PROJECT MANUAL

AHM Youth and Family Services, Inc.
In Partnership with the Town of Hebron CT

(AHM) Furnace Conversion

25 Pendleton Drive HEBRON, CT

RFP #2023-01

Engineer / Consultant:

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Principal, Progressive Engineering, Inc. 290 Burnside Avenue
East Hartford, CT 06108
Phone 860-895-8385 x121

January 2, 2023

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SECTION 00010

AHM Youth and Family Services Inc
In Partnership with the Town of Hebon CT

Legal Notice Bid

#2023-01

AHM Youth and Family Services, Inc. (AHM) is seeking sealed bids for **a conversion of the furnaces in the PAC and Health rooms located at 25 Pendleton Drive in Hebron, CT.** Bidding documents are available from the office of the Executive Director, Tressa Giordano, at 25 Pendleton Drive, Hebron, Connecticut, 06248. Ms. Giordano may be contacted via E-Mail at TressaG@ahmyouth.org or by Phone at (860) 228-9488 ext. 13. All bid documents may be found at: https://ahmyouth.org/ahm-youth-family-services-inc-ahm-is-seeking-sealed-bids-for-a-conversion-of-the-furnaces-in-the-pac-and-health-rooms/ .

All bids must be sealed and must be received at the Executive Director's Office prior to the due date. Bids will be submitted to Tressa Giordano, Executive Director, AHM Youth and Family Services, Inc, 25 Pendleton Drive, Hebron CT 06248. Proposals shall include one (1) printed original, six (6) printed copies and one (1) digital proposal.

All bids are due no later than **February 1, 2023 9a.m.** Bids must be in a sealed envelope and clearly marked **"Bid# 2023-01, Furnace Conversion, AHM Youth and Family Services, Inc., 25 Pendleton Drive, Hebron, Connecticut"** on the outside of the envelope. The bids will be opened publicly and read aloud at AHM's Office Building.

> The Specifications include (**Conversion of two furnaces, condensing units and controls from water-based to air-based equipment, removal of existing water-based components and relocation and replumbing hot water heater.)**

There will be a **Mandatory Pre-Bid meeting** at the **AHM Offices located at 25 Pendleton Drive, Hebron, CT** on **January 13, 2023 at 9:00 A.M.** All bidders are required to attend with their Subcontractors.

Any questions can be submitted via email to TressaG@ahmyouth.org. AHM will award the bid to the lowest responsible bidder and reserves the right to waive any technical defects in the bids and to reject any bids which do not conform to the terms and conditions in the bid specifications.

AHM also reserves the right to reject any or all bids and waive the informalities or irregularities in the bid procedure or bids when it is deemed by the AHM Board of Directors that it is in the best interest of AHM to reject.

After opening of Bids, all Bids shall stand available for acceptance for a period of ninety (90) days.

Bid security in the form of a certified check or bid surety bond, issued by a bonding company licensed to do business in the State of Connecticut, is required in the amount of 10% of base bid. Bid security shall be made payable to AHM Youth and Family Services, Inc.

A completed Statement of Bidders Qualifications (Section 00600) shall accompany the bid.

The successful Bidder shall furnish to AHM on the form specified, prior to the execution of the Contract, a performance and labor and material payment bond in an amount not less than one hundred percent (100%) of the Contract sum.

The classification for which Contractors are being sought is Heating, Ventilation and Air Conditioning (HVAC).

AHM is an Affirmative Action, Equal Opportunity Employer.

If applicable, the Contractor and all Sub-Contractors must comply with State Prevailing Wage Provisions (C.G.S. 31-53).

If applicable, the Contractor must comply with the CHRO-Affirmative Action requirements (C.G.S. 4a-60, 4a-60a, 4a-60g, and 46a-68b through 46a-68f, inclusive, as amended by June 2015 Special Session Public Act 15-5.

AHM reserves the right to reject or accept any or all Bids and to waive any informalities, omissions, excess verbiage or technical defects in the bidding if, in the opinion of the AHM Board of Directors, it would be in their best interest to do so.

END OF SECTION

SECTION 00100

INSTRUCTIONS TO BIDDERS AHM, HEBRON, CONNECTICUT 06248

AHM/Hebron Furnace Conversion

HEBRON, CONNECTICUT

RFP #2023-01

The following instructions and specifications shall be observed by all Bidders:

I. GENERAL CONDITIONS

INTENT: The name of the Project is AHM Furnace Conversion, 25 Pendleton Drive, Hebron, CT. The period of time that the contract would need to completed within is 30 days.

The purpose of these specifications is to obtain Sealed bids for **Furnace Conversion at AHM, 25 Pendleton Drive, Hebron, CT.**

1. **Bid Opening**

Sealed bids will be accepted by the Executive Director, AHM, 25 Pendleton Drive, Hebron, Connecticut 06248 ***no later than*** 9:00 A.M., February 1 at which time they shall be publicly opened and read. **Bids received by AHM after the date and time specified will not be accepted.**

2. **Withdrawal of Bid**

Bids may be withdrawn 90 days after bid opening if no award has been made.

3. **Award of Bid**

Award of bid shall be made to the lowest responsible bidder. The lowest responsible bidder is that person or firm whose bid to perform is lowest, who is qualified and competent to do the work, whose past performance of work is satisfactory to AHM and whose bid documents comply with the procedural requirements stated herein.

AHM/Hebron reserves the right to reject any and all bids, or part of such bid, or waive any defect, irregularity or informality of any bid when it is determined to be in the best interest of AHM.

Failure to completely fill out the bid forms could result in rejection of bid submission. If an option is not available, it should clearly be stated on the bid form.

4. **Bid Return Envelope**

Bids are to be submitted in an envelope clearly marked with the bid title, bid number and opening date so as to prevent opening a sealed bid prior to the date specified. Any bids not so marked and opened by AHM prior to the date specified shall be rejected.

6. **Bid Security**

Bid security in the form of a certified check or bid surety bond, issued by a bonding company licensed to do business in the State of Connecticut, is required in the amount of 10% of base bid. Bid security shall be made payable to AHM Youth Services.

Bid Bonds are required. Bids from vendors that have previously failed to satisfactorily complete performance on a contract with AHM, will not be considered.

7. **Acceptance of Subcontractor**

Submission of name of Subcontractor in Bid shall be deemed to constitute an acceptance by Contractor, if awarded the Contract, of Bid of such Subcontractor. Any alteration therein, after award of contract, shall be subject to approval of AHM.

8. **Changes and/or Additions**

All changes or additions to these specifications shall only be done by written communication bearing the signature of the AHM Executive Director.

9. **Questions Relating to Specifications**

Any request from prospective bidders for interpretation of meaning of specifications or other contract documents shall be made in writing to the AHM Executive Director, 25 Pendleton Drive, Hebron, Connecticut 06248, and to be given consideration must be received at least seven (7) days prior to date fixed for opening of bids. All Pre-Bid Questions must be submitted via email to tressg@ahmyouth.org no later than 2 business days following the bidder's conference. Responses will be emailed to all bidders 5 days before bid submissions are due to AHM.

If necessary, interpretations will be made in the form of a written Addendum to Bid Documents, which Addenda shall become a part of Contract. Not later than four (4) days prior to date fixed for opening of Bids, Addenda will be provided to all persons who obtained Bid Documents. Failure of any Bidder to receive any such Addenda shall not relieve bidder from any obligation under this bid as submitted.

10. **Equal Opportunity - Affirmative Action**

The successful bidder shall comply in all aspects with the Equal Employment Opportunity Act. All bidders must certify that they agree and warrant that it will not discriminate against any person or group of persons on the grounds of sex, race, color, religion, age, marital status, ancestry, national origin, past history of mental disorder, mental retardation, or physical disability or other basis in any manner prohibited by the laws or ordinances of the United States, the State of Connecticut, or AHM. Findings of non-compliance with applicable State and Federal regulations could be sufficient reason for revocation or cancellation of this contract.

AHM and the town of Hebron are Affirmative Action, Equal Opportunity Employers.

11. **Price and Discounts**

Prices bid shall not include any taxes, Local, State or Federal, as AHM is not liable. In addition to the prices bid each bidder may quote binding discounts which will be considered in making the award. All labor and materials shall be included in the prices quoted on the bid form. Tax exempt certificates are available upon request from the AHM Executive Director's Office and the town of Hebron's Finance Director.

12. **Insurance Requirements**

See Specification Section 00800 - Supplementary Conditions, Pages 13-18, Article 11 - Insurance and Bonds for description of Insurance Requirements.

13. **Non-collusive Affidavit and AHM Code of Ethics Policy**

Any act or acts of misrepresentation or collusion shall be the basis for disqualification of any bid or proposal submitted by such person or company guilty of said misrepresentation or collusion. If the bidder has made any misrepresentations or has been involved in collusion and such conduct is discovered after the execution of an Agreement with AHM, AHM may cancel the Agreement without incurring liability, penalty, or damages. The attached Non-collusive Affidavit of Proposer form and acknowledgement of the AHM Code of Ethics Policy must be submitted with the formal bid proposal.

15. **Severability**

If any terms or provisions of this bid shall be found to be illegal or unenforceable, then such term or provision shall be deemed stricken and the remaining portions of this bid shall remain in full force and effect.

16. **Trade Contractor Classification**

The classification for which contractor are being sought is HVAC.

17. **Project Funding**

The Project is paid, in part, by ARPA funds provided through the Town of Hebron.

18. **Prevailing Wage Provisions**

If applicable, the Contractor and all Sub-Contractors must comply with State Prevailing Wage Provisions (C.G.S. 31-53).

19. **CHRO-Affirmative Action Requirements**

If applicable, the Contractor must comply with the CHRO-Affirmative Action requirements (C.G.S. 4a-60, 4a-60a, 4a-60g, and 46a-68b through 46a-68f, inclusive, as amended by June 2015 Special Session Public Act 15-5.

II. TECHNICAL SPECIFICATIONS/ADDITIONAL REQUIREMENTS

1. **Responsibility**

The Contractor shall provide all labor, material and equipment that is both shown on the drawings and identified in the Project Manual and items of work that are not depicted therein, but would be reasonably inferred as being required in order to provide the Owner with a complete and totally functioning HVAC system. In addition, the Contractor shall provide at a minimum a one (1) year warranty on all labor, material and equipment. Said warranty period shall only commence upon the formal issuance of the acceptance of the work by the Owners' Consultant as being complete and functioning as intended.

2. **Completion Date**

The successful bidder must finish by no later than 30-days after onsite work begins. Failure to comply with this deadline will result in a fine of $500.00 per day for every day the vendor fails to comply with the deadline.

3. **Availability**

Regular working hours for the HVAC Conversion work within the occupied areas shall be defined as Monday, Tuesday and Thursday 9:00 A.M. to 7:00 P.M., Wednesday 9:00 A.M. to 5 P.M. and Friday 9:00A.M. Weekend and before or after weekday working hours is permitted when approved in advance by AHM.

4. **Rejection of Bids**

Any bid received that does not contain the information requested in bidder's qualifications shall be rejected. AHM reserves the right to waive certain missing information if it does not have a bearing on the overall decision to award the bid.

5. **Specifications**

See Table of Contents section of this Project Manual for description of Specification Sections.

END OF SECTION

SECTION 00300

BID PROPOSAL FORM

AHM YOIUTH AND FAMILY SERVICES INC.
HEBRON, CONNECTICUT 06248

BID # 2023-01

Opening Date: **9:00 A.M., Wednesday, February 1, 2023**

Executive Director's Office
AHM Youth and Family Services, Inc.
25 Pendleton Drive
Hebron, CT 06248

In accordance with AHM Specifications, the undersigned agrees to the following:

(Include the specifications again here and create lines for the cost proposal to be listed.)

References (if necessary)

We have done work or provided services for the following municipalities and dates:

1 _____

2 _____

3 _____

SUBMITTED BY:

(Bidder's full Company Name)……..

(Bidder's full address)……

……

(Bidder's telephone and fax numbers)……

(Bidder's email address)…….

1. OFFER

Having examined the Place of The Work and all matters referred to in the Instructions to Bidders and the Contract Documents prepared by Progressive Engineering Inc. for the

above-mentioned project, we, the undersigned, hereby offer to enter into a Contract to perform the Work of the Base Bid for the Sum of:

$…….dollars (……...)
(amount in words) (amount in figures)

2. UNIT PRICES

We propose and agree that the following unit prices for work performed in accordance with Contract Documents, measured in place, shall be used to compute cost to AHM should amount of work required by the Contract Documents be changed by order of AHM. Unit prices include all necessary material, overhead and profit, and applicable taxes.

The unit price amounts will be added or deducted from the Contract Sum by Change Order. For work added to Contract, these unit prices include all costs, overhead and profit for all parties involved including the Contractor and Subcontractors. For work deleted from Contract, credit to AHM for such work shall be computed on the basis of unit price.

Schedule of Allowances included in Base Bid

ITEM NO.	UNIT	PRICE

3. ACCEPTANCE

This offer shall be open to acceptance and irrevocablefor ninety (90) days from the bid closing date.

If AHM accepts this bid within the time period stated above, we will:

- Execute the Agreement within ten days of receipt of notice of acceptance of this bid.
- Furnish the required bonds and insurance certificates within ten (10) days of receipt of notice of acceptance of this bid in the form described in the Supplementary Conditions.
- Commence work within ten days after award of Contract and written Notice to Proceed.

If this bid is accepted within the time stated, and we fail to enter into an Agreement or we fail to provide the required Bonds, the Bid Security shall be forfeited as damages to AHM by reason of our failure.

In the event our bid is not accepted within the time stated above, the required Bid Security shall be returned to the undersigned, in accordance with the provisions of the Instructions to Bidders; unless a mutually satisfactory arrangement is made for its retention and validity for an extended period of time.

We understand AHM reserves the right to accept any Bid or reject any or all Bids and to waive any informality in the Bidding.

5. CONTRACT TIME

If this Bid is accepted, we will be required to complete the Work in accordance w following schedule:

Final Punch List work shall be complete, all temporary facilities removed, and s later than 30-days after work is initiated or as designated by AHM.

6. ADDENDA

The following Addenda have been received. The modifications to the Bid below have been considered and all costs are included in the Bid Sum.

Addendum No. ……. Dated ……..

Addendum No. ……. Dated ……..

Addendum No. ……. Dated ……..

7. APPENDICES

In accordance with the Instructions to Bidders, we include the following required Appendices concurrent with Bid submission. The information provided shall be an integral part of our Bid.

Bid Bond - Section 00510

Statement of Bidders Qualifications – Section 00600

Non-Collusive Affidavit of Proposer – Section 00860

8. The undersigned is familiar with the conditions surrounding this call for bids, is aware that AHM reserves the right to reject any and all bids, and is submitting this bid without collusion with any other person, individual or corporation.

_____	_____
Signature	Witness
_____	_____
Printed Name & Title of Signer	Date
_____	_____
Company Name	Phone
_____	_____
Address	Fax
_____	
Town/City State Zip	

END OF SECTION

SECTION 00500

AGREEMENT FORMS

PART 1 GENERAL

1.01 Standard AIA Document Forms to be used for this Contract are as follows (note: provide latest edition of each form listed below):

A101-2017 Standard Form of Agreement Between Owner and Contractor

A312 Performance Bond and Labor and Material Payment Bond

G702 Application for Payment

G703 Certificate for Payment

G705 Certificate of Insurance

G706A Contractor's Affidavit of Release of Liens

G707 Consent of Surety Company to Final Payment

END OF SECTION

SECTION 00510

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned

_____ as Principal; and _____ as Surety, are hereby held and firmly bound unto **AHM Youth and Family Services, Inc. of Hebron, Connecticut,** in the penal sum of _____ Dollars ($_____), for the payment of which, well and truly to be made we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

Signed this _____ day of _____, 20_____

The condition of the above obligation is such that whereas the Principal has submitted to **AHM of Hebron, Connecticut,** a certain Bid, attached hereto and hereby made a part hereof, to enter into a Contract in writing, for the _____

NOW, THEREFORE,

a) If said Bid shall be rejected, or, on the other hand,

b) If said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached thereto (properly completed in accordance with said Bid) and shall furnish a bond for his faithful performance of said Contract, and shall in all other respects perform the agreement created by the acceptance of said Bid.

