in accordance with UCA 13-8-5 as amended. Contractor shall also comply with the requirements of UCA 13-8-5, including restrictions of retainage regarding subcontractors and the distribution of interest earned on the retention proceeds. The DFCM shall not be responsible for enforcing the Contractor's obligations under State law in fulfilling the retention law requirements with subcontractors at any tier.

ARTICLE 6. INDEBTEDNESS. Before final payment is made, the Contractor must submit evidence satisfactory to the DFCM that all payrolls, materials bills, subcontracts at any tier and outstanding indebtedness in connection with the Work have been properly paid. Final Payment will be made after receipt of said evidence, final acceptance of the Work by the DFCM as well as compliance with the applicable provisions of the General Conditions.

Contractor shall respond immediately to any inquiry in writing by DFCM as to any concern of financial responsibility and DFCM reserves the right to request any waivers, releases or bonds from Contractor in regard to any rights of Subcontractors (including suppliers) at any tier or any third parties prior to any payment by DFCM to Contractor.

ARTICLE 7. ADDITIONAL WORK. It is understood and agreed by the parties hereto that no money will be paid to the Contractor for additional labor or materials furnished unless a new contract in writing or a Modification hereof in accordance with the General Conditions and the Contract Documents for such additional labor or materials has been executed. The DFCM specifically reserves the right to modify or amend this Contractor's Agreement and the total sum due hereunder either by enlarging or restricting the scope of the Work.

ARTICLE 8. INSPECTIONS. The Work shall be inspected for acceptance in accordance with the General Conditions.

ARTICLE 9. DISPUTES. Any dispute, PRE or Claim between the parties shall be subject to the provisions of Article 7 of the General Conditions. DFCM reserves all rights to pursue its rights and remedies as provided in the General Conditions.

ARTICLE 10. TERMINATION, SUSPENSION OR ABANDONMENT. This Contractor's Agreement may be terminated, suspended or abandoned in accordance with the General Conditions.

ARTICLE 11. DFCM'S RIGHT TO WITHHOLD CERTAIN AMOUNT AND MAKE USE THEREOF. The DFCM may withhold from payment to the Contractor such amount as, in DFCM's judgment, may be necessary to pay just claims against the Contractor or Subcontractor at any tier for labor and services rendered and materials furnished in and about the Work. The DFCM may apply such withheld amounts for the payment of such claims in DFCM's discretion. In so doing, the DFCM shall be deemed the agent of Contractor and payment so made by the DFCM shall be considered as payment made under this Contractor's Agreement by the DFCM to the Contractor. DFCM shall not be liable to the Contractor for any such payment made in good faith. Such withholdings and payments may be made without prior approval of the Contractor and may be also be prior to any determination as a result of any dispute, PRE, Claim or litigation.

ARTICLE 12. INDEMNIFICATION. The Contractor shall comply with the indemnification provisions of the General Conditions.

ARTICLE 13. SUCCESSORS AND ASSIGNMENT OF CONTRACT. The DFCM and Contractor, respectively bind themselves, their partners, successors, assigns and legal representatives to the other party to this Agreement, and to partners, successors, assigns and legal representatives of such other party with respect to all covenants, provisions, rights and responsibilities of this Contractor's Agreement. The Contractor shall not assign this Contractor's Agreement without the prior written consent of the DFCM, nor shall the Contractor assign any moneys due or to become due as well as any rights under this Contractor's Agreement, without prior written consent of the DFCM.

ARTICLE 14. RELATIONSHIP OF THE PARTIES. The Contractor accepts the relationship of trust and confidence established by this Contractor's Agreement and covenants with the DFCM to cooperate with the DFCM and A/E and use the Contractor's best skill, efforts and judgment in furthering the interest of the DFCM; to furnish efficient business administration and supervision; to make best efforts to furnish at all times an adequate supply of workers and materials; and to perform the Work in the best and most expeditious and economic manner consistent with the interests of the DFCM.

ARTICLE 15. AUTHORITY TO EXECUTE AND PERFORM AGREEMENT. Contractor and DFCM each represent that the execution of this Contractor's Agreement and the performance thereunder is within their respective duly authorized powers.

ARTICLE 16. ATTORNEY FEES AND COSTS. Except as otherwise provided in the dispute resolution provisions of the General Conditions, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in any action in the District Court and/or appellate body to enforce this Contractor's Agreement or recover damages or any other action as a result of a breach thereof.

PERFORMANCE BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

That _____ hereinafter referred to as the "Principal" and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah, hereinafter referred to as the "Obligee," in the amount of _____ DOLLARS (\$) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____, for the approximate sum of _____ Dollars (\$ _____), which Contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall faithfully perform the Contract in accordance with the Contract Documents including, but not limited to, the Plans, Specifications and conditions thereof, the one year performance warranty, and the terms of the Contract as said Contract may be subject to Modifications or changes, then this obligation shall be void; otherwise it shall remain in full force and effect.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the state named herein or the heirs, executors, administrators or successors of the Owner.

The parties agree that the dispute provisions provided in the Contract Documents apply and shall constitute the sole dispute procedures of the parties.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the Provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20_____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ (Seal)

Attorney-in-Fact

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney in-fact of the above-named Surety Company and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20_____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

PAYMENT BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____ authorized to do business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); with its principal office in the City of _____, hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah hereinafter referred to as the "Obligee," in the amount of _____ Dollars (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____ for the approximate sum of _____ Dollars (\$ _____), which contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall pay all claimants supplying labor or materials to Principal or Principal's Subcontractors in compliance with the provisions of Title 63, Chapter 56, of Utah Code Annotated, 1953, as amended, and in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise it shall remain in full force and effect.

That said Surety to this Bond, for value received, hereby stipulates and agrees that no changes, extensions of time, alterations or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any way affect its obligation on this Bond, and does hereby waive notice of any such changes, extensions of time, alterations or additions to the terms of the Contract or to the Work or to the specifications or drawings and agrees that they shall become part of the Contract Documents.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)
Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ (Seal)
Attorney-in-Fact

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General



CERTIFICATE OF SUBSTANTIAL COMPLETION

PROJECT _____ PROJECT NO: _____

AGENCY/INSTITUTION _____

AREA ACCEPTED _____

The Work performed under the subject Contract has been reviewed on this date and found to be Substantially Completed as defined in the General Conditions; including that the construction is sufficiently completed in accordance with the Contract Documents, as modified by any change orders agreed to by the parties, so that the State of Utah can occupy the Project or specified area of the Project for the use for which it is intended.

The DFCM - (Owner) accepts the Project or specified area of the Project as Substantially Complete and will assume full possession of the Project or specified area of the Project at _____ (time) on _____ (date).

The DFCM accepts the Project for occupancy and agrees to assume full responsibility for maintenance and operation, including utilities and insurance, of the Project subject to the itemized responsibilities and/or exceptions noted below:

The Owner acknowledges receipt of the following closeout and transition materials:

- Record Drawings
- O & M Manuals
- Warranty Documents
- Completion of Training Requirements

A list of items to be completed or corrected (Punch List) is attached hereto. The failure to include an item on it does not alter the responsibility of the Contractor to complete all the Work in accordance with the Contract Documents, including authorized changes thereof. The amount of _____. (Twice the value of the punch list work) shall be retained to assure the completion of the punch list work.

The Contractor shall complete or correct the Work on the list of (Punch List) items appended hereto within _____ calendar days from the above date of issuance of this Certificate. If the list of items is not completed within the time allotted the Owner has the right to be compensated for the delays and/or complete the work with the help of independent contractor at the expense of the retained project funds. If the retained project funds are insufficient to cover the delay/completion damages, the Owner shall be promptly reimbursed for the balance of the funds needed to compensate the Owner.

_____ by: _____
CONTRACTOR (include name of firm) (Signature) DATE

_____ by: _____
A/E (include name of firm) (Signature) DATE

_____ by: _____
USING INSTITUTION OR AGENCY (Signature) DATE

_____ by: _____
DFCM (Owner) (Signature) DATE

**General Contractor Performance Rating Form**

Project Name:		DFCM Project#	
Contractor: <small>(ABC Construction, John Doe, 111-111-1111)</small>	A/E: <small>(ABC Architects, Jane Doe, 222-222-2222)</small>	Original Contract Amount:	Final Contract Amount:
DFCM Project Manager:		Contract Date:	
Completion Date:		Date of Rating:	

Rating Guideline	QUALITY OF PRODUCT OR SERVICES	COST CONTROL	TIMELINESS OF PERFORMANCE	BUSINESS RELATIONS
5-Exceptional	Contractor has demonstrated an exceptional performance level in any of the above four categories that justifies adding a point to the score. Contractor performance clearly exceeds the performance levels described as "Very Good"			
4-Very Good	Contractor is in compliance with contract requirements and/or delivers quality product/service.	Contractor is effective in managing costs and submits current, accurate, and complete billings	Contractor is effective in meeting milestones and delivery schedule	Response to inquiries, technical/service/administrative issues is effective
3-Satisfactory	Minor inefficiencies/errors have been identified	Contractor is usually effective in managing cost	Contractor is usually effective in meeting milestones and delivery schedules	Response to inquires technical/service/administrative issues is somewhat effective
2-Marginal	Major problems have been encountered	Contractor is having major difficulty managing cost effectively	Contractor is having major difficulty meeting milestones and delivery schedule	Response to inquiries, technical/service/administrative issues is marginally effective
1-Unsatisfactory	Contractor is not in compliance and is jeopardizing achievement of contract objectives	Contractor is unable to manage costs effectively	Contractor delays are jeopardizing performance of contract objectives	Response to inquiries, technical/service/administrative issues is not effective

1. Rate Contractors quality of workmanship, management of sub contractor performance, project cleanliness, organization and safety requirement.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

2. Rate Contractor administration of project costs, change orders and financial management of the project budget.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

3. Rate Contractor's performance and adherence to Project Schedule, delay procedures and requirements of substantial completion, inspection and punch-list performance.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

4. Evaluate performance of contractor management team including project manager, engineer and superintendent also include in the rating team's ability to work well with owner, user agency and consultants.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

5. Rate success of Contractor's management plan, completion of the plans mitigation of project risks and performance of value engineering concepts.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

Signed by:	Date:	Mean Score
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Additional Comments:

**PROJECT MANUAL
FOR**

Cannon Health Bldg HVAC

Van Boerum & Frank Associates
330 South 300 East
Salt Lake City, Utah

NOVEMBER 2008



SPECIFICATION INDEX

230100	Mechanical Requirements
230150	Temporary Use of Equipment and Systems
230500	Common Work Results for HVAC
230513	Common Motor Requirements for HVAC Equipment
230529	Hangers and Supports
230550	Operations and Maintenance Manuals
230553	Identification for Piping & Equipment
230594	General Testing, Adjusting, Balancing and Commissioning
230720	Pipe Insulation
232113	Hydronic Piping
232500	Chemical Water Treatment
233119	HVAC Casings
233713	Diffusers, Registers, and Grilles
237325	Fan Wall Type Custom Air Handlers
239900	Automatic Temperature Controls

SECTION 23 0100 - MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

- A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.
- B. All sections of Division 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.
- C. Measure all air flows before any work takes place, on all air systems.
- D. See drawings for alternate work.