Then this obligation shall be void; otherwise, the same shall remain in force and effect, it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of the said Surety and its bond shall be in no way impaired or affected by any extension of the time within which AHM may accept such Bid; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

_____ Seal)

Principal Surety

By _____

END OF SECTION

SECTION 00600

STATEMENT OF BIDDER'S QUALIFICATIONS

Submitted by:

_____
Name

_____
Address

A Corporation _____ A Co-Partnership _____ An Individual _____

How many years has your organization been in business:

As a General Contractor? _____ As a Subcontractor? _____

How many years has it been in business under its present name? _____

Does your firm conform to the EEO requirements? Yes _____ No _____ If a Corporation: Date of Incorporation: ____ State of Incorporation ____ Name, Title and Address of all principal officers:

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

If a Co-Partnership: Date of Organization: _____

Date, Title and Address of all Partners:

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

BONDING COMPANY _____

Have you ever defaulted on a Contract?: _____ If so, attach separate statement listing location and circumstances.

Bidder may be required to submit financial information at AHM's request.

Remarks:

_____

_____

List projects of similar size, specification (HVAC conversion) and character your organization has completed within the past three (3) years for the AHM's references:

Project (Name & Address)	Owner (Town of Hebron) (Name & Address)	Contract Architect	Date of Amount	Completed on Time Completion	Work Done With Own Force (Yes or No)	% of Work	Trades

Attach separate statement if necessary to fully describe qualifications for this work.)

Name and experience of key personnel to be associated with this project.

Person in Charge			Superintendent			Foreman (men)	
Name		Experience	Name		Experience	Name	Experience

Trade Contractor to identify what their Worker's Compensation Modification Factor is:

_____

_____

_____

_____

Bidder to identify if they have been cited by OSHA for any safety infractions in the last five (5) years:

_____

_____

_____

_____

State of:)

) ss:

County of:) being duly sworn deposes and says that his is of and that answers to the foregoing questions and all statements therein contained are true and correct.

Sworn to before me this day of 20 _____

Notary Public:

My Commission Expires:

SECTION 00800 SUPPLEMENTARY CONDITIONS

THE TERM OWNER SHALL BE CHANGED TO AHM FOR THE PURPOSE OF THIS CONTRACT AND ALL DOCUMENTS PERTAINING TO THE FURNACE CONVERSION PROJECT.

GENERAL

A. These Supplementary Conditions amend or supplement the General Conditions of the Contract for Construction (AIA Document A201, 2017 Edition) and other provisions of the Contract Documents as indicated below. All provisions, which are not so amended or supplemented, remain in full force and effect.

B. The terms used in these Supplementary Conditions, which are defined in the General Conditions of the Contract for Construction (AIA Document A201, 2017 Edition), have the meanings assigned to them in the General Conditions.

C. The Contractor shall be an Equal Employment Opportunity Employer.

ARTICLE 1 - GENERAL PROVISIONS

1.1 BASIC DEFINITIONS

Add the following Subparagraph to Paragraph 1.1:

"1.1.9 CONSULTANT - The term Architect shall be changed to HVAC Consultant or Consultant for the purpose of this Contract and all documents pertaining to the roof project. The term Architect means the HVAC Consultant, Consultant, or his representative."

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

Add the following to the end of Subparagraph 1.2.1:

"In the event of conflicts or discrepancies among the Contract Documents, interpretations will be based on the following order of priorities:

.1 The Agreement;

.2 Addenda, with those of later date having precedence over those of earlier date;

.3 The Supplementary Conditions;

.4 The General Conditions of the Contract for Construction; and

.5 Drawings and Specifications.

In the case of an inconsistency between Drawings and Specifications of within either Document not clarified by addendum, the better quality and greater quantity of work shall be provided in accordance with the Consultant's interpretation."

Add the following Subparagraph to Paragraph 1.2:

"1.2.4 The Sections of Division 1 - General Requirements of the Specifications shall govern the execution of all Sections of the Specifications."

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

Add the following to the end of Subparagraph 1.5.1:

"Reproduction or use of the Contract Documents without the written consent of the Consultant is strictly prohibited."

ARTICLE 2 - OWNER

2.3 INFORMATION AND SERVICES REQUIRED OF THE OWNER

Add the following Clause to Subparagraph 2.3.4:

"2.3.4.1 Data concerning site, size, access to site, staging and storing, present obstructions on or near the site, conditions of existing adjacent structures, locations and depths of sewers, conduits or pipes, gas lines, position of sidewalks, curbs and pavements, and other data concerning site conditions has been obtained from sources Owner believes reliable. Accuracy of such data, however, is not guaranteed and is furnished solely for accommodation of the Contractor. Use of such data is made at Contractor's sole risk and expense."

Delete Subparagraph 2.3.6 and substitute the following:

"2.3.6 The Owner shall furnish to the Contractor up to three (3) sets of Construction Documents. Additional sets will be furnished at the cost of reproduction, postage, and handling."

Add the following Subparagraph to Paragraph 2.3:

"2.3.7 The Owner may, at its discretion, provide a Project Representative whose duties shall be those defined in Exhibit A of the General Conditions of the Contract for Construction, AIA Document B352, Duties, Responsibilities and Limitations of Authority of full-time Project Representative, including the modifications thereto."

2.5 OWNER'S RIGHT TO CARRY OUT THE WORK

Delete the first sentence of Paragraph 2.5 and substitute the following:

"If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a three-day period after receipt of written notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may after such three-day period give the Contractor a second written notice to correct such deficiencies within a three-day period."

ARTICLE 3 - CONTRACTOR

3.1 GENERAL

Add the following to the end of Subparagraph 3.1.2:

"Should a conflict occur within and between sections of the Contract Documents, the Contractor shall be deemed to have estimated the more expensive way indicated and the Consultant shall have the option of incorporating any component or directive specified into the work, without regard to cost."

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

Add the following to the end of Subparagraph 3.2.2:

"Contractor shall give notice of discovered error or discrepancy to Consultant immediately and in writing for interpretation and correction deemed necessary in satisfactory performance of the Work.

In the event of discrepancies within the Contract Documents:

3.2.1 Addenda shall modify the Contract Documents.

3.2.2 Stated dimensions shall take precedence over implied dimensions (DO NOT SCALE DRAWINGS).

3.2.3 Large-scale drawings shall take precedence over smaller scale drawings.

3.2.4 The Consultant shall clarify inconsistencies in specifications without regard to cost.

3.2.5 Notice of any discrepancy shall be forwarded in writing to the Consultant within twenty-four (24) hours. Consultant shall issue a revision to the Contract Documents within one (1) week of notification.

3.2.6 The Contractor is responsible for measuring the work. Dimensions on the drawings are offered as a guide only."

3.4 LABOR AND MATERIALS

Delete Subparagraph 3.4.2 and substitute the following Subparagraph and Clauses:

"3.4.2 After the Contract has been executed, the Consultant will consider a formal request for the substitution of products in place of those specified only under the conditions set forth in the General Requirements, Division 1 of the Specifications. By making requests for substitutions, the Contractor;

3.4.2.1 represents that the Contractor has personally investigated the proposed substitute product and determined that it is equal or superior in all respects;

3.4.2.2 represents that the Contractor will provide the same warranty for the substitution that the Contractor would for that specified;

3.4.2.3 certifies that the cost data presented is complete and includes all related costs under this Contract except the Consultant's redesign costs, and

waives all claims for additional costs related to the substitution which subsequently became apparent;

3.4.2.4 shall coordinate the installation of the accepted substitution, making such changes as may be required for the Work to be complete in all respects; and

3.4.2.5 shall make requests for substitutions within 30 days of execution of the Contract."

3.5 WARRANTY

Add the following Subparagraphs to Paragraph 3.5:

"3.5.3 The Contractor shall guarantee all materials and workmanship for a period of one (1) year from the date of Substantial Completion of the building(s).

3.5.4 As required by Contract Documents, Contractor shall obtain the written warranty from manufacturer and installer and deliver it to the Consultant at the time when work of warranty is delivered and installed.

3.5.5 Unless otherwise specified, Contractor shall warrant (guaranty) all work against defects resulting from the use of material, workmanship, or equipment which is inferior, defective, or not in accordance with the terms of the Contract. This warranty shall be in effect for one (1) year from the date of issuance of the Certificate of Substantial Completion for the Project or the designated portions thereof. This warranty shall be in addition to, and not a substitute for, any other rights of the Owner under the Contract Documents or existing in law."

ARTICLE 3.6 - TAXES

Add the following Subparagraph to Paragraph 3.6:

"3.6.1 Contractor shall include no amount for State Sales Tax or Federal Excise Tax on products purchased for this Project. The Owner will furnish tax exemption form."

ARTICLE 3.7 - PERMITS, FEES, NOTICES, AND COMPLIANCE WITH LAWS

Add the following Subparagraph to Paragraph 3.7:

"3.7.6 Contractor shall pay costs of all permit fees. Contractor shall pay costs charged by utility companies for service connections, inspections and tests, and related utility company fees normally assessed as part of the construction process."

ARTICLE 3.8 - ALLOWANCES

Add the following to the end of Clause 3.8.2.2:

"...except when installation is specified as part of the allowance in the General Requirements, Division 1, of the Specifications."

ARTICLE 3.9 - SUPERINTENDENT

Add the following Subparagraphs to Paragraph 3.9:

"3.9.4 Contractor's site representative shall be satisfactory to the Owner, based on credentials to be submitted by Contractor, and such representative shall be changed only with consent of the Owner. If for any reason Contractor's representatives are unsatisfactory to the Owner, and upon request of the Owner, other qualified representatives shall be substituted.

3.9.5 Contractor shall designate Superintendent, foreman, or other competent personnel as standby emergency repair crew in case of after-hours leaks or other similar emergency. Submit a minimum of two (2) names with telephone numbers that are available during non-business hours in the event of an emergency."

ARTICLE 3.12 - SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

Change Subparagraph 3.12.7 to include the following:

Third line, change "approved" to "reviewed."

Change Subparagraph 3.12.8 to include the following:

Second line, change "approval" to "review."

Seventh line, change "approval" to "review."

ARTICLE 3.15 - CLEANING UP

Add the following Subparagraph to Paragraph 3.15:

"3.15.3 If the Owner finds, in his opinion, that waste materials or debris are adversely affecting the function of the facility, he shall give the Contractor written notice to remove same. If the Contractor fails to remove it within forty-eight (48) hours of receipt of notice, the Owner shall do so and the cost thereof shall be charged to the Contractor. The area shall be inspected and cleaned at the end of each work day."

ARTICLE 3.17 - ROYALTIES, PATENTS AND COPYRIGHTS

Add the following to the end of Paragraph 3.17:

"In the event of legal action arising out of such infringement for which Contractor is responsible and which action has the effect of stopping the Work, the Owner may require the Contractor to substitute other products of like kind as will make it possible to pursue and complete the Work. Costs and expenses caused thereby shall be borne by the Contractor."

ARTICLE 4 - ARCHITECT

4.2 ADMINISTRATION OF THE CONTRACT

Add the following Clause to Subparagraph 4.2.2:

"4.2.2.1 Where it is stated in the Documents that the Contractor shall pay for services of the Consultant, such payment shall be at a rate of two and one half (2.5) times the Consultant's Direct Personal Expense plus any expenses incurred in providing such services. Direct Personal Expense is defined as the direct salaries of the Consultant's personnel engaged on the Project and the portion of the cost of their mandatory and customary contributions and benefits related thereto, such as employment taxes and other statutory employee benefits, insurance, sick leave, holidays, vacations, pensions, and similar contributions and benefits."

Change the first two lines of Subparagraph 4.2.7 to read as follows:

"The Consultant will review and take appropriate action upon Contractor's submittals..."

Change the first two lines of Subparagraph 4.2.10 to read as follows:

"The Owner may, at its discretion, provide a full-time Project Representative to…"

Add the following Clause to Subparagraph 4.2.13:

"4.2.13.1 The Owner/Consultant, whose decision shall be irrevocable, shall select all finishes, i.e., color and texture."

ARTICLE 5 - SUBCONTRACTORS

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

Delete the first sentence of Subparagraph 5.2.1 and substitute the following:

"Concurrently with submission of bids, the Contractor shall submit in writing a List of Subcontractors with the names of persons or entities (including those who are to furnish specially fabricated materials or equipment) proposed for each principal portion of the Work."

Add the following Clause to Subparagraph 5.2.1:

"5.2.1.1 To facilitate and expedite the investigations of proposed Subcontractors, Sub-subcontractor, fabricators and suppliers of materials and equipment, the Contractor, at request of the Owner, shall submit a statement in writing in sufficient detail to establish that each has the capability, experience, reliability and uncommitted productive capacity to carry out the Work to be performed pursuant to each such proposed subcontract, sub-subcontract or procurement contract, in a manner consistent with the requirement of this

Contract. All such submittals shall include a fully detailed analysis of principal personnel and organization, financial condition, construction plant, equipment and facilities."

Add the following Subparagraph to Paragraph 5.2:

"5.2.5 The Contractor shall contract with Subcontractors whom are satisfactory to the Owner, based on credentials to be submitted by the Contractor, and such Subcontractors shall be changed only with consent of the Owner. If for any reason Subcontractors are unsatisfactory to the Owner, and upon request of the Owner, other qualified representatives shall be substituted."

Delete the first two lines of Paragraph 5.3 and substitute the following:

"By an appropriate written agreement, a copy of which shall be forwarded to the Consultant under the provisions of Article 5.2.1 above, the Contractor shall require each…"

ARTICLE 7 - CHANGES IN THE WORK

7.1 GENERAL

Add the following to the end of Subparagraph 7.1.1:

"The Contractor's proposal for a change in the Work shall be itemized completely and shall include material costs and quantities; labor wages, time, insurance and pensions; equipment rental, other than small tools. There shall be no extension in the Contract Time unless the Contractor can effectively demonstrate that the work delayed is on the critical path of Project Schedule."

7.2.2 CHANGE ORDERS

Add the following to Paragraph 7.2:

"Subparagraphs 7.3.3 and 7.3.7 apply to Change Orders as well as Change Directives."

7.3 CONSTRUCTION CHANGE DIRECTIVES

Change Clause 7.3.3.2 to read as follows:

"7.3.3.2 Unit prices applicable to this Project shall be Contractor's total unit price and shall include overhead and profit as stated in the Contract Documents or subsequently agreed upon;"

Add the following Clauses to Subparagraph 7.3.3:

"7.3.3.5 A 'reasonable allowance for overhead and project' for work solely performed by the Contractor, as indicated above and utilized in the compilation of cost and credit figures in Article 7.3.3., shall not exceed fifteen (15%) of the net cost of the work.

7.3.3.6 For work performed by Subcontractors, cost to Owner may include an allowance for Subcontractor's overhead and profit not to exceed fifteen percent (15%) of Subcontractor's net cost, plus an allowance for General

Contractor's overhead and profit not to exceed five percent (5%) of the Contractor's net cost."

Change Subparagraph 7.3.4 to include the following:

In the third line, delete the words, "an amount for overhead and profit" and substitute "an allowance for overhead and profit in accordance with Subparagraph 7.3.10."

Add the following Subparagraph and Clauses to Paragraph 7.3:

"7.3.11 In Subparagraph 7.3.7, the allowance for the combined overhead and profit included in the total cost to the Owner for a change in the Work shall be based on the following:

7.3.11.1 For the Contractor, for work performed by the Contractor's own forces: fifteen percent (15%) of the net cost.

7.3.11.2 For the Contractor, for work performed by one or more Subcontractors: ten percent (10%) of the combined net cost of additions and deductions of the Subcontractors.

7.3.11.3 For each Subcontractor, for work performed by the Subcontractor or his Subcontractors: fifteen percent (15%) of the combined net cost of their work.

7.3.11.4 In any event, the total allowance for overhead and profit for a change in the Work shall not exceed fifteen percent (15%) of the net cost of the work.

7.3.11.5 For a change in the Work resulting in a net deduction in cost, there shall be no allowance for overhead and profit.

7.3.11.6 Cost to which overhead and profit is to be applied shall be determined in accordance with Subparagraph 7.3.7.

7.3.11.7 Proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, materials and Subcontracts. Labor and materials shall be itemized in the manner prescribed above. Where major cost items are Subcontracts, they shall be itemized also. In no case will a change be approved without itemization."

ARTICLE 8 - TIME

8.1 DEFINITIONS

Add the following Subparagraph to Paragraph 8.1:

"8.1.5 Contract Time is identified in Document 00300, Bid Form - Stipulated Sum."

8.2 PROGRESS AND COMPLETION

Add the following Subparagraphs to Paragraph 8.2:

"8.2.4 Except in the event of an emergency, no substantial field operations shall be performed outside of regular working hours without prior written approval of the Consultant and Owner. The Contractor shall not be entitled to additional compensation for work performed outside of regular working hours.

8.2.5 Regular working hours for the HVAC Conversion work within the occupied areas shall be defined as Monday, Tuesday and Thursday 9:00 A.M. to 7:00 P.M., Wednesday 9:00 A.M. to 5 P.M. and Friday 9:00A.M. Weekend and before or after weekday working hours is permitted when approved in advance by AHM."