1.2 SCOPE OF WORK

- A. The project described herein is the **Cannon Health Building**. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

1.3 CODES & ORDINANCES

- A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.
- B. Applicable codes:

Latest Edition
International Building code- 2006 Edition
International Mechanical Code- 2006 Edition
International Plumbing Code- 2006 Edition
International Fire Code- 2006 Edition

1.4 INDUSTRY STANDARDS

- A. All work shall comply with the following standards.
 - 1. Associated Air Balance council (AABC)
 - 2. Air Conditioning and Refrigeration Institute (ARI)
 - 3. Air Diffusion council (ADC)
 - 4. Air Movement and Control Association (AMCA)
 - 5. American Gas Association (AGA)
 - 6. American National Standards Institute (ANSI)

7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
8. American Society of Mechanical Engineers (ASME)
9. American Society of Testing Materials (ASTM)
10. American Water Works Association (AWWA)
11. Cooling Tower Institute (CTI)
12. ETL Testing Laboratories (ETL)
13. Institute of Electrical and Electronic Engineers (IEEE)
14. Hydronics Institute (HI)
15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
16. National Fire Protection Association (NFPA)
17. National Electrical Code (NEC)
18. National Electrical Manufacturers Association (NEMA)
19. National Electrical Safety code (NESC)
20. Utah safety Standard (OSHA), Utah State Industrial Council.
21. Sheet Metal and Air Conditioning Contractor=s National Association (SMACNA)
22. Underwriters Laboratories (UL)
23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
24. Heat Exchanger Institute (HEI)
25. Hydraulic Institute (HI)
26. Thermal Insulation Manufacturer=s Association (TIMA)
27. Scientific Apparatus Makers Association (SAMA)

B. Compliance Verification:

1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.
2. Form U-1, the manufacturer=s data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.
3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.

1.5 UTILITIES & FEES

- A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

1.6 SUBMITTALS AND SHOP DRAWINGS

- A. Submittals: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect six (6) copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of 14 days. The first day starts after the day they are received in the engineers office to which the project is being constructed from. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within 14 days of returned submittals. Refer to each specification section for items requiring submittal review. Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tabs each item or

group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within 120 days of the contract award date. **Partial submittals will not be reviewed until the complete submittal is received.**

Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.

Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.

Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. In no way does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. Regardless of any items overlooked by the submittal review, the requirements of the contract drawings and specifications must be followed and are not waived or superseded in any way by the review.

By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined above, the contractor shall reimburse the engineer for additional time and expenses at the engineer's current, recognized, hourly rates.

1.7 DRAWINGS AND MEASUREMENTS

- A. Construction Drawings: The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.

It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect's office before work is started.

This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time, a change in location required by obstacles or the installation of

other trades not shown on the mechanical plans shall be made without charge.

The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.

The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.

- B. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch= 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.

1.8 CONTRACTOR'S USE OF BUILDING EQUIPMENT

- A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

1.9 EXISTING CONDITIONS

- A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.
- B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.
- C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

1.10 EQUIPMENT CAPACITIES

- A. Capacities shown for equipment in the specifications and on the drawings are the minimum

acceptable. No equipment shall be considered as an alternate which has capacities or performance less than that of design equipment.

- B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

- A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code and SMACNA GUIDELINES. Refer to section Mechanical Vibration Controls and Seismic Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

1.12 COOPERATION WITH OTHER TRADES

- A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.
- B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.
- C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.
- D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

1.13 RESPONSIBILITY OF CONTRACTOR

- A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.
- B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken.

1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

- A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown

on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.

- B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

1.15 UNFIT OR DAMAGED WORK

- A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

1.16 WORKMANSHIP

- A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

1.17 SAFETY REGULATION

- A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

1.18 ELECTRICAL SERVICES

- A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Installation of any and all wiring done under Division 22 or 23 shall be in accordance with the requirements of Division 26, Electrical.

All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.

Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

- A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds

and all labor shall be done in a most thorough and workmanlike manner.

- B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.

- C. The access to equipment shown on the drawings are the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.
- D. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.
- E. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

- A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.
- B. All open duct and pipe openings shall be adequately covered at all times.

1.21 INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.
- B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.
- C. All costs for this work shall be included in the prices quoted by equipment suppliers.

1.22 EQUIPMENT LUBRICATION

- A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the

Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

- B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.
- C. Detergent oil as used for automotive purposes shall not be used for this work.

1.23 CUTTING AND PATCHING

- A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.
- B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

1.24 ACCESS

- A. Provide access doors in walls, ceilings and floors, for access to mechanical equipment such as valves, dampers, VAV boxes, fans, controls, etc. Refer to Division 8 for door specifications. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation.
- B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.
- C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.

1.25 CONCRETE BASES AND INSERTS

- A. Bases: The concrete bases shall be provided and installed as work of Division 3, Concrete. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.

All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.

- B. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete, they shall be furnished as work of this Division. Inserts shall be installed as work of Division 3, Concrete, but under the close supervision and direction of this section.

Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping where more than one pipe is suspended at a common location. Spacing of the inserts shall match the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support system shall include all inserts, vertical supports, horizontal support members, clamps, hangers, rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

1.26 CLEANING AND PAINTING

A. **Cleaning:** After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.

B. **Painting:** Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting.

Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.

C. **Removal of Debris, Etc:** Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

1.27 CONTRACT COMPLETION

A. **Incomplete and Unacceptable Work:** If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

B. **Maintenance Instructions:** The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.

C. **Instructions To Owner's Representatives:** In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not reduced. The ATC Contractor shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

D. **Guarantee:** By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.

The guarantee so assumed by the Contractor and as work of this Section is as follows:

That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.

That the circulation of water shall be complete and even.

That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.

That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.

That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.

All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, on year from the date of the Architect's Certificate of Substantial Completion.

All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.

If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

1.28 CURBS

- A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by division 22 and 23.

1.29 TEST RUN

- A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

1.31 EQUIPMENT STARTUP AND CHECKOUT:

- A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.
- B. This contractor shall coordinate commissioning procedures and activities with the commissioning agent.

1.32 DEMOLITION

General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

Proceed with demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

Maintain adequate ventilation when using cutting torches.

Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

Dispose of demolished items and materials promptly.

Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

END OF SECTION 23 0100

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SECTION 230500 - COMMON WORK RESULTS 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. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 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 (3.2-mm) 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 (3.2 mm) 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, BAg1, 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.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:
 - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 1. Manufacturers:
 - a. Thompson Plastics, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Watts Industries, Inc.; Water Products Div.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass.
- D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 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 in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

- a. PVC Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.2 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- 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 HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 230500

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC 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.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 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.
- C. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.
- D. Motors 3/4 HP and Larger: Polyphase.
- E. Motors Smaller than 3/4 HP: Single phase.

- F. Frequency Rating: 60 Hz.
- G. Voltage Rating: Determined by voltage of circuit to which motor is connected.
- H. Service Factor: According to NEMA MG 1 – 2003, unless otherwise indicated.
- I. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- J. Enclosure: Open drip-proof, unless otherwise indicated.
- K. All motors shall have ASTM Grade 5 hardware that is Yellow Zinc-dichromate plated.

2.3 POLYPHASE MOTORS

- A. Motors Used in Across the Line Starters or with Reduced-Inrush Controllers: Match wiring connection requirements for the indicated controller. Motor leads connections that are brought to motor terminal box shall be suitable with controller or starting method.

Description: **EPACT NEMA MG 1, Low Voltage Induction Motor – Single Speed Application.**

1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
 2. EPACT Energy-Efficient Design: As indicated by application.
 3. Stator: Copper windings, unless otherwise indicated. Multispeed motors shall have separate winding for each speed.
 4. Rotor: Squirrel cage, unless otherwise indicated.
 5. Design Classification: NEMA Design B
 6. Temperature Rise: Class F rise, unless otherwise indicated.
 7. Insulation: Class F, unless otherwise indicated.
 8. Minimum vibration: Each motor shall not exceed 0.5 G vibration peak/peak.
 9. Bearings: Motor bearings shall be rated for an L-10 life 40,000 hours with an external load per NEMA MG 1-14 and an L-10 life of 100,000 hours in direct coupled applications for continuous duty and shall be of the regreasable type with grease relief fitting or Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading Per the motor manufactures standards.
- B. Motors Used with Variable-Frequency Controllers shall meet the following: Current Ratings, characteristics, and features shall be rated for a minimum of 10:1 turndown ratio and the motor that is provided will be coordinated and approved by controller manufacturer. A Variable Frequency driven motor shall have the following characteristics:
 1. Critical vibration frequencies shall be minimized so that motor will operate throughout the range of controller output based on the system requirements.
 2. Temperature Rise: Class B rise.
 3. Insulation: Class F.
 4. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors and inverter duty rated for NEMA MG-1-31 1998.
 5. Bearings: Motor bearings shall be rated for an L-10 life 50,000 hours with an external load per NEMA MG 1-14 and an L-10 life of 100,000 hours in direct coupled applications for continuous duty and shall be of the regreasable type with automatic grease relief valve.

6. Motors shall be sized with respect to horsepower rating without using the service factor. All motors being operated by adjustable or variable frequency drives shall have a service factor 1.15 at equipments elevation.
 7. The winding insulation system shall have an insulation rating of 1860 volt, peak with a 0.1 micro second rise time.
 8. Motor stator and rotor steel shall be low-loss C-5 electrical grade silicon steel with interlaminated insulation system capable of withstanding a minimum 1000°F burnout.
 9. Motors are to be of the NEMA Premium efficiency Design
 10. All motor nameplates shall have raised letters stamped on stainless steel and be fastened to the motor frame with four stainless steel drive pins. Name plate shall meet applicable Nema MG1 standards.
- C. Severe-Duty Motors: Where indicated, motors are (TEFC) totally enclosed with 1.15 minimum service factors at altitude, and shall have greased bearings, integral condensate drains, and capped relief vents. Windings shall be insulated with non-hygroscopic material class H insulation. External finish shall be chemical-resistant paint over corrosion-resistant primer. The minimum performance and construction requirements are outline in part B of this specification.
- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1-12 and shall consist of:
1. No load watts input, current and speed (RPM).
 2. Winding resistance test.
 3. High-potential test.
 4. Locked rotor watts input and current.
 5. Stator insulation resistance test.
 6. Visual inspection and factory approval.
 7. Each motor shall have a factory certified test report forwarded with each motor and included in O&M Manual.

2.4 SINGLE-PHASE MOTORS

- A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
1. Permanent-split capacitor.
 2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.
- C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.
- D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.
- E. Motors are to have the ECM label where variable speed with variable input (0-5vDC) is indicated.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

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SECTION 230529 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 5. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Bergen-Power Pipe Supports.
 - 3. B-Line Systems, Inc.; a division of Cooper Industries.
 - 4. Carpenter & Paterson, Inc.
 - 5. Empire Industries, Inc.
 - 6. ERICO/Michigan Hanger Co.
 - 7. Globe Pipe Hanger Products, Inc.

8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 1. B-Line Systems, Inc.; a division of Cooper Industries.
 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 3. GS Metals Corp.
 4. Power-Strut Div.; Tyco International, Ltd.
 5. Thomas & Betts Corporation.
 6. Tolco Inc.
 7. Unistrut Corp.; Tyco International, Ltd.

- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified 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 padded hangers for piping that is subject to scratching.
- F. 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 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, 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 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-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.
 - 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 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 2 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 20, 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.
- G. 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 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. 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.
- I. 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.
- J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel 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 building structure.
- B. 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 above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- E. 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.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. 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.
- H. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- J. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and 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.
 - 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 inserts.
 - 6. Insert Material: Length at least as long as protective shield.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 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. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

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SECTION 23 0550 - OPERATIONS & MAINTENANCE MANUALS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. All pertinent sections of Division 21, 22, & 23 Mechanical General Requirements, are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.