8.3 DELAYS AND EXTENSIONS OF TIME

Add the following Clauses to Subparagraph 8.3.2:

"8.3.2.1 Claims of delay and requests for extension of time shall set forth in detail the circumstances of such claim, the dates upon which delay began and ended, and the number of days' extension of time requested. The Contractor shall provide supporting documentation as the Consultant may require, including a revised Construction Schedule indicating the effect of the circumstances that form the basis for the claim.

8.3.2.2 The Contractor shall not be entitled to an extension of time for each and every one of a number of causes that have a concurrent and interrelated effect on the Work.

8.3.2.3 Claims for extension of time arising out of authorized changes in the Work shall be made in writing prior to or concurrent with the submission of the Contractor's proposal for such change. No extension of time arising out of changes in the Work will be granted after the date upon which the Contractor is authorized to proceed with such change unless specific provision for an extension of time has been incorporated in the authorization.

8.3.2.4 Any additional cost to the Contractor arising from such change shall be included in the amended Contract Sum set forth in such Change Order. No claim for damages for delay, arising from such change in the Work, shall be recognized or be deemed valid."

Add the following Clause to Subparagraph 8.3.3:

"8.3.3.1 Extension of Contract Time shall be the Contractor's sole remedy for delay of any kind. The Contractor expressly waives any and all rights to claim damages for any delay."

ARTICLE 9 - PAYMENTS AND COMPLETION

9.3 APPLICATIONS FOR PAYMENT

Add the following sentence to the end of Subparagraph 9.3.1:

"Form of Application for Payment shall be a notarized AIA Document G702, Application and Certificate for Payment, 1992 Edition; supported with AIA Document G703, Continuation Sheet, 1992 Edition."

Add the following Clauses to Subparagraph 9.3.1:

"9.3.1.3 The period covered by each Application for Payment shall be one calendar month ending on the 20th of each month. Provided a proper Application for Payment is submitted in accordance with the Documents not later than the 20th of the month, the Owner shall make payment to the Contractor not later than 30 days after approval of the Certificate for Payment by AHM. If an Application for Payment is received by the Consultant after the application date fixed above, payment shall be made by the Owner not later than 60 days after approval of the Certificate for Payment by AHM.

9.3.1.4 During progress of the Work, the Owner will pay the Contractor ninety-five percent (95%) of the total amount of each payment due. The remaining five percent (5%) will be retained by the Owner until the Work is completed and accepted in accordance with the Contract Documents. In addition to the 5% Retainage that will be held on all progress payments, an additional two percent (2%) will be withheld as per State Statute until such time as CHRO has accepted the Trade Contractors Affirmative Action Plan."

Delete the first two sentences of Subparagraph 9.3.2 and substitute the following:

"Unless otherwise specifically approved, the Owner will pay only for material and equipment delivered and incorporated in the Work. If approved in advance by the Owner, payment may be similarly made for material and equipment suitably stored on site or off at a location agreed upon in writing."

Add the following Clauses to Subparagraph 9.3.2:

"9.3.2.1 In addition, for consideration of payment for stored products:

(a) Storage shall be agreed upon in advance, prior to shipment.

(b) Location of storage shall be agreed upon in advance.

(c) Contractor shall be responsible for, and pay costs of, the verification and inspection of storage.

9.3.2.2 Schedule of Values and Construction Schedule will be considered in decision on any specific request for payment for storage.

9.3.2.3 Payment for material and equipment delivered and stored shall not relieve the Contractor of responsibility for furnishing equipment and material required for the Work in the same manner as if such payment were not made."

Add the following Subparagraph and Clauses to Paragraph 9.3:

"9.3.4 If payment for stored products is approved, the Contractor shall furnish, with Application for Payment, an invoice establishing value of material and equipment stored along with a statement of amount to be paid vendor.

9.3.4.1 Such stored items are subject to prior approval for storage and to inspection by the Consultant and Owner before payment will be recommended.

9.3.4.2 Contractor shall furnish Certificates of Insurance in accordance with Contract Documents for the full value of the items stored. Certificate of Insurance shall name the Owner as additional insured. Insurance shall be maintained until items are incorporated in the Work. The Trade Contractor will also furnish a "Bill of Sale" to AHM."

Change second and third lines in Subparagraph 9.4.1 to read as follows:

"…Owner, with a copy to the Contractor, the Contractor's Application for Payment (AIA Document G702) properly certified for payment, in triplicate, for such amount as the Consultant determines is properly…"

Add the following Clause to Subparagraph 9.4.1:

"9.4.1.1 If the Contractor, in submitting the Application for Payment, does not use the specified forms or submits the Application for Payment without proper notarization, the Consultant will return the Application for Payment without action."

9.6 PROGRESS PAYMENTS

Add the following to Subparagraph 9.6.1:

"The Owner shall forward one (1) copy of both the standard requisition form and the Application and Certificate for Payment, properly signed, to the Consultant and to the Contractor for record."

Add the following Clause to Subparagraph 9.6.2:

"9.6.2.1 Contractor shall furnish, with Application for Payment, satisfactory evidence of payment to vendors of products placed in approved storage. This shall be done within 30 days after date of progress payment that includes payment for such stored items. Satisfactory evidence of payment shall be one of the following:

(a) Contractor's cancelled check in correct amount with identification of invoices paid.

(b) A letter or telegram from vendor with authorized signature stating amounts and invoices paid.

(c) A receipted invoice stating amount paid.

(d) Partial and/or final lien waivers from the Supplier and/or Vendors would also be an acceptable document to indicate that payment has been made to them by the HVAC Trade Contractor."

9.7 FAILURE OF PAYMENT

Add the following Subparagraph to Paragraph 9.7:

"9.7.1 If the Contractor, in Application for Payment, does not submit evidence of payment to vendor for material and equipment stored, the Consultant will recommend deduction of the amount previously allowed for the items stored from the current or subsequent Application for Payment."

ARTICLE 9.8 - SUBSTANTIAL COMPLETION

Add the following to Subparagraph 9.8.2:

"Certificate of Substantial Completion shall be standard AIA Document G704; three (3) copies of document shall be circulated for signature and distributed for record."

ARTICLE 10 - PROTECTION OF PERSONS AND PROPERTY

10.2 SAFETY OF PERSONS AND PROPERTY

Change Clause 10.2.1.1 to include the following:

"10.2.1.1 Owner's employees, the general public, and employees…"

10.3 HAZARDOUS MATERIALS AND SUBSTANCES

Add the following Clause to Subparagraph 10.3.1:

"10.3.1.1 In the event the Contractor encounters materials believed to be hazardous that are not a part of the abatement Work included in this Contract, the Contractor shall, upon recognizing the

condition, immediately stop work in the affected area and report the condition to the Owner and Consultant immediately, and thereafter in writing."

10.4 EMERGENCIES

Add the following Subparagraph to Paragraph 10.4:

"10.4.1 The Contractor shall promptly notify insurers as applicable, the Consultant and the Owner of the nature of the emergency. Immediately thereafter, the Contractor shall submit to the Consultant a written report including description of circumstances of the emergency and the details of actions taken."

ARTICLE 11 - INSURANCE AND BONDS

11.1 CONTRACTOR'S INSURANCE AND BONDS

Delete Subparagraphs 11.1, 11.2, 11.3, 11.4, and 11.5 and substitute the following AHM's Insurance Requirements:

"11.1 INSURANCE REQUIREMENTS

All insurance coverage shall be provided by the Contractor and by or for any of their Subcontractors at no additional expense to AHM. The scope and limits of insurance coverages specified are the minimum requirements and shall in no way limit or exclude AHM from additional limits and coverage provided under the Contractor's policies and/or their Subcontractors' policies. The Contractor shall either require each of their Subcontractors to produce identical insurance coverage requirements as detailed hereinafter or the Contractor shall secure the coverage of all Subcontractors under the Contractor's own policies.

The Contractor and/or Subcontractors shall be responsible for maintaining the stated insurance coverage in force for the life of the Contract with insurance carriers licensed and authorized to underwrite such insurance in the State of Connecticut.

The type and limits of insurance coverage shall not be less than the type and limits designated herein, and the Contractor and/or Subcontractors agree that the coverage or the acceptance by AHM of Certificates of Insurance indicating the type and limits of insurance shall in no way limit the liability of the Contractor and/or Subcontractor to any such type and limits of insurance coverage.

The insurance coverage hereinafter afforded by the Contractor and/or Subcontractor shall be primary insurance, except when stated to apply in excess of or contingent upon the absence of other insurance. The amount and type of insurance shall not be reduced by the existence of other insurances held by AHM.

The Contractor and/or Subcontractor shall provide coverages that are not impaired or the aggregate is not to be impaired by any other risk, past or present, and the limits required shall be fully available to AHM if depleted below the required levels during the course of the contract and/or any extensions thereto.

The Contractor and/or Subcontractor shall not commence work under the terms of this contract until they have obtained the liability insurance coverage required by this article and have filed Certificates of Insurance on same with AHM and AHM has approved the Certificates of Insurance and the represented coverage.

Each Certificate of Insurance shall include the following pertinent information:

- Name of Insurance Carrier writing policy
- Name Insured
- Address of Named Insured
- Description of coverage (Workers' Compensation certificates should evidence the state(s) of operation including Connecticut)
- Policy Periods (effective and expiration dates)
- Limits of liability and terms
- Brief description of operations performed and property covered
- Name and address of certificate holder
- Authorized agent's name and address
- Date and signature of the issuing agent (original only)
- All additional named insured endorsement
- All cross-liability endorsements
- All indemnification and hold harmless agreements (must be supported by Contractual Liability Insurance)
- 60 day written notice provision
- A deletion of any disclaimer wording relative to providing the holder with notice of cancellation- example: "endeavor to" provide notice or wording to the effect the Carrier will not be responsible should notice not be furnished.

Each insurance policy (with the exception of OPC shall contain an endorsement naming AHM as an Additional Insured, evidence of a Cross Liability endorsement so that each insured's interests are considered and treated separately in the case of claims between the insureds, and an endorsement providing a 60 Day advance Notification to AHM in the event of any material change, modification, cancellation, or non-renewal of insurance coverage.

The Contractor and/or Subcontractors shall include a waiver of subrogation rights, on all insurance policies, so that AHM cannot be sued by the Contractor's insurer to recover any payments made on behalf of the Contractor and/or Subcontractor.

All insurance policies provided by the Contractor and/or Subcontractors shall include an endorsement indicating that any breach of warranty, by the named insured, will not be imputed to another insured.

During the course of execution of the work, whenever there is a lapse in the insurance requirements as stated herein, through cancellation, expiration, failure to renew, or any other cause, AHM shall order the cessation of all construction activities until such time as the insurance requirements are complied with. The Contractor shall have no claim or claims whatever against AHM or other parties to the contract.

The Contractor and their Subcontractors shall indemnify and save harmless AHM and all additional named insured and all appointed or elected officers, officials, directors, committee members, employees, volunteer workers, commissioners, and any affiliated, associated, or allied entities and/or bodies of, or as may be participated in by AHM, or as may now or hereinafter be constituted or established from and against all claims, damages, and losses and expenses including attorney's fees arising out of or resulting from the performance of the work under this contract, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to, or destruction of tangible property, including the loss of use resulting there from; and is caused in whole or in part by any negligent or willful act or omission of the Contractor, and their Subcontractors, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

The Contractor and their Subcontractors shall, during the execution of the work, take necessary precautions and place proper guards for the prevention of accidents; shall set up all night suitable and sufficient lights and barricades; shall fully comply with the latest revisions of the Occupational Safety and Health Act of 1970 and all other Federal, State and Local Regulations, including any and all amendments, revisions, and additions thereto, and shall indemnify and save harmless AHM and their additional named insured and their employees, officers, agents from any and all claims, suits, actions, fines, fees, damages, and costs to which they may be put by reason of death or injury to all persons and/or for all property damage of another resulting from non-compliance, unskillfulness, willfulness, negligence, or carelessness in the execution of the work, or in guarding or protecting the same, or from any improper methods, materials, implements or appliances used in execution of the work, or by or on account of any direct or indirect act or omission of the Contractor of their Subcontractors or their employees or agents, and whether or not active or agents concurrent negligent acts or omissions by the employees, officers, or agents of AHM and the additional named insured as may have directly or indirectly caused or contributed thereto.

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

The Contractor shall take all reasonable precautions for the safety of, and shall

provide all reasonable protection to prevent damage, injury, or loss to; 1) all employees on the work and all other persons who may be affected thereby; 2) all the work and all the materials and equipment to be incorporated therein, whether in storage in or on the site, under the care, custody, or control of the Contractor or any of their Subcontractors; and 3) other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designed for removal, relocation, or replacement in the course of construction.

The Contractor shall erect and maintain, as required by existing conditions and progress of the work, all reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards promulgating safety regulations and notifying Owners and users of adjacent utilities.

The Contractor and/or Subcontractor shall give all notices and comply with all applicable laws, ordinances, rules, regulations, and lawful orders for any public authority bearing on the safety of persons or property or their protection from damage, injury, or loss.

When the use or storage of explosives or other hazardous materials or equipment is necessary for the execution of work, the Contractor and/or their Subcontractors shall exercise the utmost care and shall carry on such activities under the supervision of properly qualified personnel.

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

In any emergency affecting the safety of persons or property, the Contractor shall act to prevent threatened damage, injury, or loss.

The Contractor, Subcontractor, and their insurer(s) shall waive governmental immunity as a defense and shall not use the defense of governmental immunity in the adjustment of claims or in the defense of any suit, action or claim brought against AHM. Nothing shall limit AHM from utilizing the defense of governmental immunity.

INSURANCE REQUIREMENTS

A. Insurance:

1. AHM reserves the right to waive any portion or adjust downward the amount of insurance required depending on the exposures to AHM. The Trade Contractor shall furnish a certificate of insurance to AHM’s Executive Director or his/her designee for the following insurance coverage within ten (10) days from contract execution. All insurance coverage shall be written with an insurance company licensed to conduct business in the State of

Connecticut. Insurance coverage shall remain in full force for the duration of the contract term including any and all extensions. Such certificate of insurance shall specify that AHM will receive thirty (30) days written notice of any cancellation, non-renewal or reduction in coverage and limits originally provided.

2. Any aggregate limit shall apply per project. Trade Contractor's insurance shall be primary over any other valid and collectible insurance. Any deductibles are the sole responsibility of the Trade Contractor. Such policy shall name AHM as "additional insured".

3. **Commercial General Liability** including Premises-Operations, Independent Consultants or Sub-Consultants, Sub-Trade Contractors and Sub-Sub Trade Contractors, Blanket Contractual, Products and Completed Operations, Broad Form Property Damage:

   $1,000,000 Property Damage per Occurrence

   $1,000,000 Combined Single Limit

   Property damage Liability for the following hazards if applicable: X

   (Explosion), C (Collapse), U (Underground damage).

4. **Comprehensive Automobile Liability** covering owned, non-owned, hired or leased vehicles.

   $1,000,000 Bodily Injury per Occurrence

   $1,000,000 Property Damage per Occurrence

   $1,000,000 Combined Single Limit

5. **Owners Protective Liability:**

   On purchase orders where the cost of the work, or contract price, exceeds $100,000 or is hazardous in nature, there shall also be a $4,000,000 umbrella or excess liability layer over the underlying described above. In such case there shall also be required an Owners and Consultants Protective Liability policy issued naming AHM as named insured, with a $1,000,000 per occurrence limit.

   The wording for both named insured and additional insured shall read as follows: AHM and its respective Officers, agents and servants.

6. **Worker's Compensation:**

   In accordance with Connecticut State Statutes.

   Employers Liability Limit - $1,000,000.

7. **Professional liability -** $5,000,000 limit **-** Additional coverage and limits may be required based upon the particular services contracted.

8. **Hold Harmless**

The Trade Contractor agrees to indemnify, defend and hold harmless AHM and its respective Officers, employees, agents and/or servants against demands, claims, actions or causes of actions, losses, damages, liabilities, costs and expenses, including without limitation, interest, penalties, court costs and reasonable attorney's fees, asserted against, resultant to, imposed upon or incurred by AHM resulting from or arising out of the execution of the Work.

B. Non-Collusive Affidavit and AHM's Code of Ethics Policy

Any act or acts of misrepresentation or collusion shall be the basis for disqualification of any bid or proposal submitted by such person or company guilty of said misrepresentation or collusion. If the bidder has made any misrepresentations or has been involved in collusion and such conduct is discovered after the execution of an Agreement with AHM, AHM may cancel the Agreement without incurring liability, penalty, or damages. The attached Non-collusive Affidavit of Proposer form and acknowledgement of AHM's Code of Ethics Policy must be submitted with the formal bid proposal.

11.2 PERFORMANCE BOND AND PAYMENT BOND

Delete Subparagraph A.3.4 of AIA Document A101-2017, Exhibit A and substitute the following:

"A.3.4 Contractor shall furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder. Bonds may be obtained through the Contractor's usual source and the cost thereof shall be included in the Contract Sum. The amount of each Bond shall be equal to one hundred percent (100%) of the Contract Sum.

A.3.4.1 Contractor shall deliver the Bonds to the Owner not later than three (3) days following the date the Agreement is entered into, or if the Work is to be commenced prior thereto in response to a letter of intent, the Contractor shall, prior to the commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished.

A.3.4.2 Contractor shall require the attorney-in-fact who executes the required Bonds on behalf of the surety to affix thereto a certified and current copy of the power of attorney."

ARTICLE 13 - MISCELLANEOUS PROVISIONS

13.3 RIGHTS AND REMEDIES

Add the following at the end of Subparagraph 13.3.1: "…or specified herein."

13.4 TESTS AND INSPECTIONS

Delete the third sentence of Subparagraph 13.4.1. and substitute the following:

"The Contractor shall schedule the above and shall notify the Consultant not later than forty-eight (48) hours prior to the inspection so that the Consultant may observe such inspection, testing, or approval. The Contractor shall bear all costs of such inspection, tests, or approvals required by public authorities or specified herein."

Add the following Clause to Subparagraph 13.4.4:

"13.4.4.1 If Consultant's observation or if inspection and testing undertaken pursuant to this Paragraph reveals that in any one or a number of identical or similar elements, incorporated in the Work, fails to comply with the requirements of the Contract Documents or the regulations or orders of any public authority having jurisdiction, the Consultant will have the authority to order inspection and testing of any or all such representative elements as he may consider necessary. The Contractor shall bear the cost of testing, correction of the Work, and the Consultant's additional services made necessary thereby."

13.5 INTEREST

Delete Paragraph 13.5 in its entirety.

Add the following new Paragraph 13.5 to Article 13:

"13.5 EQUAL OPPORTUNITY

13.5.1 Contractor shall maintain policies of employment as follows:

13.5.1.1 Contractor and the Contractor's Subcontractors shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, or national origin. The Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, religion, color, sex or national origin. Such action shall include, but not be limited to, employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. The Contractor agrees to post, in conspicuous places available to employees and applicants for employment, notices setting forth the policies of non-discrimination.

13.5.1.2 Contractor and the Contractor's Subcontractors shall, in all solicitations or advertisements for employees placed by them or on their behalf, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex or national origin."

ARTICLE 14 - TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 TERMINATION BY THE CONTRACTOR

Delete the second line through the third line of Subparagraph 14.1.3 and substitute the following:

"…from the Owner payment for all work executed in accordance with the Contract Documents, including reasonable overhead and profit."

14.2 TERMINATION BY THE OWNER FOR CAUSE

Change the end of Clause 14.2.1.3 to read as follows:

"…authority having jurisdiction;"

Delete Clause 14.2.1.4 and substitute the following Clauses:

"14.2.1.4 fails to remedy defective work;

14.2.1.5 in performance of the Work, has caused third party claims against the Owner or reasonable evidence of filing of such claim or claims;

14.2.1.6 has not performed the Work according to the Project Schedule, and there is reasonable evidence that the Work will not be completed within the Contract Time;

14.2.1.7 persistently fails to carry out the Work in accordance with the Contract Documents;

14.2.1.8 has not progressed in performance of the Work, and there is unnecessary or unreasonable delay in progress;

14.2.1.9 is adjudged bankrupt or makes a general assignment for the benefit of creditors, or if a receiver is appointed on account of his insolvency; or

14.2.1.10 otherwise is guilty of substantial breach of a provision of the Contract Documents."

Delete Subparagraph 14.2.2 and substitute the following:

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

ARTICLE 15 - CLAIMS AND DISPUTES

15.1 CLAIMS

Add the following to the end of Clause 15.1.6:

"There shall be no extension of the Contract time for adverse weather conditions unless the number of days of inclement weather is substantially greater or conditions substantially more severe than the average for the calendar period as recorded by a recognized weather observation agency."

Add the following Clauses to Subparagraph 15.1.6:

"15.1.6.3 No extension of Contract Time shall be granted unless the Contractor can demonstrate to the Consultant's satisfaction that work delayed is on the critical path of the Work.

15.1.6.4 The Consultant shall have the right to defer his decision on any claim, made pursuant to the provisions of the Contract, until the actual effect which forms the basis of the claim may be fully assessed."

15.2 INITIAL DECISION

Delete the third sentence of Subparagraph 15.2.1 and substitute the following:

"An initial decision by the Consultant shall be required as a condition precedent to mediation or litigation of all claims between the Contractor and Owner arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Consultant with no decision having been rendered by the Consultant."

15.3 MEDIATION

Delete Subparagraph 15.3.1 and substitute the following:

"15.3.1 Any claim arising out of or related to the Contract, except claims relating to aesthetic effect and except those waived as provided for in Subparagraphs 15.1.6, 9.10.4 and 9.10.5 shall, after initial decision by the Consultant or 30 days after submission of the Claim to the Consultant, be subject to mediation as a condition precedent to the institution of legal or equitable proceedings by either party."

Delete Paragraph 15.4 ARBITRATION in its entirety.

END OF SECTION

SECTION 00850

LIST OF DRAWINGS

M-1 HVAC Demolition

General Notes

General HVAC Notes

Project Scope

HVAC DEMOLITION GENERAL NOTES:

1. GENERAL DEMOLITION NOTES SHALL APPLY TO ALL MECHANICAL DRAWINGS.
2. FIELD VERIFY EXISTING BOILERS/PUMPS/DUCT HOT WATER COILS/HEAT PUMPS/CONDENSING UNITS/INDIRECT WATER HEATER/DUCTWORK/PIPING CONFIGURATION LOCATION PRIOR TO REMOVAL. REMOVE BOILERS/PUMPS/DUCT HOT WATER COILS/HEAT PUMPS/CONDENSING UNITS, INDIRECT WATER HEATER AND ASSOCIATED PIPING AND CONTROLS. REMOVE DUCTWORK FOR REMOVAL OF EXISTING EQUIPMENT AND PREPARE FOR THE INSTALLATION ON NEW FURNACES WITH DX COILS.
3. PORTIONS OF EXISTING SYSTEMS ARE OMITTED FROM AREAS THAT HAVE NO TRADE ASSOCIATED SCOPE TO MAINTAIN GRAPHICAL CLARITY.
4. VISIT SITE AND EXAMINE EXISTING CONDITIONS TO BECOME FAMILIAR WITH THEM AND DIFFICULTIES THAT WILL AFFECT EXECUTION OF WORK PRIOR TO PROPOSAL SUBMISSION.
5. PROPOSAL SUBMISSION WILL BE CONSTRUED AS EVIDENCE THAT SUCH AN EXAMINATION HAS BEEN MADE AND LATER CLAIMS WILL NOT BE RECOGNIZED FOR EXTRA LABOR, EQUIPMENT OR MATERIALS REQUIRED BECAUSE OF DIFFICULTIES ENCOUNTERED WHICH COULD HAVE BEEN FORESEEN SUCH AN EXAMINATION HAS BEEN MADE.
6. NOTES AND GRAPHIC REPRESENTATIONS SHALL NOT LIMIT DEMOLITION EXTENT REQUIRED.
7. WORK REQUIRED TO REMAIN IN SERVICE BUT INTERFERING WITH ALTERATIONS SHALL BE RELOCATED AND RECONNECTED USING MATERIALS AND STANDARDS OF THIS CONTRACT.
8. EQUIPMENT & DEVICES REMOVED SHALL BE DISCONNECTED PRIOR TO DEMOLITION WORK. REMOVED EQUIPMENT SHALL BE TAKEN FROM SITE & DISPOSED OF IN ACCORDANCE WITH APPLICABLE LAWS & ENVIRONMENTAL REGULATIONS, UNLESS OTHERWISE INDICATED.
9. EQUIPMENT REQUIRED TO BE TURNED OVER TO OWNER SHALL BE PLACED IN A MUTUALLY ACCEPTABLE LOCATION.

GENERAL HVAC NOTES:

1. GENERAL DRAWING NOTES SHALL APPLY TO ALL MECHANICAL DRAWINGS.
2. FIELD VERIFY LOCATIONS OF MECHANICAL EQUIPMENT BEFORE FABRICATION OF DUCTWORK. PROVIDE COORDINATED SHEET METAL SHOP DRAWINGS,
3. VERIFY EQUIPMENT CONNECTIONS WITH MANUFACTURER'S INSTALLATION DRAWINGS. PROVIDE DUCTWORK TRANSITIONS AND FLEXIBLE CONNECTORS FOR FURNACES AND FANS. FIELD VERIFY AND COORDINATE DIMENSIONS BEFORE FABRICATION.
4. COORDINATE DUCTWORK ROUTING WITH ALL TRADES. PROVIDE OFFSETS AND FITTINGS AS REQUIRED FOR INSTALLATION. CONTRACTOR SHALL BEAR COSTS ASSOCIATED WITH ROUTING MODIFICATIONS.
5. SUPPORT EQUIPMENT AND DUCTWORK FROM BUILDING STRUCTURE. MAINTAIN VIBRATION FREE INSTALLATION.
6. PROVIDE VOLUME DAMPER ON OA AND RA FOR BALANCING. PROVIDE DUCTWORK TRANSITIONS FOR FURNACES.
7, INSULATE SUPPLY, RETURN AND RELIEF DUCTWORK.
8. WIRE NEW THERMOSTATS FOR NEW FURNACES.
9. PROVIDE SERVICE/ACCESS CLEARANCES FOR MECHANICAL EQUIPMENT PER MANUFACTURERS' INSTRUCTIONS AND RECOMMENDATIONS. COORDINATE PRIOR TO INSTALLATION OF EQUIPMENT AND DUCTWORK.
10. BALANCE AIR SYSTEMS TO QUANTITIES INDICATED. BALANCE TOTAL SUPPLY AIR AND OUTSIDE AIR.
11. PROVIDE DUCTWORK OFFSETS FOR CROSSING DUCTWORK. PROVIDE INTERNAL DUCTWORK SUPPORTS PER SMACNA FOR DUCTS EXCEEDING 3:1 ASPECT RATIO.
12. PROVIDE NEW THERMOSTAT, MOUNT THERMOSTATS/SENSORS 48" ABOVE FINISHED FLOOR.
13. PROVIDE TEMPORARY HEAT DURING CONSTRUCTION.

PROJECT SCOPE:

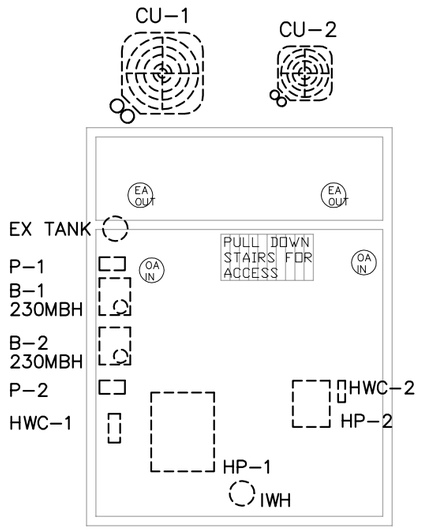
GENERAL:
REMOVE WATER EQUIPMENT (BOILERS/PUMPS/WATER COILS/WATER HEATER/PIPING) FOR SECOND FLOOR MER AND REPLACE WITH PROPANE FIRED FURNACES. LOCATE A NEW ELECTRIC WATER HEATER IN FIRST FLOOR CLOSET.
PROVIDE PE STAMPED AND SIGNED DRAWINGS FOR PERMIT.

REMOVE:
BOILERS, PUMPS, HOT WATER COILS. PIPING, HEAT PUMPS AND CONDENSING UNITS, INDIRECT WATER HEATER, PUMP AND PIPING. REMOVE ASSOCIATED ELECTRICAL.

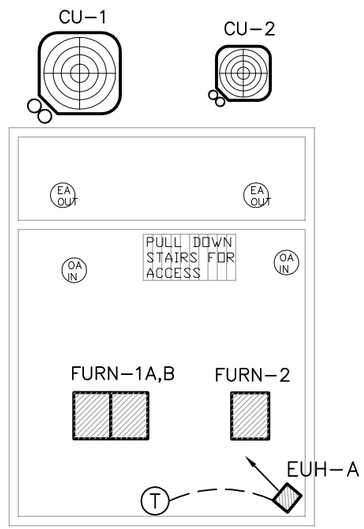
NEW:
FURNACES, DX COILS, DUCTWORK, CONDENSING UNITS (WITH PADS), DX PIPING, CONTROLS
VENT/FLUE REUSE EXISTING ROOF PENETRATIONS
ELECTRIC WATER HEATER, LOCATE IN FIRST FLOOR, INCLUDE MIXING VALVE
PROPANE PIPING TO FURNACES
PIPING FOR FLUE AND COOLING CONDENSATE

ATC:
BASE:
LOCAL CONTROL VIA WALL THERMOSTATS
NEW WIFI/WEB BASED THERMOSTATS FOR NEW UNITS AND EXISTING TO REMAIN UNIT
CONTROL OF THREE UNITS VIA APPLICATION ON CELL PHONE
ALTERNATE 1:
SEE SPECIFICATION SECTION.

ELECTRICAL
POWER FOR HVAC, ATC, PLUMBING
FIRE ALARM DEVICES: CO DETECTOR IN MER AND TWO LARGE ASSEMBLY ROOMS, SMOKE DETECTORS FOR LARGER FURNACE.



DEMOLITION PLAN



CONSTRUCTION PLAN

2ND LEVEL MER ROOM

project name:
AHM BUILDING
25 PENDLETON DRIVE, HEBRON, CT

PROGRESSIVE ENGINEERING, INC
290 BURNSIDE AVE., EAST HARTFORD, CT 06108
TEL: 860.895.8385 FAX: 860.895.8386

drawing title:
CONVERSION TO FURNACES
MECHANICAL MER FLOOR PLAN

date:	project no.:	drawing no.:
12/05/22	22063	M-1
drawn by: PM	rev no.: -	scale: 1/8=1'-0"

SECTION 00850

LIST OF DRAWINGS

M-2 Gas Fired Furnace Schedule

Air Cooled Condensing Unit Schedule

Electric Unit Heater Schedule

GAS FIRED FURNACE SCHEDULE

UNIT	MODEL	TYPE	SUPPLY FAN				GAS HEATING					DX COOLING COIL				ELECTRICAL					ACCESSORIES
			CFM	OA CFM	ESP IN. W.G.	MOTOR HP	INPUT MBH	OUTPUT MBH	EFF %	FUEL	STAGES	MODEL	NOMINAL TONS	EAT DB/WB	APD	VOLTS	PHASE	HZ	MCA	MOCP	
FURN-1A	59TP6B120V24-22	VERTICAL	3000	600	0.60	1.0	120	115.2	96	PROPANE	2	CAVTCOIL412A00	10.0	81/67	0.60"	120	1	60	12.6	20	ALL
FURN-1B	59TP6B120V24-22	VERTICAL					120	115.2	96	PROPANE	2					120	1	60	12.6	20	ALL
FURN-2	59TP6B120V24-22	VERTICAL	1995	360	0.60	1.0	120	115.2	96	PROPANE	2	CNPVP6024ALA	5.0	81/67	0.60"	120	1	60	12.6	20	1-4,6-8,10-11

NOTES:
1. SELECTIONS BASED ON CARRIER AND ACCEPTABLE APPROVED EQUAL FROM TRANE MODEL S9X2 AND LENNOX MODEL EL296UH110XE60C.
2. COOLING PERFORMANCE IS RATED AT 95° F AMBIENT, PROVIDE R-410 REFRIGERANT.
3. FURNACE 1 IS A TWINED UNIT.