- 1. Testing and Balancing is specified in section 230594.
- 2. Training and Instructions to Owner's Representative is specified in section 230100.

1.2 SCOPE OF WORK

- A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).
- B. Coordination of work required for system commissioning.

1.3 SUBMITTALS

- A. Submit product data in accordance with Division 1 and Section 230100. Submit the following:
- B. Sample of O and M manual outline.

PART 2 - PRODUCTS

2.1 O & M MANUALS

- A. The operating and maintenance manuals shall be as follows:
 - 1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows: (coordinate with Section 1730)

OPERATING AND MAINTENANCE
MANUAL
FOR THE

(INSERT PROJECT NAME)

2007

VOLUME No. ()

VAN BOERUM & FRANK ASSOCIATES, INC.

MECHANICAL ENGINEER

(INSERT ARCHITECT)

Binders shall be a manufactured by Hiller Bookbinding.

PART 3- EXECUTION

3.1 OPERATING AND MAINTENANCE MANUALS:

- A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.
- B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.
- C. The manuals shall include water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner's representatives.
- D. An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be include the following:

SYSTEM DESCRIPTIONS

START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE

OPERATION AND MAINTENANCE BULLETINS

AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

AIR AND WATER SYSTEM BALANCING REPORTS

EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES

SYSTEM COMMISSIONING REPORTS

EQUIPMENT START-UP CERTIFICATES

END OF SECTION 23 0550

N:\08\08200\08249 Cannon Health Bldg HVAC\03_Specifications\100 %\230550 Operations and Maintenance Manuals.doc

SECTION 230553 – IDENTIFICATION FOR PIPING & 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.

1.2 SUMMARY

- A. This Section includes mechanical identification materials and devices.
- B. Match the existing ID.

1.3 SUBMITTALS

- A. Product Data: For identification materials and devices.
- B. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

- A. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems" for lettering size, length of color field, colors, and viewing angles of identification devices.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS**2.1 IDENTIFYING DEVICES AND LABELS**

- A. General: Products specified are for applications referenced in other Division 22 & 23 Sections. If more than single type is specified for listed applications, selection is Installer's option.
- B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
 - 2. Location: Accessible and visible.

- C. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
 - 1. Stencil Paint: Exterior, oil-based, alkyd gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 2. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- D. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
- F. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least 3 times letter height and of length required for label.
- G. Lettering: Manufacturer's standard preprinted captions as selected by Engineer.
- H. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 1. Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.
- I. Plastic Duct Markers: Manufacturer's standard laminated plastic, in the following color codes:
 - 1. Green: Cold-air supply.
 - 2. Yellow: Hot-air supply.
 - 3. Blue: Exhaust, outside, return, and mixed air.
 - 4. Hazardous Material Exhausts: Use colors and designs recommended by ASME A13.1.
 - 5. Terminology: Include direction of airflow; duct service such as supply, return, and exhaust; duct origin, duct destination, and design flow.
- J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick.
 - 1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 - 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick, polished brass..
 - 2. Size: 1-1/2-inches diameter, unless otherwise required.
 - 3. Indicate valve service and normal position on valve. Example Cold water, N.O.
- L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
- M. Valve Tag Fasteners: Brass, wire-link chain; beaded chain; or S-hooks.
- N. Access Panel Markers: 1/16-inch- thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch center hole for attachment.

- O. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
 - 1. Green: Cooling equipment and components.
 - 2. Yellow: Heating equipment and components.
 - 3. Brown: Energy reclamation equipment and components.
 - 4. Blue: Equipment and components that do not meet criteria above.
 - 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
 - 6. Terminology: Match schedules as closely as possible. Include the following:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 - 7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
 - 1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

PART 3 - EXECUTION

3.1 LABELING AND IDENTIFYING PIPING SYSTEMS

- A. Install pipe markers on each system. Include arrows showing normal direction of flow.
- B. Marker Type: Stenciled markers with painted, color-coded bands complying with ASME A13.1.
- C. Marker Type: Plastic markers, with application systems. Install on pipe insulation segment where required for hot, noninsulated pipes.
- D. Fasten markers on pipes and insulated pipes by one of following methods:
 - 1. Snap-on application of pretensioned, semirigid plastic pipe marker.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe or insulation.
 - 4. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 3/4 inch wide, lapped a minimum of 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 5. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 1-1/2 inches wide, lapped a minimum of 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- E. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations according to the following:
 - 1. Near each valve and control device.

3.2 VALVE TAGS

- A. Install 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. Indicate service and normal position of all tagged valve and control devices. List tagged valves in valve schedule.
- B. Tag Material: Brass.

3.3 EQUIPMENT SIGNS AND MARKERS

- A. Install engraved plastic-laminate signs or equipment markers on or near each major item of mechanical equipment. Include signs for the following general categories of equipment:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Fire department hose valves and hose stations.
 - 3. Fans, blowers, primary balancing dampers, and mixing boxes.
 - 4. Packaged HVAC central-station and zone-type units.
 - 5. Tanks and pressure vessels.
 - 6. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- B. Optional Sign Types: Stenciled signs may be provided instead of engraved plastic, at Installer's option, where lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.
 - 1. Lettering Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Terms on Signs: Distinguish between multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3.4 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.
- B. Clean faces of identification devices and glass frames of valve charts.

END OF SECTION 230553

SECTION 230594 - GENERAL TESTING, ADJUSTING, BALANCING AND COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Setting quantitative performance of HVAC equipment.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Measuring sound and vibration.
 - 7. Reporting results of the activities and procedures specified in this Section.
- B. Measure all air flows before any work takes place, on all air systems.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. 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.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- I. 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.

- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- K. Test: A procedure to determine quantitative performance of a system or equipment.
- L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- M. AABC: Associated Air Balance Council.
- N. AMCA: Air Movement and Control Association.
- O. NEBB: National Environmental Balancing Bureau.
- P. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

- A. Contract Documents Examination Report: Within 90 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.
- B. Strategies and Procedures Plan: Within 120 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.
- C. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- D. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.
- E. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB. Balancing may only be performed by the following:
 - 1. BTC Services, Inc.
 - 2. Bonneville Test & Balance
 - 3. Certified Test & Balance
 - 4. RSAnalysis
 - 5. Test & Balance Inc.
- B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 14 days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:

- a. Submittal distribution requirements.
 - b. Contract Documents examination report.
 - c. Testing, adjusting, and balancing plan.
 - d. Work schedule and Project site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or frame NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. National Project Performance Guarantee: Provide a guarantee on AABC or NEBB forms stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent 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 Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine project record documents described in Division 1 Section "Project Record Documents."
- D. Examine equipment performance data, including fan and pump curves. 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. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- F. Examine system and equipment test reports.
- G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

- J. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
- K. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- L. Examine strainers for clean screens and proper perforations.
- M. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- O. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.
- P. Examine equipment for installation and for properly operating safety interlocks and controls.
- Q. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to design values.
- R. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB national standards and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- 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 the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

- A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume, multizone, dual-duct, induction-unit supply-air systems and process exhaust-air systems. These additional procedures are specified in other articles in this Section.
- B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

- b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
- 2. Measure static pressure across each air-handling unit component.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
- 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
- 4. 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. Adjust fan speed higher or lower than design to achieve design conditions. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
- 6. 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 no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
- C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.
- D. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
 - 1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow

condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure 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 duct losses.
 3. Measure total system airflow. Adjust to within 10 percent of design airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
 8. Record the final fan performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance systems similar to constant-volume air systems.
 2. Set terminal units and supply fan at full-airflow condition.
 3. Adjust inlet dampers of each terminal unit to design airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum design airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum design airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units being tested at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to design airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.
 7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at design flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 HYDRONIC SYSTEMS' BALANCING PROCEDURES

- A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
 - C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
 - D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.
 - E. Adjust balancing stations to within specified tolerances of design flow rate as follows:
 1. Determine the balancing station with the highest percentage over design flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
 3. Record settings and mark balancing devices.
 - F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.
 - G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

- A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

- A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating if high-efficiency motor.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
 - 1. Entering- and leaving-water temperatures.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperatures of entering and leaving air.
 - 5. Wet-bulb temperatures of entering and leaving air for cooling coils designed for more than 5000 cfm.
 - 6. Airflow.
 - 7. Air pressure drop.

3.13 TEMPERATURE TESTING

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.14 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- G. Confirm interaction of electrically operated switch transducers.
- H. Confirm interaction of interlock and lockout systems.
- I. Verify main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.15 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.16 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 1. Include a list of the instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to the certified field report data, include the following:
 1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 1. Title page.
 2. Name and address of testing, adjusting, and balancing Agent.
 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 testing, adjusting, and balancing Agent who certifies the report.
 10. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 11. Nomenclature sheets for each item of equipment.
 12. Data for terminal units, including manufacturer, type size, and fittings.

13. Notes to explain why certain final data in the body of reports vary from design values.
 14. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
- F. Equipment Test Reports: For all equipment tested:
1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 2. Motor Data: Include the following:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 3. Test Data: Include design and actual values for the following: (all elements of the system that were tested, including air and water flows, static pressures, pump hoods, inlet and outlet static pressures, inlet, outlet pressure type of coils, raws, circuits face areas, inlet, outer wet bulb, dry bulb temperatures, duct sizes tested, inlet and outlet flows temperatures and pressures and all other pertinent data. The report to be organized per each item tested.)
 - a. Total rate in cfm, gpm and lbs/hr.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.
 - g. Cooling coil static-pressure differential in inches wg.
 - h. Heating coil static-pressure differential in inches wg.
 - i. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside-air damper position.
 - l. Return-air damper position.
- G. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.18 ADDITIONAL TESTS

- A. Within 120 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

3.19 ADDITIONAL CHECKLISTS (see next page)

System Readiness Checklist
Piping and Appurtenances

Installation:

- Piping installed with slope to drain.
- Hose end drain valves installed at all low points.
- Air vents with valves installed at all high points of the hot water systems.
- Automatic air vents piping installed for drainage to nearest drain.
- Unions installed on all equipment requiring disconnects for servicing.
- Dielectric unions installed on all dissimilar materials per specifications.
- Expansion joints and loops are installed as needed and per manufacturer's recommendations.
- Pressure and temperature gages installed at all specified points.
- Pressure and temperature gage ranges per specifications.
- P/T ports installed at locations specified.
- Relief valves installed on all pressure vessels as specified.
- Strainers installed at all specified locations including blow-off valve and cap.
- Air separators, expansion tanks and suction diffusers installed.
- Water treatment system installed per project documents.
- Glycol feeder system installed per project documents.
- Valves provided and installed per specification in regards to connection style and size.
- Valves installed for area and group isolation, maintenance isolation and service disconnects.
- Valves installed with stems oriented up.
- Control valves installed and wired to control system.
- All specified equipment, piping, valves, pump bodies, drains, unions are insulated per specification - removable insulation installed as specified.
- All valves tagged with number and function, valve index posted.
- Pipes across traffic areas provided with protection.
- Piping is shielded to prevent water leakage above electrical equipment/panels.
- Mechanical supporting devices installed at specified locations and spacing

Start-Up:

- Commissioning Authority has been notified for witness of start-up.
- Expansion tank pressures have been checked and set per engineer's guidance.
- Water pipe pressure tested and accepted. Attach reports.
- Water piping flushed and cleaned and chemically treated per specifications and accepted. Attach reports.
- Strainers cleaned per specification procedure prior to balancing.
- All air has been removed/bleed from the system prior to balancing.
- Water chemical treatment complete, treatment system operational, attach treatment report.
- Glycol feeder verified operational.
- Control valves verified operational.

System Readiness Checklist
Piping and Appurtenances (Continued)

Readiness:

- Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer's checklists.
- Damaged factory finishes have been replaced, repaired or touched up.
- Equipment and systems are labeled per project documents.
- Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

System Readiness Checklist

Air Handling Equipment

Installation:

- Manufacturer's required maintenance clearance provided.
- Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- Inspection and access doors are operable.
- Condensate drain with P-trap and cleanout is installed and unobstructed.
- Associated piping, shutoff valves, control valves and insulation are complete.
- Dampers and actuators installed and verified operational.
- Ductwork is complete including access to all serviceable components.
- Plenum and casings have been cleaned.
- Pipe and conduit penetrations have been caulked.
- Units are level and secured.
- Units have been lubricated prior to start-up.
- All filter access provided so filter can be replaced without the use of tools.
- Coil fins have been cleaned and combed out after construction in equipment area is completed.
- Unit disconnect within sight of unit, power available to unit.
- All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- Controls installed and verified operational.
- Unit heaters provided with provisions for cleaning via "water bath" method to include a water source and drain pan.
- Ceiling access doors have been provided as required for unit service access.
- Ductwork installed at unit inlets and outlets is greater than or equal to manufacturer's required minimum values.

Start-Up:

- Motor rotation has been verified.
- Voltage and phase has been verified.
- Belts have been properly adjusted and aligned.

System Readiness Checklist (Preliminary Version)

Air Handling Equipment (continued)

Readiness:

- Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer's checklists.
- Temporary filters have been removed and new installed.
- All required testing completed and test reports submitted.
- Damaged factory finishes have been replaced, repaired or touched up.
- Equipment and systems are labeled per project documents.
- All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

System Readiness Checklist
Variable Speed Drive Systems

Unit No: _____

Installation:

- Manufacturer's required maintenance clearance provided.
- Unit disconnect within sight of unit, power available to unit and disconnect labeled.
- External controls installed.
- Internal controls and safeties installed.
- Controlled parameter sensor (air or water) installed and configured through control system.
- Proper ventilation has been provided to over temperature nuisance trips.

Start-Up:

- Commissioning Authority has been notified for witness of start-up.
- Motor operation and rotation verified.
- Internal controls and safeties verified operational.
- External controls verified operational.
- Operating parameters measured and recorded.

Readiness:

- Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer's checklists.
- Damaged factory finishes have been replaced, repaired or touched up.
- Equipment and systems are labeled per project documents.
- Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

System Readiness Checklist
Temperature Control

Installation:

- All control points have been provided per the Project Documents and are communicating with front end computer.
- System graphics are complete (showing all devices controlled, all adjustable points shown, all specified components), accurate (reflects actual field/unit installation, end-to-end verification of points done) and functional.
- Access Security levels have been set up per owner's needs.
- Network connection is complete, the central operator terminal has been updated and remote monitoring of the system has been tested.
- All specified associated equipment (such as PC, Monitor, printer, modem & laptop) has been provided, installed and is operational.
- Surge protection and battery back-up devices installed per Project Documents and tested.
- Control wiring, panels and all system components are permanently labeled, including point address designation, system reference and descriptions.
- Acceptance start-up test plan has been submitted and approved. Attach copy of test plan.
- Graphical interface plan has been submitted and approved by CA.
- All control points have been provided per the Project Documents and are communicating with front end computer.
- System graphics are complete (showing all devices controlled, all adjustable points shown, all specified components), accurate (reflects actual field/unit installation, end-to-end verification of points done) and functional.
- Room temperature and other setpoints installed per specification and owner's direction.
- Operating schedules have been set up per owner's direction
- Trend logs have been set up per Project Documents and/or as directed by the CA.
- Minimum OA %, from balancer, provided on graphics as permanent reference value.
- Alarms have been programmed per Project Documents and owner's direction.
- Stability of loop and VFD's has been verified.
- All sensors have been calibrated including temperature, pressure, flow and metering devices.

Start-Up:

- Point to point testing and sensor calibration is complete and checkout forms complete with copy submitted.
- Variable speed drive start-up per manufacturer's representative complete.

System Readiness Checklist
Temperature Control

Readiness:

- Manufacturer's installation procedures were followed.
- All required testing completed and test reports submitted.
- Damaged factory finishes have been replaced, repaired or touched up.
- Equipment and systems are labeled per project documents.
- All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

System Readiness Checklist
Testing, Adjusting, and Balancing

Installation:

- Balancing agenda provided to engineer. Provide copy to CA for review.
- Pre-balance conference complete.
- All equipment has been checked prior to balancing. Installation checklists attached.
- Fan belt tension and fan rotation verified prior to balancing.
- Air balanced prior to water balance.
- Construction filters removed, clean filters installed, damper position and operation checked prior to balancing. Air balance due with filters simulated as 1/2 dirty.
- Bathrooms are negative relative to other areas.
- Rooms pressures are positive while allowing for door closure in economizer mode.
- Relief damper operation has been checked to assure dampers open and close as needed.
- All systems balanced to design criteria except as approved by mechanical engineer and CA.
- Overall building pressure checked with outside air at 100% to assure adequate relief.
- All volume dampers, fire dampers, balancing and controls valves are set in a fully open position at the start of balancing.
- Hydronic system and strainers has been cleaned and treated prior to balancing.
- Expansion tanks are properly pressurized and not water logged.
- Air vents installed and operational, water system balanced with no air in system.
- Final damper and speed controller permanently marked for final balancing positions.
- List of control minimum OA damper positions in report and provided to controls contractor.
- Preliminary report has been provided on approved forms with data specified, attach copy.
- All defects/ deficiencies have been noted to CA/ engineer during testing, included in report.
- Noise and vibration has been checked and adjusted as necessary.
- All TAB procedures are complete and ready for the system balance demonstration. The TAB contractor will demonstrate proper balance by measuring and verifying 10% of the systems as selected and witnessed by the Commissioning Authority.

System Readiness Checklist
Testing, Adjusting, and Balancing

Start-Up: Not Applicable.

Readiness:

- All required testing completed and test reports submitted.
- All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

END OF SECTION 230594

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SECTION 230720 - PIPE INSULATION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Duct Insulation" for insulation for ducts and plenums.
 - 3. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat trace inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties and equipment connections.
 - 6. Application of field-applied jackets.
- C. 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.
- D. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Schuller International, Inc.
 - e. John Manville.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
 - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 - 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
- C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper.
 - 1. Finish and Thickness: Smooth finish, 0.010 inch thick.
 - 2. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
 - 3. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - 4. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 1. Apply insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and

shield.

- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply 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. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- S. Floor Penetrations: Apply insulation continuously through floor assembly.
 - 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 - 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-

retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.

3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers.
 4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FIELD-APPLIED JACKET APPLICATION

- A. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive. Color for each piping system shall be selected by the Architect.
- B. Apply metal jacket where indicated, 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.

3.6 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the 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.

3.7 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors.
 - 2. Vibration-control devices.
 - 3. Below-grade piping, unless otherwise indicated.
 - 4. Chrome-plated pipes and fittings, unless potential for personnel injury.
 - 5. Non-Chilled water air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.8 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.9 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Chilled-water supply and return.
 - 1. Operating Temperature: 35 to 75 deg F.
 - 2. Insulation Material: Mineral Fiber with reinforced all service jacket.
 - 3. Insulation Thickness: See table A.
 - 4. Field-Applied Jacket: PVC, (Mechanical Rooms and where exposed.)
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.

Table A

Insulation Thickness:

Insulation thicknesses in Table A are based on insulation having thermal resistivity in the range of 4.0 to 4.6 hr. °F square foot/Btu per inch of thickness on a flat surface at a mean temperature of 75°F.

TABLE 'A' - MINIMUM PIPE INSULATION
INSULATION THICKNESS IN INCHES FOR PIPE SIZES

PIPING SYSTEMS TYPES	TEMPERATURE RANGE °F	RUN OUTS UP TO 2"	1" AND LESS	1 ½" TO 2"	2 ½" TO 4"	5" TO 10"	12" AND LARGER
COOLING SYSTEMS							
Chilled water	40-55	1"	1"	1½"	1½"	1½"	1½"
*1 Runouts not exceeding 12 feet in length to individual terminal units. *2 For piping exposed to outdoor air, increase thickness by 1/2 inch.							
For the purposes of the following Table A the following fluid temperatures and pressures are to be used unless specified otherwise:							

END OF SECTION 230720

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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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes piping, special-duty valves, and hydronic specialties chilled-water cooling, and condenser water systems; makeup water for these systems; blowdown drain lines; and condensate drain piping.

1.3 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.5 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.6 EXTRA MATERIALS

- A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grooved Mechanical-Joint Fittings and Couplings:
 - a. Gruvlok Corporation.
 - b. Victaulic Company of America.
 - 2. Calibrated Balancing Valves:
 - a. Armstrong Pumps, Inc.
 - b. Flow Design, Inc.
 - c. Gerand Engineering Company.
 - d. Griswold Controls.
 - e. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - f. Taco, Inc.
 - 3. Automatic Flow-Control Valves:
 - a. Flow Design, Inc.
 - b. Griswold Controls.
 - 4. Air Vents (automatic):
 - a. Armstrong Machine Works.
 - b. Bell & Gossett ITT; Fluid Handling Div.

- c. Hoffman Specialty ITT; Fluid Handling Div.
- d. Spirax Sarco.
- e. Honeywell-Baukman.

5. Y-Pattern Strainers:

- a. Armstrong Machine Works.
- b. Hoffman Specialty ITT; Fluid Handling Div
- c. Metraflex Co.
- d. Spirax Sarco
- e. Trane Co.
- f. Victaulic Co. of America
- g. Watts Regulator Co.

6. Flexible Connectors:

- a. Amber-Booth
- b. Mason Industries
- c. Metraflex Co.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2) and Smaller: ASTM A 53, Type S (seamless) or F, Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 12): ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.
- C. Steel Pipe, NPS 14 through NPS 18): ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.
- D. Steel Pipe, NPS 20: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2) and smaller and electric-resistance welded for NPS 2-1/2) and larger.
- E. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

- I. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- J. Flanges and fittings below are available in several classes, materials, facings, and end connections. Coordinate with Project requirements.
- K. 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.
- L. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47), Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
- M. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- N. Combinations of grooved mechanical-joint couplings and short nipples may also be used. Refer to Victaulic Company of America's technical information.
- O. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F) and pressures up to 150 psig).
- P. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- Q. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 VALVES

- A. Globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."
- B. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- C. Calibrated Balancing Valves, NPS 2) and Smaller: Bronze body, ball type, 125-psig) working pressure, 250 deg F) maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- D. Calibrated Balancing Valves, NPS 2-1/2) and Larger: Cast-iron or steel body, ball type, 125-psig) working pressure, 250 deg F) maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- E. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an

identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:

1. Gray-iron or brass body, designed for 175 psig) at 200 deg F) with stainless-steel piston and spring.
2. Brass or ferrous-metal body, designed for 300 psig) at 250 deg F) with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig) at 250 deg F).