ACCESSORIES:
1. STARTER & DISCONNECT SWITCH.
2. ROOF CONCENTRIC VENT/FLUE KIT.
3. PROGRAMMABLE THERMOSTAT WITH REMOTE TEMPERATURE SENSOR
4. RETURN AIR FILTER SECTION (MERV#8), CONSTANT VOLUME OPERATION
5. SUPPLY & RETURN DUCT SMOKE DETECTORS
6. PROVIDE MOTORIZED OUTSIDE AIR DAMPER & INTERLOCK WITH UNIT
7. DX COIL WITH TXV AND PIPING
8. PIPE IN CONDENSATE NEUTRALIZING TUBE, MODEL JM-2, MANUFACTURED BY JJM BOILER WORKS
9. HOT GAS BYPASS AND CONTROLS
10. CONDENSATE PUMP WITH SECONDARY DRAIN PAN UNDER UNIT. LEAK DETECTION IN SECONDARY DRAIN PAN TO DISABLE UNIT OPERATION ON SENSING WATER
11. PROVIDE MOUNTING HARDWARE FOR VERTICAL INSTALLATION, INCLUDE VIBRATION ISOLATORS

HVAC TAGS

FURN	FURNACE
CU	CONDENSING UNIT
B	BOILER
P	PUMP
EUH	ELECTRIC UNIT HEATER
FD	FIRE DAMPER
CFM	CUBIC FEET PER MINUTE
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
EA	EXHAUST AIR
DN	DOWN
ETR	EXISTING TO REMAIN

AIR COOLED CONDENSING UNIT SCHEDULE

UNIT	SERVING	MODEL	TONS	COMPRESSORS	SEER	STAGES	ELECTRICAL					ACCESSORIES
							MCA	MOCP	VOLTS	PHASE	HZ	
CU-1	FURN 1	38AUDB12A0A5-0A0CO	10	2	15.0	2	39.0	50	208	3	60	ALL
CU-2	FURN 2	24ACC660B003	5	1	16.0	1	32.4	50	208	1	60	ALL

NOTES:
1. SELECTIONS BASED ON CARRIER AND ACCEPTABLE APPROVED EQUAL FROM TRANE:
MODEL 5T: 4TTA4060A3000A, 10T: TTA120E3
AND
LENNOX:
MODEL 5T: 14ACX-060, 10T ELS120S4ST1Y

ACCESSORIES:
1. STARTER AND DISCONNECT
2. SUCTION & DISCHARGE SERVICE VALVES
3. HIGH & LOW PRESSURE SAFETY SWITCHES
4. LIQUID LINE FILTER DYER WITH STRAINER
5. LOW AMBIENT CONTROLLER & PRESSURE SWITCH KITS
6. HOT GAS BYPASS AND CONTROLS
7. TXV VALVE & DX PIPING TO FURNACES
8. CRANKCASE HEATER
9. COMPRESSOR START ASSIST
10. CYCLE PROTECTOR
11. TIME DELAY RELAY
12. SUPPORT FEET
13. EVAPORATOR FREEZE THERMOSTAT

ELECTRIC UNIT HEATER SCHEDULE

TAG	MODEL	TYPE	CFM	WATTS	MBH	VOLTAGE	AMPS	PHASE	ACCESSORIES
EUH-A	ARUH2C24CHAR	UNIT	350	1500	5.1	208	11.3	1	ALL

NOTES:
1. UNIT SELECTION BASED ON STELPRO; EQUIVALENT MANUFACTURERS BY QMARK AND BERKO.

ACCESSORIES:
1. DISCONNECT SWITCH, INTERNAL THERMOSTAT
2. THERMAL PROTECTION
3. MOUNTING FRAME AND HARDWARE.

project name:
AHM BUILDING
25 PENDLETON DRIVE, HEBRON, CT

PROGRESSIVE ENGINEERING, INC
290 BURNSIDE AVE., EAST HARTFORD, CT 06108
TEL: 860.895.8385 FAX: 860.895.8386

drawing title:
CONVERSION TO FURNACES
MECHANICAL SCHEDULES

date:	project no.:	drawing no.:
12/05/22	22063	M-2
drawn by: PM	rev no.: -	scale: 1/8=1'-0"

END OF SECTION

SECTION 00860

AHM / Town of Hebron
NON COLLUSIVE AFFIDAVIT OF PROPOSER

The undersigned proposer, having fully informed themselves regarding the accuracy of statements made herein certifies that;

(1) the proposer developed the bid independently and submitted it without collusion with, and without any agreement, understanding, or planned common course of action with any other entity designed to limit independent bidding or competition;

(2) the proposer, its employees and agents have not communicated the contents of the bid to any person not an employee or agent of the proposer and will not communicate the proposal to any such person prior to the official opening of the proposal, and

(3) acknowledges that AHM's Code of Ethics Policy has been received and understood.

The undersigned proposer further certifies that this statement is executed for the purpose of inducing AHM to consider the proposal and make an award in accordance therewith.

_____ _____

Legal Name of Proposer/Firm Business Address

_____ _____

Signature and Title Date

_____

Printed Name of Title Person

Subscribed and Sworn to me this _____day of _____, 20___

Notary Public
My Commission Expires

_____

END OF SECTION

SECTION 00870

AHM CODE OF ETHICS

AHM Code of Ethics and Conduct -

The AHM Code of Ethics & Conduct As a board member, staff member, intern, or volunteer for this organization, I fully understand the trust and confidence that has been placed in me, and the ramifications of my actions upon this agency and those we serve. It is my responsibility to uphold the following recommended standards and practices. Whenever my role as a board member, staff member, intern or volunteer comes into question, I will take the necessary steps to ensure that the integrity of the agency, and the safety and well-being of our clients will not be compromised. Furthermore, I will rely upon the expertise and guidance of the agency's leadership team for staff, interns and volunteers and the board's executive committee for board members whenever a question regarding a potential conflict of interest arises from my work with AHM. Above all else, I understand that my individual actions have a direct impact upon the entire organization and its mission.

As a Board Member: I recognize the importance of my role as the employer and the need for impartiality when dealing with all fiduciary and legal matters pertaining to the organization and its employees. As such, as a board member, I waive my rights to access individual intervention services for myself or a family member, including any counseling, social work or juvenile justice service to avoid placing staff members in a dual relationship, (that of employer and employee). Any other request to participate in nonintervention services should be discussed in advance with the Board President and Executive Director. Later in this document a schedule of current programs will outline potential conflicts of interest.

As a staff member, or intern: I waive my rights to access individual intervention services for myself or a family member, including any counseling, social work or juvenile justice service. Any other requests to participate in a non-intervention service must be formally made in writing to the Executive Director. I understand that while I cannot receive intervention services through AHM, the Executive Director will provide a list of resources so that I may try to access similar services elsewhere. Later in this document a schedule of current programs will outline potential conflicts of interest.

As an ongoing committee volunteer with the organization: I may be asked to meet with the Executive Director in a confidential setting to discuss my request to receive intervention services within the organization, (counseling, social work or juvenile justice). This will only happen if a staff member feels that there may be a professional conflict of interest caused by a dual relationship with volunteers. Every effort will be made to provide those services through AHM, so long as they are provided by a staff member that does not have a dual relationship or conflict of interest with the volunteer. Later in this document a schedule of current programs will outline potential conflicts of interest. At all times, when representing this organization, I will consider the legal, ethical, and professional boundaries that must be upheld in order to promote the health, safety and well-being of those we serve.

END OF SECTION

SECTION 01010

SUMMARY OF WORK

1.1 **SCOPE**

A. General Contract:

1. Owner's general conditions are a part of this division. perform work in strict accordance with applicable codes and regulations of local and state agencies and utility companies. The contractor shall bear cost of all fees, permits, licenses and taxes, and utility company charges in connection with work.
2. These drawings are schematic design only. contractor to complete design, have drawings pe stamped/signed and obtain permits with local authority.
3. At construction end, provide owner with a complete set of as-built drawings, including all mechanical plans, indicate routing of piping, ducts, location of equipment, valves, cleanouts and access panels. As-built documentation is drawn utilizing the most recent version of AutoCAD. Provide owner with one set of electronic copies and one set of reproducible documents.
4. Contractor shall provide a guarantee covering all material and workmanship for one (1) year following date of acceptance, except that refrigeration compressors shall be guaranteed for a period of five (5) years.
5. At construction end, contractor shall fully instruct owner in operation, adjustment and maintenance of equipment and systems. 6. Contractor shall provide owner with three (3) sets of complete maintenance and operating instructions and technical data, in booklet form, of all equipment and devices furnished in contract, including as-built drawings for project.

B. General:

1. Remove water-based heating HVAC equipment in second floor mechanical equipment room (MER) and replace with air-based heating equipment (furnaces). See schematic drawings.
2. Remove indirect water heater and replace with an electric water heater and locate in first floor closet or janitor closet.
3. Provide Automatic Temperature Controls (ATC)
    a. New thermostats for new units
    b. New thermostat for existing to remain unit
4. Provide temporary heat during construction.
5. Electrical demolition and new
6. Provide PE stamped and signed drawings for permit.

C. HVAC:

1. Remove boilers (2), Pumps (2), water coils, piping, heat pumps, associated condensing units, controls and electrical.
2. Provide (furnish and install) new propane furnaces and condensing units.
   a. Furnaces, thermostats (WIFI/Web compatible)
   b. DX coils
   c. Ductwork connections
   d. DX piping
   e. Condensing units with concrete pads
   f. Electric unit heater for MER.
3. Air balancing
4. Provide electrical power

D. Plumbing:

1. Remove indirect water and associated piping, pump, controls and electrical. Reuse mixing valve with new water heater,
2. Provide new electrical water heater locate in first floor closet.
3. Extend piping from second floor MER to new water heater location
4. Provide propane piping to furnaces. Provide piping for flue and cooling condensate.
5. Provide electrical power

E. BAS:

1. Local control via wall thermostats
2. New WIFI/Web based thermostats for new units
3. New WIFI/web based thermostat for existing to remain unit
4. Control of three units via application on cell phone
5. Provide electrical power
6. Alternate 1: See specification section. Note: building does not presently have a BAS.

F. Electrical

1. Power for HVAC and ATC
2. Power for Plumbing
3. Additional fire alarm devices
   a. CO detector in MER
   b. CO detector in the two large assembly rooms.
   c. Smoke Detectors in larger furnace.

END OF SECTION

SECTION 01020

TECHNICAL SPECIFICATIONS

SECTION 22 0519 - METERS AND GAGES

SECTION 22 0523 – VALVES

SECTION 22 0700 – PIPE INSULATION

SECTION 22 1116 – DOMESTIC WATER PIPING

SECTION 22 1119 – PLUMBING SPECIALITIES

SECTION 22 1126 – LIQUIFIED PETROLEUM GAS PIPING

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

SECTION 23 0010 – GENERAL CONDITIONS FOR MECHANICAL TRADES SECTION 23 0500 – BASIC MECHANICAL MATERIAL AND METHODS SECTION 23 0529 – HANGERS AND SUPPORTS

SECTION 23 0548 – MECHANICAL VIBRATION & SEISMIC CONTROLS

SECTION 23 0553 – MECHANICAL IDENTIFICATION

SECTION 23 0593 – TESTING, ADJUSTING AND BALANCING

SECTION 23 0700 – DUCT INSULATION

SECTION 23 0900 – HVAC INSTRUMENTATION AND CONTROLS

SECTION 23 2300 – REFRIGERANT PIPING

SECTION 23 3113 – METAL DUCTS

SECTION 23 3114 – DUCT ACCESSORIES

SECTION 26 0010 – GENERAL CONDITIONS FOR ELECTRICAL TRADES

SECTION 26 0500 – BASIC ELECTRICAL MATERIALS AND METHODS

SECTION 26 0519 – CONDUCTORS AND CABLES

SECTION 26 0533 – RACEWAYS AND BOXES

SECTION 26 0553 – ELECTRICAL IDENTIFICATION

SECTION 26 2726 – WIRING DEVICES

SECTION 26 2816 – DISCONNECT SWITCHES AND CIRCUIT BREAKERS

END OF SECTION

SECTION 22 0519 - METERS AND GAGES

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 meters and gages for mechanical systems.

1.3 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

B. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.

C. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

D. Shop Drawings: For brackets for duct-mounting thermometers.

E. Maintenance Data: For meters and gages to include in maintenance manuals specified in Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Liquid-in-Glass Thermometers:

    a. Ernst Gage Co.
    b. Palmer Instruments, Inc.
    c. Trerice: H. O. Trerice Co.

2. Direct-Mounting, Filled-System Dial Thermometers:

    a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
    b. Trerice: H. O. Trerice Co.
    c. Weiss Instruments, Inc.

3. Remote-Reading, Filled-System Dial Thermometers:

a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
b. Trerice: H. O. Trerice Co.
c. Weiss Instruments, Inc.

4. Bimetal Dial Thermometers:

a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
b. Ernst Gage Co.
c. Trerice: H. O. Trerice Co.
d. Weiss Instruments, Inc.

5. Insertion Dial Thermometers:

a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
b. Trerice: H. O. Trerice Co.
c. Weiss Instruments, Inc.

6. Pressure Gages:

a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
b. Ernst Gage Co.
c. Trerice: H. O. Trerice Co.

7. Test Plugs:

a. Peterson Equipment Co., Inc.
b. Trerice: H. O. Trerice Co.
c. Watts Industries, Inc.; Water Products Div.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Hot Water: 30 to 300 deg F, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1.

B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red or blue reading, organic liquid filled with magnifying lens.

E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

F. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 DIRECT-MOUNTING, FILLED-SYSTEM DIAL THERMOMETERS

A. Description: Vapor-actuated, universal-angle dial type.

B. Case: Drawn steel or cast aluminum, with 4-1/2-inch- diameter, glass lens.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Thermal Bulb: Copper with phosphor-bronze bourdon pressure tube.

E. Movement: Brass, precision geared.

F. Scale: Progressive, satin-faced nonreflective aluminum with permanently etched markings.

G. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.5 REMOTE-READING, FILLED-SYSTEM DIAL THERMOMETERS

A. Description: Vapor-actuated, remote-reading dial type.

B. Case: Drawn steel or cast aluminum, with 4-1/2-inch- diameter, glass lens.

C. Movement: Brass, precision geared.

D. Scale: Progressive, satin-faced nonreflective aluminum with permanently etched markings.

E. Tubing: Bronze, double-braided, armor-over-copper capillary; of length to suit installation.

F. Bulb: Copper with separable socket for liquids; averaging element for air.

2.6 BIMETAL DIAL THERMOMETERS

A. Description: ASME B40.3; direct-mounting, universal-angle dial type.

B. Case: Stainless steel with 5-inch- diameter, glass lens.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Element: Bimetal coil.

E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

F. Stem: Stainless steel for separable socket, of length to suit installation.

2.7 INSERTION DIAL THERMOMETERS

A. Description: ASME B40.3, bimetal type.

B. Dial: 1-inch diameter.

C. Case: Stainless steel.

D. Stem: Dustproof and leakproof 1/8-inch- diameter, tapered-end stem with nominal length of 5 inches.

2.8 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.

2. Material: Stainless steel, for use in steel piping.

3. Material: Steel, for use in steel piping.

4. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.

5. Insertion Length: To extend to one-third of diameter of pipe.

2.9 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.

1. Material: Brass, for use in copper piping.

2. Material: Steel, for use in steel piping.

3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.

4. Insertion Length: To extend to one-third of diameter of pipe.

5. Cap: Threaded, with chain permanently fastened to socket.

6. Heat-Transfer Fluid: Oil or graphite.

2.10 DUCT THERMOMETER SUPPORT FLANGES

A. Description: Flanged-fitting bracket for mounting in hole of duct, with threaded end for attaching thermometer.

1. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of exterior insulation.

2.11 PRESSURE GAGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens.

C. Connector: Brass, NPS 1/4.

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade B, plus or minus 2 percent of middle 50 percent of scale.

F. Range: Comply with the following:

1. Fluids under Pressure: Two times the operating pressure.

2.12 PRESSURE-GAGE FITTINGS

A. Valves: NPS 1/4 brass or stainless-steel needle type.

B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.13 TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500-psig minimum.

D. Core Insert: Self-sealing valve, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gage.

E. Core Material for Air, Water, Oil, and Gas: 20 to 200 deg F, chlorosulfonated polyethylene synthetic rubber.

F. Core Material for Air and Water: Minus 30 to plus 275 deg F, ethylene-propylene-diene terpolymer rubber.

G. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to one-third of diameter of pipe.

C. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.

1. Install with stem extending to one-third of diameter of pipe.

2. Fill wells with oil or graphite and secure caps.

D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

3.3 PRESSURE-GAGE INSTALLATION

A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.

B. Install liquid-filled-type pressure gages at suction and discharge of each pump.

C. Install pressure-gage needle valve and snubber in piping to pressure gages.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 & 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.

3.5 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 220519

SECTION 22 0523 - VALVES

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 general-duty valves:
   1. Copper-alloy ball valves.
   2. Ferrous-alloy ball valves.
   3. Ferrous-alloy butterfly valves.
   4. Bronze check valves.
   5. Gray-iron swing check valves.
   6. Ferrous-alloy wafer check valves.
   7. Spring-loaded, lift-disc check valves.
   8. Bronze gate valves.
   9. Cast-iron gate valves.
   10. Cast-iron plug valves.