2.6 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig) working pressure; 225 deg F) operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8) discharge connection and NPS 1/2) inlet connection.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig) working pressure; 240 deg F) operating temperature; with NPS 1/4) discharge connection and NPS 1/2) inlet connection.
- C. Fitting in paragraph below is used where a single pipe acts as both supply and return, such as a branch supply line at a convector or finned-tube radiation. These fittings are available in NPS 3/4 to NPS 2 (DN 20 to DN 50).
- D. Diverting Fittings: 125-psig) working pressure; 250 deg F) maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.
- E. Y-Pattern Strainers: 125-psig) working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2) and larger, threaded connections for NPS 2) and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- F. Combinations of grooved mechanical-joint couplings and short nipples may also be used. Refer to Victaulic Company of America's technical information.
- G. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig) minimum working pressure and 250 deg F) maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch) misalignment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hydronic cooling piping, NPS 2) and Smaller: Aboveground, use Type L) drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or within slabs, use Type K) annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs. Provide dielectric unions at junctions of copper & steel piping.
- B. Hydronic cooling, NPS 2-1/2 to 8": Schedule 40 steel pipe with welded and flanged joints or grooved mechanical-joint couplings.

- C. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Gate, ball, and butterfly valves.
 - 2. Throttling Duty: Globe, ball, and butterfly valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

3.3 PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. 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.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4) nipple and ball valve in blowdown connection of strainers NPS 2) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2).
- H. Anchor piping for proper direction of expansion and contraction.
- I. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, at each coil on all sides of automatic valves where valves do not have union connections, elsewhere as indicated and wherever necessary to prevent undue difficulty in making repairs or replacement. Unions are not required at flanged connections.
- J. Install flanges on valves, apparatus, and equipment having 2-1/2-inch NPS and larger connections.
- K. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration-producing equipment.

- L. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- L. No piping shall be run above any electrical panels, electrical equipment, or access clearances for electrical panels or equipment. No piping shall be run through any electrical rooms.
- M. Provide valving for complete drainage of system.
- N. All piping systems shall be installed so that they can be easily drained by means of drainage of low points of all piping without disconnecting pipe. If not specifically indicated on the drawings, the frequency of draining shall determine whether drain caps, plugs, cocks, or valves are to be used.

All installed pipe lines shall be straight, free from dents, scars, and burrs, with ends reamed smooth, and shall remain straight against strains tending to cause distortion during system operation. The Contractor shall make proper allowance for pipe line expansion and contraction so that no unsightly distortion, noise, damage, or improper operation results therefrom.

Piping shall run only parallel or at right angles to the walls or axes of the building and shall be neatly organized. The Contractor shall study the architectural, structural, mechanical, electrical, and other drawings to eliminate conflict of piping with other structure lighting or other services. Unless specified otherwise, no piping shall be exposed in a finished room, except in shop or storage areas. All changes in direction shall be made with fittings.

No piping shall be run above any electrical panels, electrical equipment or access clearances for electrical for electrical panels or equipment. No piping shall be allowed to run through any electrical rooms.

All piping shall be clean and free from acids and loose dirt when installed and shall be kept clean during the completion of the installation.

Plugs of rags, wools, cottons, waste, or similar materials may not be used in plugging. All piping shall be so arranged to not interfere with removal of other equipment or devices; and to not block access to manholes, access openings, etc. Piping shall be arranged to facilitate equipment maintenance. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. Piping shall be placed and installed so that there will be no interference with the installation of the air-conditioning equipment, ducts, etc. All piping shall be so installed to insure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated and packed, and the glands shall be adjusted at the completion of the work and before final acceptance. All piping shall be erected to insure proper draining. Cooling and heating piping mains may be run level, with traps avoided where possible. No bushings, short nipples, or street-type fittings shall be used.

Drain valves shall be installed at all low points in all piping systems to allow for complete drainage of piping systems.

When insulated pipes are supported by a roller hanger they shall be protected from damage by suitable pipe covering protection saddles. Saddles shall support pipe on roller and shall be packed with insulation.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 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. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following minimum rod sizes and maximum spacing:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
1 1/4 in. and smaller	1/2 in.	6 ft
1-1/2 in. and 2 in.	1/2 in.	9 ft.
2-1/2 in. and 2 in.	5/8 in.	10 ft.
4 in. and 6 in.	3/4 in.	10 ft.
8 in. and 10 in.	7/8 in.	10 ft.
12 in. and 14 in	1 in.	10 ft.
16 in. through 24 in.	(2)-1in	10 ft.

In addition to the spacing listed, an additional hanger shall be provided 1 foot 0 inches from each pipe drop, rise or turn.

D. Support vertical runs at each floor.

Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Automatic air vents may cause damage to ceilings and other finished surfaces. Air vents aid in system filling. Air removal after initial startup is accomplished by air separator or boiler dip-tube. Manual air vents may be a better solution.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.

- C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure and temperature gages at coil inlet connections.

3.8 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 system with clean water. Clean strainers.
 - 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.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- 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 trapped air. Use drains installed at low points for complete draining of liquid.
 - 3. Check expansion tanks to determine that they are not air bound and that system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design 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 either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of 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.

3.9 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
 - 1. Open valves to fully open position. Close coil bypass valves.
 - 2. Check pump for proper direction of rotation.
 - 3. Set automatic fill valves for required system pressure.
 - 4. Check 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. Check operation of automatic bypass valves.
 - 7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
 - 8. Lubricate motors and bearings.

3.10 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

3.11 COMMISSIONING

- A. Fill system and perform initial chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that system is completely full of water.
- C. Perform these steps before operating the system:
 - 1. Open valves to fully open position. Close coil bypass valves.
 - 2. Check pump for proper direction of rotation.
 - 3. Set automatic fill valves for required system pressure.
 - 4. Check air vents at high points of systems 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. Check operation of automatic bypass valves.
 - 7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
 - 8. Lubricate motors and bearings.

END OF SECTION 232113

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SECTION 232500 - CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes water-treatment systems for the following:
 - 1. Chilled-water systems, flush and clean system.

1.3 SYSTEM DESCRIPTION

- A. Closed System: One bypass feeder on each system, with isolating and drain valves installed around balancing valve downstream of circulating pumps, unless otherwise indicated.

- 1. Introduce closed system treatment through bypass feeder when required or indicated by test.
- 2. Performance: Water treatment sized and equipped to treat raw water available at Project site to sustain the following water characteristics:

- 1) Hardness: less than 200ppm as CaCO_3
- 2) Sodium Nitrite: 800 —1000 ppm as NaNO_2
- 3) Conductivity (μmhos): 3000 to 4000 $\mu\text{mhos}/\text{cm}$
- 4) Silica: 60 ppm or less.
- 5) pH: 9.5 or above.

Water characteristics will change with location and type of treatment - usually the treatment parameters will be left to the water treatment supplier based on the type of treatment specified.

- 3. Closed Circulating Water Systems:
 - 1) Chemicals:
 - a) Liquid Alkaline Cleaner
 - b) Non-Chromate, Borate-Nitrite corrosion inhibitor
 - 2) Cleaning: Cleaning shall be performed by the contractor under the supervision of the chemical supplier at the time of start up. The system shall be filled with water and checked for leakage and debris. Add the proper dosage of liquid alkaline cleaner and circulate for 24 hours at required temperature. Drain and flush piping, clean the strainers. Flush until system pH is no more than eight.
 - 3) Control: The contractor shall provide a Sodium Nitrite drop test kit for checking the concentration of sodium nitrite in the system.

- 4) Service: The contractor shall provide initial and continuing field service to fulfill the requirements and objectives of the General Water Treatment Specifications.

1.4 QUALITY ASSURANCE

- A. Supplier Qualifications: A recognized chemical water treatment supplier with warehousing facilities in the Project's vicinity and that is or employs an experienced consultant, available at reasonable times during the course of the Work to consult with Contractor, Architect, and Owner about water treatment.
- B. Chemical Standards: Meet state and local pollution-control regulations.
- C. Comply with NFPA 70 for components and installation.
- D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.5 MAINTENANCE

- A. Service Period: Provide chemicals and service program for period of one year from startup date of equipment, including the following:
 1. Initial water analysis and recommendations.
 2. Startup assistance.
 3. Training of operating personnel.
 4. Periodic field service and consultation.
 5. Customer report charts and log sheets.
 6. Laboratory technical assistance.

1.6 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified. Include manufacturer's technical product data, rated capacities of selected equipment clearly indicated, water-pressure drops, weights (shipping, installed, and operating), furnished specialties, accessories, and installation and startup instructions.
- C. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chemical Water Treatment Products:

- 1) Powers

2.2 CHEMICALS

- A. Furnish chemicals recommended by water treatment system manufacturer for treating water to seals, and accessories.
- B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
- C. Biocide: Chlorine release agents or microbiocides.
- D. Closed System (Water) Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install treatment equipment level and plumb, according to manufacturer's written instructions, rough-in drawings, the original design, and referenced standards.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 1. Install piping adjacent to equipment to allow servicing and maintenance.
- B. Electrical: Conform to applicable requirements of Division 26 Sections for connecting electrical equipment.
 1. Install electrical devices furnished with boiler but not specified to be factory mounted

3.3 FIELD QUALITY CONTROL

1. Testing Agency: A qualified independent testing agency employed and paid by Owner will perform field quality-control testing.
2. Testing Agency: Provide the services of a qualified independent testing agency to perform field quality-control testing.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

- B. Ensure that system is operational, filled, started, and vented prior to cleaning. Place terminal control valves in OPEN position during cleaning. Use water meter to record capacity in each system.
- C. Add cleaning chemicals as recommended by manufacturer.
 - 1. Chilled-Water System: Circulate for 48 hours, then drain. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed.

3.5 COMMISSIONING

- A. Startup Services: Provide the services of a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Startup Procedures: During boiler system startup, operate boiler water treatment system (after charging with specified chemicals) to maintain required steady-state characteristics of feedwater.

3.6 DEMONSTRATION

- A. Provide services of supplier's technical representative for half a day to instruct Owner's personnel in operation, maintenance, and testing procedures of boiler water treatment system.
- B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- C. Review data in the operation and maintenance manuals. Refer to Division I Section "Contract Closeout."
- D. Schedule training with Owner, through the Architect, with at least 7 days' advance notice.

END OF SECTION 232500

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SECTION 233119 - HVAC CASINGS

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. Factory-fabricated, field-assembled, single- and double-wall casings for HVAC equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Static-Pressure Classes:

- 1. Upstream from Fan(s): 2-inch wg.
- 2. Downstream from Fan(s): 4-inch wg.

- B. Structural Performance:

- 1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.
 - a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft..

- C. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

- 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:

- 1. Factory-fabricated casings.
- 2. Liners and adhesives.
- 3. Sealants and gaskets.
- 4. Seismic-restraint devices.

- B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Sheet metal thickness(es).
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Access doors including frames, hinges, and latches.
6. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
7. Locations for access to internal components.
8. Hangers and supports including methods for building attachment, vibration isolation, seismic restraints, and casing attachment.
9. Interior lighting, including switches.

C. Welding certificates.

D. Product Certificates: For acoustically critical casings, from manufacturer.

1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

E. Field quality-control reports.

1.5 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/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate sizes and locations of steel supports. Supports are specified in Division 05 Section "Metal Fabrications."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 GENERAL CASING FABRICATION REQUIREMENTS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 6, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
 2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Exterior Surface Galvanized Coating Designation: G90.
 2. Interior Surface Galvanized Coating Designation:
 - a. Sections Not Exposed to Moisture: G90.
 - b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90.
- C. Factory- or Shop-Applied Antimicrobial Coating:
1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
 5. Applied Coating Color: Standard.
- D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.
- F. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Provide shaft seals where fan shafts penetrate casing.
- G. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-11, "Casing Access Doors - 2-inch wg," and Figure 6.12, "Casing Access Doors - 3-10-inch wg"; and according to pressure class of the plenum or casing section in which access doors are to be installed.
1. Size: 20 by 54 inches.
 2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
 3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
 5. Neoprene gaskets around entire perimeters of door frames.
 6. Doors shall open against air pressure.

- H. Condensate Drain Pans: Formed sections of Type 304, stainless-steel sheet complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches past coil.
1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
 2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
 3. Insulation: Polystyrene or polyurethane.
 4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
 5. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg. Include slab height in trap calculation.

2.2 SHOP-FABRICATED CASINGS

- A. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
- B. Double-Wall Casing Inner Panel: Solid sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
- C. Interstitial Insulation: Polyurethane foam complying with NFPA 90A or NFPA 90B.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Coat insulation with antimicrobial coating.
 3. Cover insulation with polyester film complying with UL 181, Class 1.
- E. Interstitial Insulation: Flexible-elastomeric duct liner complying with ASTM C 534, Type II for sheet materials and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
- F. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.
- G. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90.
- H. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.
- I. Reinforce casings with galvanized-steel angles.

2.3 MANUFACTURED CASINGS

- A. Description: Double-wall, insulated, pressurized equipment casing.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acoustical Surfaces, Inc.
 - 2. AeroSonics, Inc.; a division of TUTCO, Inc.
 - 3. Buffalo Air Handling.
 - 4. CertainTeed Corp.; Insulation Group.
 - 5. CLEANPAK International.
 - 6. D&D Sound Control.
 - 7. IACL.
 - 8. Industrial Noise Control, Inc.
 - 9. McGill AirSilence LLC.
 - 10. SEMCO Incorporated.
 - 11. Vibro-Acoustics.
- C. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and solid perforated, galvanized sheet steel interior wall; with space between wall filled with insulation.
 - 1. Wall Thickness: 2 inches 4 inches.
 - 2. Fabricate with a minimum number of joints.
 - 3. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
 - 4. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.
 - 5. Sheet Metal Thicknesses:
 - a. Exterior Wall Thickness: 0.040 inch minimum.
 - b. Interior Wall Thickness: 0.034 inch minimum.
 - 6. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.
 - 7. Double-Wall Casing Inner Panel: Solid sheet steel.
 - 8. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant and vermin proof and that complies with NFPA 90A.
 - 9. Fabricate panels with continuous tongue-and-groove or self-locking joints effective inside and outside each panel.
- D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

2.4 CASING LINER

- A. Fibrous-Glass 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 Corp.; Insulation Group.
 - b. Johns Manville.

- c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to surface of the liner that will form the interior surface of casing to act as a moisture repellent and an erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
- B. Natural-Fiber Casing Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor, and complying with NFPA 90A or NFPA 90B.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bonded Logic, Inc.
 - b. Reflectix Inc.
 - 2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested according to ASTM C 518.
 - 3. 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.
 - 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- 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, galvanized steel, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop or Factory Application of Casing Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
- 1. Adhere a single layer of indicated thickness of casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing 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 casings or cut and fit to ensure butted-edge overlapping.
 - 5. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm.
 - 6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 - 7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined casing preceding unlined duct.

- c. Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm or where indicated.
- 8. Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

2.5 SEALANT MATERIALS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel or stainless steel.
- C. Solvent-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Base: Synthetic rubber resin.
 - 3. Solvent: Toluene and heptane.
 - 4. Solids Content: Minimum 60 percent.
 - 5. Shore A Hardness: Minimum 60.
 - 6. Water resistant.
 - 7. Mold and mildew resistant.
 - 8. VOC: Maximum 395 g/L.
 - 9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 - 10. Service: Indoor or outdoor.
 - 11. Substrate: Compatible with galvanized sheet steel or stainless steel.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single component, acid curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine concrete bases roof curbs and steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.
- B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Equipment Mounting: Install HVAC casings on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported casings, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install seismic restraints on casings. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Apply sealant to joints, connections, and mountings.
- E. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Support casings on floor or foundation system. Secure and seal to base.
- G. Support components rigidly with ties, braces, brackets, seismic restraints, and anchors of types that will maintain housing shape and prevent buckling.
- H. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
 - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

3. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
- B. HVAC casings will be considered defective if they do not pass tests and inspections.
 - C. Prepare test and inspection reports.

END OF SECTION 233119

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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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B Related Sections include the following:
 - 1. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 - 2. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers, and grilles.

1.3 DEFINITIONS

- A Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C Register: A combination grille and damper assembly over an air opening.

1.4 SUBMITTALS

- A Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- B Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.
- C Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes. Colors to be off-white, unless otherwise selected by Architect during submittal stage.

- D Samples for Verification: Of diffusers, registers, and grilles, in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

1.5 QUALITY ASSURANCE

- A Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated.
- B NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Air Factors
 2. Krueger
 3. Metal Aire
 4. Nailor
 5. Price
 6. Titus

2.2 REGISTERS, GRILLES, & DIFFUSERS

- A. General: The frames for all registers, grilles, and diffusers shall match type of ceiling where they are to be installed. Special frames shall be provided for narrow T-bar ceilings. Refer to reflected ceiling plan and other specification divisions for ceiling type. See drawings for the exact type.

2.4 SOURCE QUALITY CONTROL

- A. Testing: Test performance 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. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the 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 connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

N:\08\08200\08249 Cannon Health Bldg HVAC\03_Specifications\100 %\233713 Diffusers, Registers and Grilles.doc



PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes new fans, coils and VFD;s for indoor installations. Each fan system shall have two VFD”S.
 - 1. Factory-fabricated, field-assembled, double-wall casings for HVAC equipment
 - 2. Shop Drawings for each air handler are required.
 - 3. This division shall be responsible for complete submittals which shall include the engineering of the Casings, fans and coils.
 - 4. Air handlers shall be provided with a multi-fan array. The multiply fans must comply with the manufactures recommendations distances for space before, after and to the sides of each fan.
 - 5. The fans shall be wire for a single point connection. This division shall provide VFD’s which shall be factory wired as well. The Manufacturer shall submit with his bid the delivery time to the site and the ship date.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each central-station air-handling unit specified, including the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified coil-performance ratings with system operating conditions indicated.
 - 4. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 5. Material gages and finishes.
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Coordination Drawings, including floor plans and sections drawn to scale. Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- E. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

- F. Maintenance data for custom air-handling units to include in the operation and maintenance manual.

1.4 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.
- B. Comply with NFPA 70 for components.
- C. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Coordination: Coordinate layout and installation of air-handling units with piping and ductwork and with other installations.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver air-handling unit as a factory-assembled module with protective crating and covering.
- B. Lift and support units with manufacturer's designated lifting or supporting points.
- C. Field assembled units furnished in multiple sections per manufacturers instructions.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.
- B. Coordinate size and location of structural-steel support members.

1.7 WARRANTY

- A. The special warranty specified in this Article shall not deprive Owner of other rights. Owner may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.
- B. Special Warranty: Submit a written warranty signed by manufacturer and Installer agreeing to repair any leaks in the exterior units casings for a period 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance by one of the following:

1. Ventrol
2. ClimateCraft
3. Huntair

2.2 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers.

B. Motor and Electrical Components: Refer to Division 15 Section "Motors."

2.3 ACCESS DOORS

A. Access doors shall be 2" thermal break construction with exterior panel minimum 20-gauge Bonderized Powder Coated, A60 galvanized and interior panel minimum 20-gauge Bonderized Powder Coated, A60 galvanized. Door jam & frame shall be constructed of extruded aluminum with continuously welded corners for rigidity. Door panels shall be insulated with (2") expandable foam insulation completely encapsulated and sealed between the door panels and frame. Provide doors located and sized to allow for routine maintenance including motor replacement and filter replacement, electrical components and any other sections or components requiring access or maintenance.

B. Doors shall be provided with a minimum (2) dual acting heavy duty key locking composite latches through 48" high, (3) latches through 72" high. Latches shall be operable from both the interior and exterior of the unit. Door latches on doors into fan sections shall be provided with a hasp or other mechanism to facilitate locking of the doors. Door hinge shall be heavy duty Stainless Steel. Door shall be sealed with continuous hollow closed cell foam gasket.

C. Doors to be provided with double high performance closed cell replaceable neoprene bulb type gasket seals around the entire perimeter of the door / frame.

D. Doors shall open against static pressure unless obstructed by internal components. If obstructed by internal components on the positive sections requiring access, the doors shall open with pressure and shall be provided with a safety restraining mechanism. Doors used to access rotating equipment shall be provided with an OSHA approved safety latching mechanism requiring a tool to open and shall also have a highly visible, permanently fixed, caution sign on the exterior of the door. Doors with access to moving parts must also have locking hardware and meet current UL mechanical protection guidelines. Standard door size shall be 24" wide by 60" high unless restricted by height or section width.

E. Doors shall be provided with thermal pane wire glass viewing windows as called out for on the unit drawings in the specifications. Minimum window size to be 12" x 12" Thermal Break.
Note: Door size limits window availability / maximum window size.

2.4 FANS

- A. The FANWALL Array, shall consist of multiple, direct driven, plenum fans constructed per AMCA requirements for the duty specified, (Class I, II, or III). All fans shall be selected to deliver design air flow at the specified operating TSP at the specified motor speed and as scheduled. The FANWALL Array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan speed. Each fan/motor "cube" (cell, cartridge) shall consist of an 11 gauge, A60 galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge, A60 galvanized steel motor support plate and structure. The fan cartridge intake wall, inlet funnel, and motor support structure shall have a Powder Coated Finish Color to be Gray or Sky White for superior corrosion resistance and easy cleaning.

When using FANWALL Array Control with Variable Frequency Drive(s), all motors shall be IEEE inverter duty, premium efficiency, TENV, T-frame motors selected at the specified or scheduled operating voltage and RPM(s). Each motor shall be provided with an AEGIS Shaft Grounding Ring (SGR) to prevent Electrical Discharge Machining (EDM) damage to the motor bearings and extend motor life by safely channeling harmful shaft currents to ground. The AEGIS SGR Conductive MicroFiber Brush system is a ring that slides over the end of the motor shaft and is locked in place with screw-on mounting brackets. The AEGIS system is frictionless, has no wear and requires no maintenance or additional service during the life of the motor. Alternative protection methods, such as isolated bearings or ceramic bearings, must be pre-approved by the engineer.

Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, Grade 1.0 with peak to peak deflection equal to or less than 0.5 mil at the design operating speed for the fan/motor cartridge.

NOTE: FANWALL Arrays do NOT require spring isolators, seismic isolation, or inertia bases. Other manufacturers will provide spring isolators, if required for vibration and sound isolation.

- B. The Discharge and Inlet bare fan Sound Power Levels for each individual octave band shall NOT exceed the values specified or scheduled for each individual Supply / Return FANWALL Array.

Alternate manufacturers must submit acoustical data for review and approval prior to the bid indicating that the proposed alternate equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit weights, acoustical performance, or specified total fan HP when compared to each individual Supply / Return FANWALL Array. Proposals submitted which indicate a higher connected fan HP and higher sound power levels than specified or scheduled will NOT be accepted.