B. Related Sections include the following:
   1. Division 22 & 23 Section "Mechanical Identification" for valve tags and charts.
   2. Division 23 Section "HVAC Instrumentation and Controls" for control valves and actuators.
   3. Division 22 & 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. PTFE: Polytetrafluoroethylene plastic.
   5. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

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 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

2. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Solder Joint: With sockets according to ASME B16.18.

a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

2. Threaded: With threads according to ASME B1.20.1.

J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 CAST-IRON ANGLE VALVES

A. Manufacturers:

1. Type II, Cast-Iron Angle Valves with Metal Seats:

a. Crane Co.; Crane Valve Group; Jenkins Valves.
b. Crane Co.; Crane Valve Group; Stockham Div.
c. NIBCO INC.

B. Cast-Iron Angle Valves, General: MSS SP-85, Type II.

C. Class 125, Cast-Iron Angle Valves: Bronze mounted with gray-iron body and bronze seats.

2.4 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:

   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Grinnell Corporation.
   f. Jamesbury, Inc.
   g. NIBCO INC.
   h. Watts Industries, Inc.; Water Products Div.

2. Two-Piece, Copper-Alloy Ball Valves:

   a. Conbraco Industries, Inc.; Apollo Div.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.

   e. Grinnell Corporation.
   f. Hammond Valve.
   g. Jamesbury, Inc.
   h. Milwaukee Valve Company.
   i. NIBCO INC.
   j. Red-White Valve Corp.
   k. Watts Industries, Inc.; Water Products Div.

3. Three-Piece, Copper-Alloy Ball Valves:

   l. Conbraco Industries, Inc.; Apollo Div.
   m. Grinnell Corporation.
   n. Hammond Valve.
   o. Jamesbury, Inc.
   p. NIBCO INC.
   q. PBM, Inc.
   r. Red-White Valve Corp.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 400-psig minimum CWP rating.

D. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

E. Three-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.5 FERROUS-ALLOY BALL VALVES

A. Manufacturers:

1. American Valve, Inc.
2. Conbraco Industries, Inc.; Apollo Div.
3. Crane Co.; Crane Valve Group; Stockham Div.
4. Hammond Valve.
5. Jamesbury, Inc.
6. Milwaukee Valve Company.
7. NIBCO INC.

B. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends.

C. Ferrous-Alloy Ball Valves: Class 150, full or regular port.

2.6 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

1. Flangeless, Ferrous-Alloy Butterfly Valves:

    a. Crane Co.; Crane Valve Group; Stockham Div.
    b. Milwaukee Valve Company.
    c. NIBCO INC.
    d. Red-White Valve Corp.
    e. Watts Industries, Inc.; Water Products Div.

2. Single-Flange, Ferrous-Alloy Butterfly Valves:

    a. Crane Co.; Crane Valve Group; Jenkins Valves.
    b. Crane Co.; Crane Valve Group; Stockham Div.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Watts Industries, Inc.; Water Products Div.

3. Flanged, Ferrous-Alloy Butterfly Valves:

    a. Bray International, Inc.

b. Grinnell Corporation.
c. Tyco International, Ltd.; Tyco Valves & Controls.

4. Grooved-End, Ductile-Iron Butterfly Valves:

a. Grinnell Corporation.
b. Milwaukee Valve Company.
c. NIBCO INC.

B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.

C. Flangeless, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer type with one- or two-piece stem.

D. Single-Flange, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with one- or two-piece stem.

E. Flanged, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Flanged-end type with one- or two-piece stem.

2.7 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 1, Bronze, Horizontal Lift Check Valves with Metal Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Stockham Div.
c. Red-White Valve Corp.

2. Type 2, Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.

3. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Red-White Valve Corp.

4. Type 2, Bronze, Vertical Lift Check Valves with Nonmetallic Disc:

a. Grinnell Corporation.
b. Milwaukee Valve Company.

5. Type 3, Bronze, Swing Check Valves with Metal Disc:

    a. American Valve, Inc.
    b. Cincinnati Valve Co.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. Grinnell Corporation.
    f. Hammond Valve.
    g. Milwaukee Valve Company.
    h. NIBCO INC.
    i. Red-White Valve Corp.
    j. Watts Industries, Inc.; Water Products Div.

6. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Crane Co.; Crane Valve Group; Stockham Div.
    d. Grinnell Corporation.
    e. Hammond Valve.
    f. Milwaukee Valve Company.
    g. NIBCO INC.
    h. Red-White Valve Corp.
    i. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 1, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

D. Type 1, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

E. Type 1, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

F. Type 1, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

G. Type 2, Class 125, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

H. Type 2, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

I. Type 2, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

J. Type 2, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

K. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

L. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

M. Type 4, Class 125, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

N. Type 4, Class 150, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.8 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:

1. Type II, Compact-Wafer, Lift-Disc Check Valves:

   a. Grinnell Corporation.
   b. Hammond Valve.
   c. Metraflex Co.
   d. Milwaukee Valve Company.
   e. NIBCO INC.

2. Type III, Globe Lift-Disc Check Valves:

   a. Grinnell Corporation.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

3. Type IV, Threaded Lift-Disc Check Valves:

   a. Grinnell Corporation.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Watts Industries, Inc.; Water Products Div.

B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

C. Type I, Class 125, Wafer Lift-Disc Check Valves: Wafer style with cast-iron shell with diameter matching companion flanges.

D. Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle.

E. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends.

F. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

G. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends.

2.9 BRONZE GATE VALVES

A. Manufacturers:

1. Type 1, Bronze, Nonrising-Stem Gate Valves:

    a. Crane Co.; Crane Valve Group; Jenkins Valves.
    b. Crane Co.; Crane Valve Group; Stockham Div.
    c. Grinnell Corporation.
    d. Hammond Valve.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Red-White Valve Corp.
    h. Watts Industries, Inc.; Water Products Div.

2. Type 2, Bronze, Rising-Stem, Solid-Wedge Gate Valves:

    a. Crane Co.; Crane Valve Group; Jenkins Valves.
    b. Crane Co.; Crane Valve Group; Stockham Div.
    c. Grinnell Corporation.
    d. Hammond Valve.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Red-White Valve Corp.

3. Type 3, Bronze, Rising-Stem, Split-Wedge Gate Valves:

    a. Cincinnati Valve Co.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Grinnell Corporation.
    d. NIBCO INC.

B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.

C. Type 1, Class 125, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge and union-ring bonnet.

D. Type 1, Class 150, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge and union-ring bonnet.

E. Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge and union-ring bonnet.

F. Type 2, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge and union-ring bonnet.

G. Type 3, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze split wedge and union-ring bonnet.

H. Type 3, Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze split wedge and union-ring bonnet.

2.10 CAST-IRON GATE VALVES

A. Manufacturers:

1. Type I, Cast-Iron, Nonrising-Stem Gate Valves:

a. Crane Co.; Crane Valve Group; Jenkins Valves.
b. Crane Co.; Crane Valve Group; Stockham Div.
c. Grinnell Corporation.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corp.
h. Watts Industries, Inc.; Water Products Div.

2. Type I, Cast-Iron, Rising-Stem Gate Valves:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Grinnell Corporation.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corp.
i. Watts Industries, Inc.; Water Products Div.

B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

C. Class 125, NRS, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, nonrising stem, and solid-wedge disc.

D. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

E. Class 125, NRS, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, nonrising stem, and solid-wedge disc.

F. Class 125, OS&Y, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, rising stem, and solid-wedge disc.

2.11 CAST-IRON PLUG VALVES

A. Manufacturers:

1. Lubricated-Type, Cast-Iron Plug Valves:

a. Milliken Valve Co., Inc.
b. Nordstrom Valves, Inc.
c. Walworth Co.

2. Nonlubricated-Type, Cast-Iron Plug Valves:

a. Grinnell Corporation.
b. Mueller Flow Technologies.

B. Cast-Iron Plug Valves, General: MSS SP-78.

C. Class 125 or 150, lubricated-type, cast-iron plug valves.

D. Class 125 or 150, nonlubricated-type, cast-iron plug valves.

E. Class 250, nonlubricated-type, cast-iron plug valves.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.

2. Throttling Service: ball, butterfly, or globe valves.

3. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.

2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.

3. Butterfly Valves, NPS 2-1/2 and Larger: Flangeless, Single-flange or Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.

4. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 125, vertical, bronze.

5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.

6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.

7. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.

8. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type I, Class 125, cast iron.

9. Gate Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.

10. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS , bronze-mounted cast iron.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 & 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 & 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 0523

SECTION 22 0700 - 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;; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. 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, 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.

1.4 QUALITY ASSURANCE

A. 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. 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.

C. Coordinate installation and testing of electric heat tracing.

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

1. Mineral-Fiber Insulation:

   a. CertainTeed Manson.
   b. Owens-Corning Fiberglas Corp.
   c. Schuller International, Inc.

2. Flexible Elastomeric Thermal Insulation:

   a. Armstrong World Industries, Inc.
   b. Rubatex Corp.

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. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

a. Class 1, Grade A 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.

3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.

4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.

5. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.

2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

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. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.

2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

A. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.

2. Galvanized Steel: 0.005 inch thick.

3. Aluminum: 0.007 inch thick.

4. Brass: 0.010 inch thick.

5. Nickel-Copper Alloy: 0.005 inch thick.

B. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.5 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

G. Keep insulation materials dry during application and finishing.

H. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

I. Apply insulation with the least number of joints practical.

J. 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.

K. 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.

L. 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.

M. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

N. 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.

O. 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.

P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

R. 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.

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. Cover fittings with standard PVC fitting covers.

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. Apply insulation to flanges as specified for flange insulation application.

3. 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.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.

2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply 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 cut sections of sheet insulation of the same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.

2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.

3. Apply insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

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. Fire-suppression piping.

4. Below-grade piping, unless otherwise indicated.

5. Chrome-plated pipes and fittings unless potential for personnel injury.

6. 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 and vapor retarders.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.9 INTERIOR CONCEALED INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot and recirculated hot water.

1. Operating Temperature: 105 to 140 deg F.

2. Insulation Material: Mineral fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:

a. Pipe, ½" Through 4":1" Thick.

4. Vapor Retarder Required: Yes.

5. Finish: None.

B. Service: Domestic cold water.

1. Operating Temperature: 40 to 60 deg F (2 to 15 deg C).

2. Insulation Material: Mineral fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:

a. Pipe, ½" Through 1": 1/2" Thick.
b. Pipe,1-1/4" Through 2":3/4" Thick.
c. Pipe, 2-1/2" Through 4: 1" Thick.

4. Vapor Retarder Required: Yes.

5. Finish: None.

C. Service: Rainwater leaders and conductors.

1. Operating Temperature: 32 to 100 deg F (0 to 38 deg C).

2. Insulation Material: Mineral fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:

   a. Pipe, All piping sizes: 1-1/2" Thick.

4. Vapor Retarder Required: Yes.

5. Finish: None.

D. Service: Roof drain bodies.

1. Operating Temperature: 32 to 100 deg F (0 to 38 deg C).

2. Insulation Material: Flexible elastomeric.

3. Insulation Thickness: 1-1/2".

4. Vapor Retarder Required: Yes.

5. Finish: Painted.

E. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.

1. Operating Temperature: 35 to 120 deg F.

2. Insulation Material: Mineral fiber.

3. Insulation Thickness: 1-1/2".

4. Field-Applied Jacket: PVC P-trap and supply covers.

5. Vapor Retarder Required: No.

6. Finish: None.

F. Service: Refrigerant suction and hot-gas piping.

1. Operating Temperature: 35 to 50 deg F (2 to 10 deg C).

2. Insulation Material: Mineral fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:
4. All Pipe Sizes, 1" Thick. Vapor Retarder Required: Yes.

5. Finish: None.

G. Service: Heating hot-water supply and return.

1. Operating Temperature: 100 to 200 deg F .

2. Insulation Material: Mineral fiber.

3. Insulation Thickness: Apply the following insulation thicknesses:

   a. Pipe ½" Through 2", 1-1/2" Thick:

4. Vapor Retarder Required: Yes.

5. Finish: None.

3.10 EXTERIOR INSULATION APPLICATION SCHEDULE

A. This application schedule is for aboveground insulation outside the building. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.

B. Service: Refrigerant suction.

1. Operating Temperature: 35 to 50 deg F (2 to 10 deg C).

2. Insulation Material: Flexible elastomeric.

3. Insulation Thickness: Apply the following insulation thicknesses:

   a. All Pipe Sizes,1" Thick

4. Field-Applied Jacket: UV inhibiting Coating.

5. Vapor Retarder Required: Yes.

6. Finish: None.

END OF SECTION 22 0700

SECTION 22 1116 - DOMESTIC WATER 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 domestic water piping and water meter inside building.

B. Related Sections include the following:
   1. Division 22 & 23 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
   2. Division 22 Section "Plumbing Specialties & Plumbing Specialties Schedule" for water distribution piping specialties.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 80 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings and water meter.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

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 PIPING MATERIALS

A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Types K and L (ASTM B 88M), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Copper, Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.

    a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

2.4 VALVES

A. Bronze and cast-iron, general-duty valves are specified in Division 22 & 23 Section "Valves."

B. Balancing and drain valves are specified in Division 22 Section "Plumbing Specialties."

PART 3 - EXECUTION

3.1 PIPE AND FITTING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Grooved joints may be used on aboveground grooved-end piping.

D. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

E. Under-Building-Slab, Domestic Water Piping on House Side of Water Meter, NPS 4 and Smaller: Soft copper tube, Type L ; copper pressure fittings; and soldered joints.

F. Aboveground Domestic Water Piping: Use the following piping materials for each size range:

1. NPS 1 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. NPS 1-1/4 and NPS 1-1/2 : Hard copper tube, Type L; copper pressure fittings; and soldered joints.
3. NPS 2 : Hard copper tube, Type L ; copper pressure fittings; and soldered joints.
4. NPS 2 : Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.
5. NPS 4 to NPS 6 (DN 100 to DN 150): Steel pipe with grooved ends; steel-piping, grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.2 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water-Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller."

3.3 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 & 23 Section "Basic Mechanical Materials and Methods."

B. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."

C. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

D. Rough-in domestic water piping for sub water-meter installation according to utility company's requirements.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 & 23 Section "Basic Mechanical Materials and Methods."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

C. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 & 23 Section "Mechanical Vibration and Seismic Controls."

B. Pipe hanger and support devices are specified in Division 22 & 23 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 & 23 Section "Hangers and Supports."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch .

F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

G. Install supports for vertical copper tubing every 10 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
   1. Water Heaters: Cold water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22.
   3. Equipment: Cold and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

   3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 1116

SECTION 22 1119 - PLUMBING SPECIALTIES

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 plumbing specialties:

1. Backflow preventers.
2. Water regulators.
3. Balancing valves.
4. Water filters.
5. Thermostatic water mixing valves.
6. Water tempering valves.
7. Strainers.
8. Trap seal primer valves.
9. Drain valves.
10. Backwater valves.
11. Miscellaneous piping specialties.
12. Sleeve penetration systems.
13. Flashing materials.
14. Cleanouts.
15. Floor drains/Floor sinks.
16. Plastic floor drains.

B. Related Sections include the following:

1. Division 22 & 23 Section "Meters and Gages" for water meters, thermometers, and pressure gages.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:
1. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Piping: 125 psig.
2. Sanitary Waste and Vent Piping: 10-foot head of water.

1.5 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:

1. Backflow preventers and water regulators.
2. Balancing valves and strainers.
3. Water hammer arresters, air vents, and trap seal primer valves and systems.
4. Drain valves.
5. Backwater valves, cleanouts, floor drains/floor sinks.
6. Air-admittance valves, vent terminals, and roof flashing assemblies.
7. Sleeve penetration systems.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field test reports.

D. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1. Backflow preventers and water regulators.
2. Thermostatic water mixing valves and water tempering valves.
3. Trap seal primer valves and systems.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.
2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

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. Products: Subject to compliance with requirements, provide one of the products specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 BACKFLOW PREVENTERS

A. Manufacturers:

   1. Ames Co., Inc.
   2. Watts Industries, Inc.; Water Products Div.
   3. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE standard, backflow preventers.

   1. NPS 2 and Smaller: Bronze body with threaded ends.
   2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.

      a. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.

   3. Interior Components: Corrosion-resistant materials.
   4. Strainer: On inlet, if indicated.

C. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

D. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

E. Intermediate Atmospheric-Vent Backflow Preventers: ASSE 1012, suitable for continuous pressure application. Include inlet screen and two independent check valves with intermediate atmospheric vent.