- C. The FANWALL Array(s) shall be provided with Coplanar Silencer package(s) with (fiberglass or Huntair BHN aseptic) sound absorption, acoustical media as noted below and or scheduled. The Coplanar Silencers shall NOT increase the fan total static pressure, nor shall they increase the airway tunnel length of the Air Handling Unit when compared to the same FWT Air Handling Unit without a Coplanar Silencer array. The Coplanar Silencers (sound attenuators) will reduce the bare fan discharge sound power levels as noted below and/or scheduled. If NOT otherwise specified, the acoustical silencers shall reduce the bare fan discharge sound power levels by a minimum of 15 db, re 10^{-12} watts with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same Air Handling Unit without the silencers.

- D. Each fan in the (Supply Air or Return Air) FANWALL Array shall be provided with an Inlet Airflow Straightener to reduce the bare fan inlet and discharge sound power levels as noted below and / or scheduled.
- E. The FANWALL Array shall consist of multiple fan and motor "cells" (cubes), spaced in the air way tunnel cross-section to provide a uniform air flow and velocity profile across the entire air way tunnel cross-section and components contained therein. Each fan motor shall be individually wired to an electrical control panel containing a Motor Starter Protector (MSP) for each motor. The Motor Starter Protectors will be wired to Variable Frequency Drive(s) (VFD) as specified elsewhere. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.
- F. The FANWALL Array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the FANWALL Array septum wall, and at a distance of 42" from the discharge side of the FANWALL Array septum wall.
- G. Each fan/motor assembly shall be removable through a 30" wide, free area, access door located on the (discharge and / or inlet) side of the FANWALL Array.) NOTE: Narrower width access doors may require the break-down of the fan/motor assemblies into separate fan and motor components. Refer to plans for locations and sizes of the Access Doors.
- H. Any inactive or "blank" FANWALL Array "cube(s)" are equipped with Blank-off Plate(s) as standard.

2.5 FANWALL TECHNOLOGY™ (FWT) ELECTRICAL

- A. Provide complete electrical and control system(s) required to run the FANWALL system(s) including all equipment, material, electrical enclosure, electrical components and electrical labor.
- B. FANWALL Array designs shall be in accordance with specific system requirements. Please see system requirements before electrical design of FANWALL system is to commence.
- C. FANWALL Array electrical designs shall be in accordance with the NEC, UL 508A, and Local Codes.
- D. Motor Circuit Protection:
 - 1. All motors in the FANWALL Array shall be provided with an individual Motor Protection for thermal overload protection. All motor starter (circuit) protectors shall be located in main enclosure(s) rated NEMA 1 Indoor or NEMA 3R Outdoor depending upon location. Electrical Enclosure(s) include Control Transformer, Lighting Transformer and will be Externally Mounted, Recess Mounted or Located Inside the Cabinet (where allowed) as required or as detailed on the plans.
 - 2. Electrical enclosures must be factory-mounted and wired for a single point power connection
- E. Input Line Filters:

1. As required by electrical design, when using variable frequency drives provide Input Line reactors with three percent (3%) impedance mounted externally if not already internal to variable frequency drive.

F. Output Filters:

1. As required by electrical design, when using variable frequency drives where distance and filtering is an issue, provide output line reactors as required. Size the output filter(s) accordingly to manufacturer's recommendations.

2.6 VIBRATION TESTING

- A. A Factory Balance test shall be performed on the fan assembly to certify that the fan meets the following vibration values:

Belt Driven - Spring Isolation Assembly

Rotational Speed	Vibration Amplitude Peak to Peak
250 rpm	5.0 mils
500 rpm	4.0 mils
750 rpm	3.0 mils
1,000 rpm	2.0 mils
1,500 rpm	1.5 mils
1,750 rpm	1.0 mils

Direct Drive - Spring Isolation Assembly

Rotational Speed	Vibration Amplitude Peak to Peak
Up to and including 2000 rpm	0.50 mils
2000 + rpm	0.25 mils

Vibration measurements shall be taken in three orthogonal directions: One taken parallel to shaft in the horizontal plane and two taken perpendicular to the shaft in the horizontal and vertical planes. The values will be checked with the levels being measured in mils peak to peak.

- B. During balancing, the fan shall be imposed with an operating resistance equal to the design external static pressure.
- C. A certificate of compliance signed by the manufacturers Quality Control Inspector shall be attached to each fan assembly at the factory and incorporated into the operating and maintenance manuals.

2.7 COILS

- A. Chilled Coils shall have .008" aluminum fins rated in accordance with ARI 410 for water, steam or ethylene/propylene glycol water mixture. The tubes shall have a minimum .035" wall thickness of seamless copper expanded into the fin collars to provide a permanent mechanical bond. No metallic or thermal bonding materials are acceptable. Return Bends shall be a minimum of one tube thickness greater than the main tubes, brazed replaceable copper (or CuproNickel). "U" type shaped tubes is not acceptable. Coil

headers shall be non-ferrous seamless copper (cast iron headers are not acceptable), and provided with brass or copper male pipe connections. Pipe connections shall be same end connections. Each Coils supply & return connections shall be raised / lowered a minimum 6" from the bottom / top of the coil to allow room for piping connection hookup especially between stacked coils, coils near floors & coils near roofs. Each coil shall be provided with capped vent & drain connections extended to the exterior of the cabinet. All coils shall be fully drainable with no trapped tubes. Coils shall be counter flow design with connections either left or right hand as specified. The use of internal restrictive devices such as turbolater springs or ribbons to obtain turbulent is not acceptable.

- B. Coil casings shall be minimum 16 gauge galvanized steel with formed flanges on all sides of the coil with the tube sheets having pressed or extruded tube holes. The coil casing shall be reinforced so that the maximum unsupported length is 60". The reinforcements shall be of the same material as the casing. Both ends of the coil to be sealed off from the main air stream by full height blankoff's on both the entering air and leaving air sides. Blankoff's to be the same material as the coil casing. Headers and return bends to be further insulated with a closed cell neoprene gasket the full height & width of the coil casing to reduce condensation.
- C. All coils are tested and rated in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 410 and certified in accordance with the ARI certification program. All tubes shall be tested at a minimum 1500 PSIG and all assemblies tested under water at 350 PSIG and rated for 250 PSIG working pressures. Individual tube and core tests before installation of header are not considered satisfactory. Hydrostatic tests alone will not be acceptable.
- D. Stacked Coils to be mounted with integral stacking flanges on the coil.
- E. Coil Supply & Return piping connections extending through the cabinet wall shall be sealed by caulking on the exterior of the casing.

2.8 PIPING

- A. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints. Pipe to the outside of the unit.

2.9 VARIABLE FREQUENCY DRIVES

- A. The manufacturer shall provide, mount and wire a Variable Frequency Drive "VFD" to (two per fan air handler fan system). Each VFD is to have a Nema 3R enclosure with a circuit breaker disconnect device. A keypad and LED/LCD display shall be integral to each VFD for programming and troubleshooting. Each VFD shall be certified and rated for operation in a temperature range of -10°C to 50°C and a RH range of 5% to 95% non-condensing. Each VFD shall be certified for operation at the jobsite altitude (show de-rating value in submittal). The VFD shall be capable of starting into a rotating load (forward or reverse) and shall smoothly accelerate or decelerate to the set point without experiencing component damage or causing a fault. Each VFD shall be provided with a DC link choke, a 5% line reactor and a harmonic filter if necessary to guarantee a total harmonic distortion of less than 5%. The VFD manufacturer shall provide certified calculations to prove the 5% or less distortion, upon request by the engineer.
- B. For applications where the VFD is to be operating at various, but constant speeds, the

supplier must coordinate with the VFD manufacturer and motor manufacturer to determine if there is a need for the motor to be provided with either insulating bearings or a shaft grounding system to prevent pitting of the bearings due to electrical discharge. For such applications, if neither of the above is provide, the manufacturer must warrant the motor against bearing failure (including labor for removal and replacement) for a minimum period of 5 years from date of start-up.

- C. Each VFD must be started and set-up by a factory authorized service technician employed by a factory certified organization. A start-up report, complete with all initial program parameter, must be included in the O&M manuals that are provided by the contractor.
- D. Approved VFD Manufacturers:
 - 1. ABB
 - 2. Danfoss Graham
 - 3. Safronics
 - 4. Yaskawa

2.10 DELIVERY, STORAGE & HANDLING

- A. Unit shall ship with all openings securely covered with wood and / or nylon reinforced plastic wrap and to be watertight. Each unit (will be covered by a tarp) and securely strapped down on an open flatbed truck.
- B. Units must be stored in a clean dry area and protected from the weather and construction traffic. Carefully follow manufacturers' storage instructions if installation does not immediately follow arrival at the job site.
- C. Follow manufacturers rigging guidelines for movement and installation of equipment.

2.11 WARRANTY

- A. Unit manufacturer to warrant it's product to be free of defects in materials and workmanship under normal use when installed and operated in accordance with factory recommendations for a period of 18 months from date of shipment or 12 months after initial equipment start-up, which ever occurs first. Equipment found to be defective should be replaced or repaired to include all parts and labor. Component parts that require periodic replacement due to normal wear such as filters, fan belts, etc. are not covered by the warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central-station air-handling units.

- B. Examine roughing-in of steam, hydronic, condensate drainage piping, and electrical to verify actual locations of connections before installation.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fans level and plumb, according to manufacturer's written instructions.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.3 DEMONSTRATION

- A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 1. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 - 2. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 237325

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SECTION 239900 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

- A. The General Conditions, Supplementary General Conditions, alternates and addenda, applicable drawings and the technical specifications, shall all apply to all work under this division.

1.2 SYSTEM DESCRIPTION:

- A. A system of DDC automatic temperature controls shall be furnished and installed as a part of this contract to give the owner a completely operable system. Acceptable manufacturers and installers shall be TAC (Control System International) by Utah Controls Inc. of Sandy, Utah as an extension of the existing DDC system.
- B. The system shall be as indicated on the drawings and specified herein. Building HVAC systems and unitary heating devices shall be entirely controlled by the DDC system. System shall include local DDC controllers mounted at each fan system, VAV box, fan-coil unit and cabinet unit heater. These local DDC controllers shall be interconnected by a 2-wire LAN (local area network) with a master/central DDC controller located in the Maintenance office. The master/central DDC controller, in turn, shall communicate with the existing campus host computer. The graphics on the computer shall display on separate, bit-mapped color screens each fan system, VAV box, cabinet unit heater, central heating system and central cooling system. Each screen shall have available for display in the appropriate location each input and output point monitored or generated by the DDC system. All digital output points shall have override capability. All screens shall be password protected so that sensitive data cannot be easily corrupted by inexperienced operators while allowing complete access to trained maintenance personnel. All of the above screens, data and features shall also be available for monitoring and modification from the Host computer located in the District offices via a Netplus router.
- C. All system and unitary controls shall be of the direct digital type (DDC). Self-tuning PID (Proportional,
- D. Integral, Derivative) control algorithms shall be applied where applicable on all applications. The control system shall be a networked, distributed intelligence system, with the control loops for each system being capable of stand-alone operation.
- E. The system shall include all control devices, valves and damper parts as called for hereinafter.

1.3 SCOPE:

- A. The control system shall consist of electronic type, direct digital controllers, input/output modules, ATC interface panels, and accessory equipment for a completely installed system of automatic temperature controls and motor starting circuit control.
- B. Replace existing 3-way chilled water control valve with new.
 - 1) Tie back to DDC control system. Sequence of controls shall be the same as the existing system is performing.
 - 2) Maintain all other existing control of chilled water coil, including mixed air sensor, discharge air sensor, freeze stat, etc.

- C. Fan replacement control operation. (Alternate No.1 and No. 2). Work as stated below includes both fan systems.
- 1) Provide enable and disable of new fan array system.
 - 2) Replace existing duct static pressure sensor and operation.
 - 3) Provide fan status for each fan of the fan array (typical of 15 fans for each array).
 - a) Alarm status of each fan shall be monitored and alarmed in any fan fails or goes into alarm. The ATC shall tie to status fan contacts (supplied by the fan manufacturer).
 - b) Contacts shall be wired in series if any single contact opens and alarm shall be generated.
 - 4) An additional fan status point shall be installed to monitor fan operation and enable ATC controls. The air handler shall maintain full operation even if any single fan shall fail. The added status point for control enable shall be via VFD status point (relay) in the VFD.
 - 5) Freeze stat, high duct static pressure (with LCD display), fire alarm safeties shall be hard wired by ATC to shut down fan system on alarm.

1.4 WORK TO BE PERFORMED BY OTHERS:

- A. Division 16 shall furnish and install all single phase and multiple phase electrical power wiring to magnetic starters, disconnect switches, VFD's and motors.
- B. The mechanical contractor shall install all valves, immersion wells and pressure taps supplied him by the ATC contractor.

1.5 INSTALLATION BY AUTOMATIC TEMPERATURE CONTROL (ATC) CONTRACTOR:

- A. The ATC contractor shall furnish and install all necessary electrical control wiring for the complete temperature control system, heating and ventilating equipment motor starting circuit controls and all electrical control interlocks for same, and for control wiring for miscellaneous HVAC equipment furnished by the Owner.
- B. The ATC contractor shall furnish & install all necessary electrical control wiring of all temperature controls, heating and ventilating equipment motor starting circuit controls, all electrical control interlocks for same and for miscellaneous packaged equipment.
- C. All line and low voltage electrical and control wiring shall be installed in EMT conduit in exposed or inaccessible areas in accordance with the latest version of the National Electrical Code, Division 16 requirements and applicable local codes. Plenum cable may be installed in accessible areas.

1.6 QUALITY ASSURANCE:

- A. Provide an unconditional ONE-YEAR parts and service warranty. This warranty shall commence at the time of demonstration of system completion of all portions of the ATC system.
- B. Emergency response by contractor shall be available 24 hrs/day 7 days/week 365 days/yr. Response time shall not be greater than 12 hours from time of call.
- C. All parts and material and their installation methods shall be in accordance with the manufacturer's recommendations and specifications. All parts and material shall be new.

1.7 SUBMITTAL AND TECHNICAL INFORMATION:

- A. Submit shop drawings (6 sets) and manufacturer's data for the following items to the mechanical engineer:

Wiring and installation diagrams.

ATC device specification sheets

Point list

Control flow diagrams, complete with all control schematics and sequences of operation.

Documentation of all software and hardware. These manuals shall be complete with installation procedures as well as start up and programming instructions. They should also contain any testing or maintenance procedures required to operate system on a continuing basis.

1.8 PROJECT COMPLETION REQUIREMENTS:

- A. Upon completion of the project, the ATC contractor shall spend the necessary time with the building's operating personnel to adequately instruct them on the operation of the system. These training sessions shall be scheduled at times convenient to the School District and shall be conducted at the project.
- B. Provide 4 copies of the project operating and maintenance instruction manuals for use during the training sessions. Each manual shall contain both a current hard copy and a CD Rom of all DDC system programming.
- C. The ATC contractor shall provide as part of his contract the on-site services of a programmer familiar with the system for an additional 24 hours, which the Engineer and/or the University may use as they see fit to fine-tune or add features to the system.
- D. The ATC contractor shall provide as part of his contract the on-site services of a technician familiar with the system to assist the air & water balance contractor in completing his portion of the project. The technician shall be available for a minimum of an additional 16 hours for this assistance.
- E. Operation & Maintenance Manuals: Provide 4 manuals in addition to those manuals specified above. These manuals shall provide descriptions of maintenance procedures for all system components, including sensors and controlled devices. They shall cover inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components. They shall include complete as-built ATC installation drawings with sequences of operation for all mechanical systems controlled by the ATC contractor. They shall each include both a hard copy & diskettes of all as-built system programming.

PART 2 - EQUIPMENT

2.1 DDC INPUT DEVICES:

- A. All DDC input devices shall provide industry standard signals and shall be compatible with the DDC controllers used.
- B. All temperature input devices shall have a rated accuracy of 1% or better.
- C. All pressure input devices shall have a rated accuracy of 2% or better. Pressure transmitters shall be selected to match the application, and shall not be damaged by pressures at five times the maximum measurable pressure.
- D. Miscellaneous input devices shall have accuracy's as individually specified.

2.2 DDC OUTPUTS:

- A. Modulating outputs shall be in accordance with industry standards and shall be compatible with the driven DDC devices.
- B. DDC digital outputs shall be either relay contact closures or Triacs rated for the application.
- C. When PWM signal transmitters are used, the Kele PWA-1A style transmitters shall be used for standardization throughout the district.

2.3 AUTOMATIC VALVES:

- A. ATC valve bodies 2" and smaller shall be screwed; larger valve bodies shall be flanged. Screwed valves shall be rated at 150 psi or greater and shall have cast iron or brass bodies. Flanged valves shall be rated at 250 psi or greater and have cast iron or steel bodies. All automatic valves shall be for DDC control application.
- B. Shut-off pressure ratings of each valve shall be as required by the application.
- C. The valves shall be manufactured by Belimo or Honeywell.

2.4 VALVE ACTUATORS:

- A. Valve actuators shall be of the gear-train type. All moving parts shall be permanently lubricated and not require addition or replacement of oil. Actuators shall meet the NEMA 3R rainproof rating and shall have an ambient temperature operating rating of -40°F to 140°F, without the addition of extra equipment. Actuators shall also carry the UL 94-5V rating for installation in return air plenums.
- B. Valve actuators shall accept the appropriate Ma, VDC or digital output signals provided by the DDC controllers.

2.5 LOCAL DDC CONTROL PANELS:

- A. Local DDC control panels shall be located near mechanical systems as necessary to provide both digital and analog input and output points as specified and/or required to achieve specified system performance.
- B. At least one INET type 7798 sub-LAN interface panel with Viewcon shall be included for local monitoring of the DDC system. This panel shall be located in the boiler room for easy access.
- C. Each local DDC control panel shall provide all control functions for the mechanical equipment specified to be controlled from that panel.
- D. Every input and output point shall be well labeled and every digital output shall have a LED indication of the position of the output relay.
- E. ATC contractor shall provide documentation of the software application program for each digital controller.
- F. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences.
- G. System acceptance shall not be completed until this documentation is provided and located in each ATC interface panel.

- H. Systems providing modulating outputs via pulse width modulation techniques shall provide within each ATC interface panel all the components required to implement the functions equivalent to an analog output.

2.6 ATC INTERFACE PANELS:

- A. ATC interface panels shall be mounted near each group of local DDC controllers other than VAV box controllers. Each panel shall be made of not less than 16 gauge steel. Panel shall have a full back plate and full hinged door such that when the door is closed, the assembly provides a completely enclosed, NEMA 1 enclosure. Panels shall be fully painted and fitted with key locks. Appropriately sized nameplates shall be used to identify all panel mounted devices. Major wiring within panels shall installed within distribution gutters (similar to Panduit). All wiring entering and leaving panels shall terminate on numbered terminal strips. All wiring within panels shall be color coded and the color shall not be changed between the terminal strip and the end destination of that wire. Panels shall contain wiring diagrams of the panel interior and associated devices. Diagrams shall identify all interior devices and shall include terminal numbers.
- B. Panels shall contain the following devices as applicable:
 - 1. Control transformers
 - 2. NEC required fusing
 - 3. Local DDC controllers (contractor option)
 - 4. NEC required grounding
 - 5. Logic relays
 - 6. 120 VAC convenience outlet
 - 7. Air pressure transmitters
 - 8. Control switches
 - 9. Pilot lights
 - 10. Terminal strips

2.7 WIRING:

- A. All wiring shall be in accordance to the latest version of the NEC electrical code
- B. All INET communications LAN wiring shall be twisted pair shielded wiring with the shield grounded in a single place on each LAN. All LAN wiring for controller LAN's and sub-LAN's shall be 18 ga. for strength. No 22 ga LAN wiring will be permitted.
- C. All wiring to AI, DI, PI, DA, and AO point types shall be shielded. The shield shall be connected to ground in the DDC panel, and shall be left disconnected but cut and taped on the sensor end.
- D. All wiring to DO points and all power wiring shall be at least 18 ga. Larger wire size may be used as required for long wire runs.
- E. All transformers for control devices shall be located in a main DDC panel and labeled as to the purpose of the transformer. This includes the power transformers for all VAV boxes.

2.8 LABELING:

- A. All ATC supplied devices shall be permanently labeled with labels indicating device name, system identifier and function within the system. All labels external of the DDC controls cabinets shall be of the engraved type.

PART 3 - SEQUENCE OF OPERATION

3.1 AIR HANDLING SYSTEMS

- A. Maintain all existing sequence of operation and provide new sequences per the scope of work.
- B. The supply fan wall shall be started from a local DDC controller through a "HAND-OFF-AUTO" switch, located on the face of the VFD panel.
- C. Fan status shall be monitored by the DDC system.
- D. In "OFF" position, fan shall be stopped. In "HAND" position the fan shall run continuously and in "AUTO" position, fan shall be on during OCCUPIED mode and cycled to maintain minimum space temperature when in the UNOCCUPIED mode.
- E. Fan system operation in AUTO and HAND mode shall be subject to freeze-stat, building fire alarm, supply duct high static pressure, and air handler door interlock switch. In AUTO mode the fan system shall be controlled by the DDC controller and subject to building optimal start-stop programs, and other conditions or logic pre-programmed into the controllers.
- F. If the fan system is shut-down, or fails to start due to abnormal conditions, a 'Safeties Alarm' shall be sent to the DDC system. When the fan is stopped under any condition, the outside air dampers shall spring return close. A manual reset, high limit pressure switch within the fan room sensing supply duct static pressure shall shut down the fan and alarm the DDC system if its 3" w.c. setting is exceeded. A manual reset averaging style low temperature freeze-stat located downstream of the pre-heating coil shall shut down the fan and alarm the DDC system if discharge temperature below 40 degrees F is exceeded. Labeled and illuminated indication shall be provided inside the DDC panel to indicate to the maintenance personnel the nature of the malfunction.
- G. A 0-5" w.c. Supply duct static pressure transmitter with its static tip located 2/3 of the way down the supply duct and acting through a DDC controller shall modulate supply fan speed to maintain the supply duct static pressure set point.
- H. The supply duct static pressure set point shall be continually adjusted by the DDC controller through a PID control loop to ensure that at least one of the VAV box dampers served by the air handler is at least 85% open. The intent of this control loop is to ensure that the supply fan VFD operates at the lowest possible speed to maintain air flow requirements on all VAV boxes. The supply duct static pressure PID control loop shall adjust the discharge set point between 0.2" and 1.5" w.c. (adjustable) as required by the VAV box dampers.
- I. The supply air temperature sensor, acting through a DDC controller, shall provide 45°F discharge air temperature low limit control of the air handling system.

END OF SECTION