F. Reduced-Pressure-Principal Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.

   1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

G. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

H. Antisiphon-Pressure-Type Vacuum Breakers: ASSE 1020, suitable for continuous pressure application. Include shutoff valves, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

I. Dual-Check-Valve-Type Backflow Preventers: ASSE 1024, suitable for continuous pressure application. Include union inlet and two independent check valves.

J. Dual-Check-Valve-Type Backflow Preventers: ASSE 1032, suitable for continuous pressure application for carbonated beverage dispensers. Include stainless-steel body; primary and secondary checks; ball check; intermediate atmospheric-vent port for relieving carbon dioxide; and threaded ends, NPS 3/8.

K. Hose-Connection Backflow Preventers: ASSE 1052, suitable for at least 3-gpm flow and applications with up to 10-foot head of water back pressure. Include two check valves; intermediate atmospheric vent; and nonremovable, ASME B1.20.7, garden-hose threads on outlet.

L. Back-Siphonage Backflow Vacuum Breakers: ASSE 1056, suitable for continuous pressure and backflow applications. Include shutoff valves, check valve, test cocks, and vacuum vent.

2.3 BALANCING VALVES

A. Memory-Stop Balancing Valves, NPS 2 and Smaller: MSS SP-110, ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard or full-port, chrome-plated brass ball, replaceable seats and seals, threaded or solder-joint ends, and vinyl-covered steel handle with memory-stop device.
1. Manufacturers:

a. Conbraco Industries, Inc.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Red-White Valve Corp.

2.4 STRAINERS (Refer to Plumbing Plans for Model & Location)

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.

2. NPS 2 and Smaller: Bronze body, with female threaded ends.
3. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.

    a. Drain: Factory or field installed, hose-end drain valve.

B. Dialysis Equipment Outlet Boxes: With hose connection, drain. (Refer to Plumbing Plans for Model & Location.

1. Box and Faceplate: Finish by Architect.
2. Shutoff Fitting: As indicated on Plumbing Plans.
3. Supply Fitting: As indicated on Plumbing Plans.
4. Drain: As indicated on Plumbing Plans.

C. Reinforcement: Coordinate requirements w/ Architect

2.5 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

B. Hose-End Drain Valve: MSS SP-80, gate valve, Class 125, ASTM B 62 bronze body, with NPS 3/4 threaded or solder-joint inlet and ASME B1.20.7, garden-hose threads on outlet and cap. Hose bibbs are prohibited for this application.

C. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with NPS 1/8 side drain outlet and cap.

2.6 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.
1. Manufacturers:

    a. Josam Co.
    b. Smith, Jay R. Mfg. Co.
    c. Tyler Pipe; Wade Div.
    d. Zurn Industries, Inc.; Specification Drainage Operation.

B. Air-Admittance Valves: Plastic housing with mechanical-operation sealing diaphragm, designed to admit air into drainage and vent piping and to prevent transmission of sewer gas into building.
1. Manufacturers:
    a. Oatey.

b. Sioux Chief Manufacturing Co., Inc.
c. Studor, Inc.

2. Fixture Vent Valve: ASSE 1051, designed for installation on waste piping, instead of vent connection, for single fixture, in NPS 1-1/4 to NPS 2.

C. Roof Flashing (Refer to Architectural Plans for Details)

D. Deep-Seal Traps: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap seal primer valve connection (Refer to Plumbing Plans for Model & Location).

1. NPS 2 : 4-inch- minimum water seal.
2. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

E. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

F. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semiopen top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

G. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

H. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set screws to secure to vent pipe.

I. Vent Terminals: Commercially manufactured, shop- or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

2.7 SLEEVE PENETRATION SYSTEMS

A. Manufacturers:

1. ProSet Systems, Inc.

B. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.

1. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
2. Stack Fitting: ASTM A 48 (ASTM A 48M), gray-iron, hubless-pattern, wye-branch stack fitting with neoprene O-ring at base and gray-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 & 23 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with airgap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

D. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.

E. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

F. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

G. Install expansion joints on vertical risers, stacks, and conductors if indicated.

H. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

I. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.

J. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

K. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

L. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

M. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

N. Install floor drains/floor sinks at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains/floor sinks for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

O. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

P. Fasten recessed-type plumbing specialties to reinforcement built into walls.

Q. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.

R. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 22 & 23 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.

S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

T. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 & 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect plumbing specialties to piping specified in other Division 22 & 23 Sections.

D. Ground equipment.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

G. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

H. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

I. Set flashing on floors and roofs in solid coating of bituminous cement.

J. Secure flashing into sleeve and specialty clamping ring or device.

K. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

L. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

M. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer, thermostatic water mixing valve, water tempering valve, trap seal primer system.

1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
2. Refer to Division 22 & 23 Section "Mechanical Identification" for nameplates and signs.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1119

SECTION 22 1126 - LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Storage containers.
8. Transport truck unloading facility specialties.
9. Pumps.
10. Vaporizers.
11. Air mixers.
12. Mechanical sleeve seals.
13. Grout.
14. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, 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. LPG: Liquefied-petroleum gas.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. For Piping Containing Only Vapor:

    a. Piping and Valves: 125 psig unless otherwise indicated.

2. For Piping Containing Liquid:

    a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.
    b. Piping Other Than Above: 250 psig unless otherwise indicated.
    c. Valves and Fittings: 250 psig unless otherwise indicated.

B. LPG System Pressure within Buildings: One pressure range. 11.0 WC or less.

C. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Seismic Performance: Vaporizers and storage container supports shall withstand the effects of earthquake motions determined according to ASCE 7.

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."

1.5 SUBMITTALS

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

1. Piping specialties.
2. Corrugated stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Storage containers.
7. Transport truck unloading specialties.
8. Pumps.
9. Vaporizers.
10. Air mixers.
11. Mechanical sleeve seals.
12. Escutcheons.

B. Shop Drawings: For facility LPG piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

C. Delegated-Design Submittal: For LPG piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is shown and coordinated with other installations, using input from installers of the items involved.

E. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.

F. Qualification Data: For qualified professional engineer.

G. Seismic Qualification Certificates: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

H. Welding certificates.

I. Field quality-control reports.

J. Operation and Maintenance Data: For LPG equipment and accessories to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.

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

C. Store pipes and tubes with protective PE coating to avoid damaging coating and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

a. Manufacturers:

1) Dresser Piping Specialties; Division of Dresser, Inc.
2) Smith-Blair, Inc.

b. Stainless-steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Stainless-steel bolts, washers, and nuts.
e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.

2.2 PIPING SPECIALTIES

A. Flexible Piping Joints:

1. Approved for LPG service.
2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. Minimum working pressure of 250 psig and 250 deg F operating temperature.
4. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch misalignment.

5. Maximum 36-inch length for liquid LPG lines.

B. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40 - mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 - mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40 - mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

F. Weatherproof Vent Cap: Cast or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.

1. CWP Rating: 250 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Socket ends for brazed joints.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.

C. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.

D. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

E. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers:

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

F. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers:

    a. Brass Craft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

G. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers:

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

H. Bronze Plug Valves: MSS SP-78.

1. Manufacturers:

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for LPG service with "WOG" indicated on valve body.

I. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Manufacturers:

    a. McDonald, A. Y. Mfg. Co.
    b. Mueller Co.; Gas Products Div.
    c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with LPG.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

J. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers:

    a. Flowserve.
    b. Homestead Valve; a Division of Olson Technologies, Inc.
    c. McDonald, A. Y. Mfg. Co.
    d. Milliken Valve Company.
    e. Mueller Co.; Gas Products Div.
    f. R&M Energy Systems; a subsidiary of Robbins & Myers, Inc.

2. Body: Cast iron, complying with ASTM A 126 Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with LPG.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

K. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Hydrostatic Relief Valves: Comply with NFPA 58.

1. Manufacturers:

    a. Engineered Controls International, Inc.; RegO Products.
    b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    c. Murray Equipment, Inc.
    d. Sherwood; a division of Harsco Corporation.

2. Operating Pressure: 350 psig.
3. Body: Brass.
4. Spring: Stainless steel.
5. Disc and Seat: Nitrile.
6. Brass body and stainless-steel, spring-operated valve with resilient rubber disc seat and protective cap.
7. Factory set and tested.
8. Listing: Valves listed and labeled by an NRTL acceptable to authorities having jurisdiction.

9. Valve shall reseat after relieving pressure.

B. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Manufacturers:

a. ASCO.
b. ASCO Power Technologies, LP; Division of Emerson.
c. ASCO Valve Canada; Division of Emerson Electric Canada Limited.
d. Dungs, Karl, Inc.
e. Eaton Corporation; Controls Div.
f. Eclipse Combustion, Inc.
g. Honeywell International Inc.

2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. Electrical operator for actuation by appliance automatic shutoff device.

C. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers:

a. ASCO.
b. ASCO Power Technologies, LP; Division of Emerson.
c. Dungs, Karl, Inc.
d. Eclipse Combustion, Inc.
e. Goyen Valve Corp.; Tyco Environmental Systems.
f. Magnatrol Valve Corporation.
g. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
h. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers:

a. Vanguard Valves, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded-end connections complying with ASME B1.20.1.

B. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers:

a. Pacific Seismic Products, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 0.5 psig.
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for LPG.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers:

a. Actaris.
b. American Meter Company.
c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
d. Invensys.
e. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.

6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers:

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers:

    a. Canadian Meter Company Inc.
    b. Eaton Corporation; Controls Div.
    c. Harper Wyman Co.
    d. Maxitrol Company.
    e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 1 psig.

2.8 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Manufacturers:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
   f. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for LPG.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. Manufacturers:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
   d. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for LPG.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:

1. Manufacturers:

   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Companion-flange assembly for field assembly.
4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
5. Insulating materials suitable for LPG.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.9 STORAGE CONTAINERS – By Vendor

A. Description: Factory fabricated, complying with requirements in NFPA 58 and ASME Boiler and Pressure Vessel Code and bearing the ASME label. Tanks shall be rated for 250-psig minimum working pressure.

2.10 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.11 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 Company (The).
    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 and sleeve.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.12 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.13 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.

2.14 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.

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

3.2 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off LPG to premises or piping section.

B. Inspect LPG piping according to NFPA 58 and International Fuel Gas Code to determine that LPG utilization devices are turned off in piping section affected.

C. Comply with NFPA 58 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.4 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 58 and the International Fuel Gas Code requirements for installation and purging of LPG piping.

B. Install underground, LPG piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

E. Install fittings for changes in direction and branch connections.

F. Joints for connection to inlets and outlets on vaporizers, air mixers, regulators, and valves may be flanged or threaded to match the equipment.

G. 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.

H. 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.

I. 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.

J. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.5 INDOOR PIPING INSTALLATION

A. Comply with NFPA 58 and the International Fuel Gas Code for installation and purging of LPG piping.

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, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons for penetrations of interior walls, ceilings, and floors.

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    d. Piping at Ceiling Penetrations in Finished Spaces: One-piece cast-brass type with polished chrome-plated finish.

e. Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped-steel type and set screw.
f. Piping in Unfinished Service Spaces: One-piece cast-brass type with polished chrome-plated finish.
g. Piping in Unfinished Service Spaces: One-piece stamped-steel type with set screw.
h. Piping in Equipment Rooms: One-piece, cast-brass type.
i. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
j. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for materials.

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed LPG piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: LPG piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install LPG piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install LPG piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

a. Do not install LPG piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
b. Do not install LPG piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use LPG piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

B. Install hangers for horizontal, drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod, 3/8 inch.

3.9 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install LPG piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior LPG piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel flat.
d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex flat.
d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd flat.
d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain LPG equipment.

3.13 OUTDOOR PIPING SCHEDULE

A. Underground LPG liquid piping shall be one of the following:

1. Schedule 40 steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
2. Annealed copper tube, Type K with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground LPG liquid piping shall be one of the following:

1. NPS 2 and Smaller: Schedule 40 steel pipe, malleable-iron threaded fittings and seal welded joints. Coat pipe and fittings with protective coating for steel piping.
2. NPS 2-1/2 and Larger: Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
3. Annealed copper tube, Type K with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

C. Aboveground LPG vapor piping shall be one of the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

2. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings.
3. Annealed copper tube, Type K with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

D. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper, with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

E. Containment Conduit: Schedule 40 steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
4. Aluminum tube with flared fittings and joints.
5. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
3. Drawn-temper copper tube, Type K with wrought-copper fittings and brazed joints.

C. Containment Conduit: Schedule 40 steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

D. Containment Conduit Vent Piping: Schedule 40 steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground Liquid Piping:

1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves for pipe NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves for pipe NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

D. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

E. Distribution piping valves for pipe NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

F. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 23 1126

SECTION 22 1316 - SANITARY WASTE AND VENT 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 soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.

B. Related Sections include the following:

1. Refer to plumbing plans for “Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water .

1.4 SUBMITTALS

C. Product Data: For pipe, tube, fittings, and couplings.

D. Shop Drawings: For solvent drainage system, include plans, elevations, sections, and details.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

2.2 PVC PIPING

A. PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. PVC Special Fittings: ASTM F 409, drainage-pattern tube and tubular fittings with ends as required for application.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground, Soil, Waste, and Vent Piping: Use any of the following piping materials for each size range:

1. NPS 1-1/4 and NPS 1-1/2: PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, Soil, Waste, and Vent Piping: Use any of the following piping materials for each size range:

1. NPS 1-1/2 : PVC pipe, PVC socket fittings, and solvent-cemented joints.

2. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. NPS 5 and NPS 6: PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Refer to Section "Sanitary Sewerage" for Project-site sanitary sewer piping.

B. Refer to Division 22 & 23 Section "Basic Mechanical Materials and Methods" for basic piping installation.

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

G. Install engineered soil and waste drainage and vent piping systems in locations indicated and as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

J. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 & 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

C. A. Backwater Valves: Install backwater valves with associated cleanout cover and extension access pipe to grade in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. Install backwater valves in accessible locations.

3.6 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 & 23 Section "Mechanical Vibration Controls and Seismic Restraints" for seismic-restraint devices.

B. Refer to Division 22 & 23 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet (30 m), if indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 & 23 Section "Hangers and Supports."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.

2. NPS 3: 48 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.

4. NPS 6: 48 inches with 3/4-inch rod.

G. Install supports for vertical PVC piping every 48 inches.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.
7. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
8. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
9. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316

SECTION 23 0010 – GENERAL CONDITIONS FOR MECHANICAL TRADES

PART 1 – GENERAL

1.1 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in this Section of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions be assumed to be omitted if not repeated herein.

C. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division.

D. The following information contains specifications of Work in connection with, and in addition to, this Division:

1. All plans associated with the project.

2. All specifications associated with the project.

E. Work is not limited to this Division or the Drawings associated with this Division. Work is specified throughout all the plans and specifications associated with the Project.

F. Division of Work responsibilities are as defined and directed by the Bidding Agent and/or the Bidding General Contractor.

1.2 INTENT

A. It is the intent of the Drawings and Specifications to call for finished Work, tested and ready for operation.

B. Furnish, deliver and install any apparatus, appliance, material or Work not shown on the Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories necessary to make the Work complete and perfect in all respects and ready for operation, even if not particularly specified, under their respective Section without additional expense to the Owner.

C. Include in the Work minor details not shown or specified but necessary for proper installation and operation, as though they were hereinafter shown or specified.

D. Provide Engineer written notice of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of authorities having

jurisdiction and any necessary items of Work omitted. In the absence of such written notice, it is mutually agreed that Work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

E. The Work indicated is diagrammatic. The Architect and/or Engineer may require, included as part of this Contract, the relocation of devices to reasonable distances from the general locations shown. Verbal clarifications of the Drawings or Specifications during the bid period are not to be relied upon. Refer any questions or clarifications to the Engineer at least five Working days prior to bidding to allow for issuance of an addendum. After the five-day deadline, Bidder must make a decision and qualify the Bid, if the Bidder feels it necessary.

1.3 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and Work included in the Contract. (Do not scale the Drawings.) Consult the Architectural Drawings and Details for exact locations of fixtures and equipment; where same are not definitely located, obtain this information from the Architect.

B. Closely follow Drawings in layout of Work; check Drawings associated with other Divisions to verify spaces in which Work will be installed. Maintain maximum headroom. Where space conditions appear inadequate, notify Engineer before proceeding with installations.

C. Engineer may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with Work of other trades and for proper execution of the Work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, include the item or arrangement of better quality, greater quantity or higher cost in the Contract price. It is at the Engineer's discretion to decide on the item and the manner in which the Work will be installed.

1.4 SURVEYS AND MEASUREMENTS

A. Before submitting a Bid, visit the site and become thoroughly familiar with all conditions under which the Work will be installed. Contractor will be held responsible for any assumptions, omissions or errors made as a result of failure to become familiar with the site and the Contract Documents.

B. Base all measurements, both horizontal and vertical, from established benchmarks. Reference all Work from these established lines and levels. Verify all measurements at site and check the correctness of same as related to the Work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or the intent of the Drawings and Specifications, notify the Engineer and do not proceed with that Work until instructions have been received from the Engineer.

1.5 CODES AND STANDARDS

A. The Codes, Standards and abbreviations listed below apply to all mechanical Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision:

IMC – Mechanical Code.
NSPC – National Standard Plumbing Code.
NFPA - Life Safety Code 101.
ANSI – The American National Standards Institute.
NEC – The National Electrical Code.
AABC – Associated Air Balance Council.
ADC – Air Diffusion Council.
AGA – American Gas Association.
AMCA – Air Moving and Conditioning Associations.
ARI – Air Conditioning and Refrigeration Institute.
ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.
ASME – American Society of Mechanical Engineers.
ASPE – American Society of Plumbing Engineers.
ASTM – American Society of Testing and Materials.
AWS – American Welding Society.
CGA – Compressed Gas Association.
CISPI – Cast Iron Soil Pipe Institute.
HIS – Hydraulic Institute Standards.
IBR – Institute of Boiler and Radiation Manufacturers.
NEBB – National Environmental Balancing Bureau.
NOFI – National Oil Fuel Institute.
NSF – National Sanitation Foundation.
OSH – Occupational Safety and Health Administration.
PDI – Plumbing and Drainage Institute.
SMACNA – Sheet Metal and Air Conditioning Contractors National Association.
UL – Underwriters' Laboratories.

B. The latest adopted editions of the following State or local Codes apply:

State Building Code, Supplements and referenced publications
Life Safety Code NFPA 101 and Supplements
Local Building Code
National Standard Plumbing Code.
International Mechanical Code.
State Fire Safety Code

C. All materials furnished and all Work installed comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and with the requirements of all Governmental departments having jurisdiction.

D. Include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations whether or not shown on Drawings and/or specified.

1.6 PERMITS AND FEES

A. Give all necessary notices, obtain all permits, pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.7 COORDINATION

A. Carry out all Work in conjunction with other trades and give full cooperation in order that all Work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General Contractor, with information as to openings, chases, equipment locations and panels required by other trades.

B. Contractors are required to examine all of the Project Documents and mutually arrange Work so as to avoid interference. In general, ductwork, heating and sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. Final decisions will be made by the Engineer regarding the arrangement of Work, which cannot be agreed upon by the Contractors.

C. Where the Work of the Contractor will be installed in close proximity to or will interfere with Work of other trades, assist in Working out space conditions to make a satisfactory adjustment.

D. If Work is installed before coordinating with other Divisions or so as to cause interference with Work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition, without extra charge to the Owner.

E. Initial contact and coordination has been conducted with utility entities for the purposes of the preparation of Bid Documents. Coordinate all final specific utility requirements.

1.8 ACCEPTANCES

A. The equipment, materials, Workmanship, design and arrangement of all Work installed under the Mechanical Sections are subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, submit to the Engineer for review a list of manufacturers of equipment proposed for the Work under the Mechanical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.

1. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, notify the Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending review by the Engineer or Owner's representative.

C. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

D. If material or equipment are installed before shop drawing review, liability for its removal and replacement is assumed by the Contractor, at no extra charge to the Owner, if, in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.

E. Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance to the drawings and/or specifications. Correct Work and/or materials not in conformance with the drawings and/or specifications whenever non-conformance is discovered.

1.9 EQUIPMENT DEVIATIONS

A. Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment as hereinafter specified, a request is to be made in writing. State in the request whether it is a substitution or an equivalent to that specified and the amount of credit or extra cost involved. Include a copy of said in the Mechanical Base Bid with manufacturer's equipment cuts. The Base Bid must be based on using the materials and equipment as specified with no exceptions.

B. In these Specifications and on the accompanying Drawings, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of Workmanship, finish and design required for

installation. In the event that only one (1) manufacturer of a product is specified and it is found that the manufacturer has discontinued the product, use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product.

C. The details of Workmanship, finish and design and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein must also conform to these standards. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be used providing it conforms, in the opinion of and meets with the acceptance of the Engineer, to the requirements of these Specifications.

D. Where two or more names are given as equivalents, the Contractor must use one of the named equivalents.

E. Where one name only is used and is followed by the words "or accepted as equivalent", the Contractor must use the item named, but he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.

F. Equipment, material or devices submitted for review as an "equivalent" to such equipment, material or devices specified must meet the following requirements:

1. The equivalent must have the same construction features such as, but not limited to:

    a. Material thickness, gauge, weight, density, etc.
    b. Welded, riveted, bolted, etc., construction
    c. Finish, priming, corrosion protection

2. The equivalent must perform with the same or better efficiency of energy consumption.

3. Local representation by the manufacturer for service, parts and technical information must be available

4. The equivalent must bear the same labels of performance certification as is applicable to the specified item.

G. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new Drawings and detailing required are to, with the concurrence of the Engineer, be prepared by the Contractor at no cost to the Owner.

H. Where such accepted deviation or substitution requires a different quantity and arrangement of wiring, conduit and equipment from that specified or indicated on the Drawings, with the concurrence of the Engineer, furnish and install any such additional

equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.

I. The definition of "accepted equivalent" is a product that, in the opinion of the Engineer, is acceptable for the intended application in lieu of the product listed in the Specifications or noted on the Drawings and has no cost impact on the project.

J. The definition of substitution is a product that, in the opinion of the Engineer, is of a lesser quality and/or has cost impact on the project or requires other changes to meet the Specification.

1.10 CHANGES IN WORK

A. A Change Order is a written order to the Contractor signed by the Owner and the Architect, issued after execution of the Contract, authorizing a change in the Work or an adjustment in the Contract sum or the Contract time. A Change Order signed by the Contractor indicates his agreement therewith, including the adjustment in the Contract sum or the Contract time.

B. All changes in the Work follow the recommendations of Article 12 of AIA General Conditions of the Contract for Construction.

1.11 MANUFACTURER'S IDENTIFICATION

A. Manufacturer's nameplate, name or trademark and address must be attached permanently to all equipment and materials furnished under this Division. The nameplate must indicate the name of manufacturer, description, size, type, serial or model number, electrical characteristics and other information. Nameplates of a Contractor or distributor are not acceptable.

1.12 SHOP DRAWINGS

A. Refer to individual specification sections for additional submittal information.

B. Submit for review detailed shop drawings of all equipment and material required to complete the project. No material or equipment may be delivered to the job site or installed until the Contractor has in his possession reviewed shop drawings for the particular material or equipment.

C. Submit shop drawings as soon as practical, within 60 days after award of Contract and before any material or equipment is purchased. Submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

D. Submit shop drawings for all equipment and/or devices specified. Included in the shop drawings are manufacturer's names, catalog numbers, cuts, diagrams and other such

descriptive data as may be required to identify the equipment. No consideration will be given to a partial shop drawing submittal. Equipment shop drawings shall be submitted by the manufacturers supplying vendor, catalog reproductions shall not be acceptable.

1. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

2. Clearly indicate all specific options and/or alternatives. Failure to do so will be grounds for rejection.

3. Clearly mark all shop drawings with the specific associated specification section.

E. Failure of the Contractor to submit shop drawings in ample time for review is not an entitlement to an extension of Contract time and no claim for extension by reason of such default will be allowed. Also, it does not entitle the Contractor to purchase, furnish and/or install equipment that has not been reviewed by the Engineer. All costs associated with the delay of construction due to equipment and/or materials arriving late or shipped to the site at a premium cost due to late or improper shop drawing submittal are the responsibility of the Contractor.

F. Furnish all necessary templates, patterns, etc., for installation Work and for the purpose of making adjoining Work conform; furnish setting plans and shop details to other trades as required.

G. Review rendered on shop drawings will not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not indicate that drawings have been checked in detail; said review does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing Work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.

H. Review of shop drawings does not apply to quantity nor relieve the Contractor of responsibility for compliance with the intent of the Drawings and Specifications. Review of shop drawings is final; no further changes will be allowed without the written consent of the Engineer.

I. Shop drawings must be specific with items submitted for review clearly identified in red ink. Data of general nature will not be accepted.

J. Make any corrections required by Engineer and resubmit required number of corrected copies of shop drawings or new samples until accepted. Direct specific attention in writing or on resubmitted shop drawings to revisions other than corrections requested by Engineer on previous submissions. Engineer will review no more than one resubmittal of any shop drawing or sample at Owner's expense. The fees for review of additional resubmittals are to be paid by the Contractor at the Engineer's standard rates.

1.13 RECORD DRAWINGS

A. Maintain a record set of Mechanical Drawings at the job site on which any changes in location of equipment, devices, panels and major conduits are recorded.

B. At the end of construction, provide the Owner with a complete set of As-Built Drawings, including all Mechanical plans, indicate routing of piping, ducts, location of equipment, valves, cleanouts and access panels. Include all inverts and elevations.. As-Built documentation is drawn utilizing the most recent version of AutoCAD. Provide the Owner with a "CD ROM" disk and one set of reproducible mylar documents.

C. Electronic copies of the contract documents will be made available, at the cost of $25.00 per sheet, to the Contractor for use in production of As-Built documentation. The Contractor assumes responsibility for completeness and accuracy of the As-Built documents. Translation or manipulation of electronic documents provided to the Contractor by the Engineer is the responsibility of the Contractor.

1.14 MATERIALS AND WORKMANSHIP

A. All materials and apparatus required for the Work, except as otherwise specified, must be new and of first-class quality and be furnished, delivered, erected, connected and finished in every detail and so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, furnish a first-class standard article as accepted by the Engineer.

B. Furnish the services of an experienced superintendent who is constantly in charge of the installation of the Work, and present on site at all times during the Work. Furnish all skilled Workmen, helpers and labor required to install, unload, transfer, erect, connect up, adjust, start, operate and test each system.

C. Unless otherwise specifically indicated on the Drawings or in the Specifications, all equipment and materials must be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

D. Quality of Work must be consistent with good trade practice and installed in a neat, Workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. Replacement of said Work, in a satisfactory manner, will be at no extra charge to the Owner.

E. Year-2000 Compliant: Certify all digitally controlled/monitored equipment and systems to be "Year 2000 Compliant". Computer hardware and software shall be capable of accurately processing, providing, and receiving date data from, into, and between the twentieth and twenty-first centuries, including leap-year calculations. All program codes are "non-date sensitive" codes that will not cause an automatic program malfunction, stop command, miscalculation or similar function stopping continued and proper operation upon a sequence of numbers that occur by date.

1.15 PROTECTION OF EQUIPMENT AND MATERIALS

A. Work under each Section includes protecting the Work and material of all other Sections from damage by Work or Workmen and includes making good all damage thus caused.

B. The Contractor is responsible for Work and equipment until final turn-over to the Owner. Protect Work and Equipment from water, dust and dirt, and against theft, injury or damage. Carefully store and secure material and equipment received on site that is not immediately installed. Close with temporary covers or plugs open ends of Work during construction to prevent entry of water, obstructing or other foreign materials.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and connecting up completely of any equipment supplied under each Section. Work under each Section also includes exercising special care in handling and protecting equipment and fixtures and includes the cost of replacing any of the above equipment and fixtures which are missing or damaged by reason of mishandling or failure on the part of the Contractor to protect.

1.16 SCAFFOLDING, RIGGING, HOISTING

A. Furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

1.17 EXCAVATION AND BACKFILLING

A. Excavation and backfilling will be coordinated with the Division 31 of the Specifications.

1. It is the responsibility of the Contractor to field coordinate sizes, depths, fill and bedding requirements and any other excavation Work required under this Division.

1.18 WATERPROOFING

A. Where any Work pierces waterproofing, including waterproof concrete and floors in wet areas, review the method of installation with the Engineer before Work is done. Furnish all necessary sleeves, caulking, flashing and fittings required to make openings and penetrations absolutely watertight.

1.19 ACCESSIBILITY AND ACCESS PANELS

A. The Contractor is responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.

B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment includes, but is not limited to: air handling equipment, hydronic systems including valves, coils, drain and vent points, motors, controllers, switchgear, etc.

Furnish access doors if better accessibility is required. Minor deviations from Drawings may be made to allow for better accessibility, but changes of magnitude or which involve extra cost must not be made without review by the Engineer.

C. Field Coordinate access doors in walls, ceilings, floors, etc. It is the responsibility of the Mechanical Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for the Work. Arrange Work in such a manner so as to minimize the quantity of access doors required. Locate all items requiring accessibility in already accessible areas, such as above lay-in ceilings, etc.

D. Upon completion of the Project, physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Relocate any equipment not so furnished or provide additional access panels at no additional cost to the Owner.

E. Furnish and install permanent ladders for access to equipment. Coordinate exact requirements in field.

1.20 TEMPORARY OPENINGS

A. As certain from examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under this Division, and field coordinate the requirements accordingly. In the event of failure of the Contractor to give sufficient notice in time to arrange for these openings during construction, the Contractor assumes all costs of providing such openings thereafter.

1.21 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, perform the connection of the new system at such time as designated by the Owner's representative. Complete Work on premium time if required at no additional cost to the Owner.

B. Notify the Engineer and the Owner of the estimated duration of the shutdown period at least ten (10) days in advance of the date the Work is to be performed.

C. Arrange Work associated with the shutdown of existing systems for continuous performance. Provide all necessary labor, including overtime, if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.22 PAINTING

A. Refer to Division 9 for painting requirements.

B. All materials shipped to the job site under this Division such as panels, plates, etc., must have prime coat and standard manufacturer's finish, unless otherwise specified.

C. Perform all painting in areas in accordance with the following:

1. Paint all concealed, non-insulated hangers, supports and other ferrous metal Work, except that which is galvanized. Coat, prior to installation, inaccessible conduits, hangers, supports, anchors and ducts.

2. Do not paint over the manufacturer's nameplate data on equipment. Take special care to avoid covering or spattering paint on the nameplate.

3. Touch up damaged equipment shop coats in the field.

1.23 TEMPORARY SERVICES

A. Refer to the General Conditions and Special Conditions for a full description of the temporary services to be provided.

1.24 CLEANING

A. Thoroughly clean all equipment of all foreign substances inside and out before being placed in operation.

B. If any part of a system should be stopped or clogged by any foreign matter after being placed in operation, disconnect the system wherever necessary to locate and remove obstructions. Then clean and reconnect the system. Repair or replace any Work damaged in the course of removing obstructions when the system is reconnected at no additional cost to the Owner.

C. Upon completion of Work under the Contract, remove from the premises all rubbish, debris and excess materials left over from the Work. Remove any oil or grease stains on floor areas caused by the Contractor, all floor areas must be left clean.

1.25 GUARANTEES

A. Guarantee all materials and Workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by the Owner.

B. During this guaranteed period, correct or replace all defects developing through materials or Workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.

END OF SECTION 230010

SECTION 23 0500 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. 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. Mechanical demolition.
   9. Painting and finishing.
   10. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

   1. ABS: Acrylonitrile-butadiene-styrene plastic.

   2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.

4. 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.

1.5 QUALITY ASSURANCE

A. 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.

B. Electrical Characteristics for Mechanical 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. There shall be no additional contract costs associated with these modifications.

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 mechanical 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 mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 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 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. JCM Industries.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. 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.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.

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 Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Epco Sales, Inc.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Epco Sales, Inc.

c. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Calpico, Inc.
b. Central Plastics Company.
c. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Precision Plumbing Products, Inc.
b. Sioux Chief Manufacturing Co., Inc.
c. Victaulic Co. of America.

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. Calpico, Inc.
    b. Metraflex Co.
    c. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR 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 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 PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

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.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

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 MECHANICAL DEMOLITION

A. Refer to Division 2 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. 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 Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls 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. 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 7 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 7 Section "Joint Sealants" for materials and installation.

N. 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.

O. 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.

P. 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 7 Section "Through-Penetration Firestop Systems" for materials.

Q. Verify final equipment locations for roughing-in.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before 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.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.

3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section. See drawing for mechanical items to be painted.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

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 mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION 230500

SECTION 23 0529 - 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 hangers and supports for mechanical system piping and equipment.

B. Related Sections include the following:

1. Division 13 Sections on fire-suppression piping for fire-suppression pipe hangers.

2. Division 23 Section "Mechanical Vibration Controls and Seismic Restraints" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

A. Product Data: For each type of pipe hanger and thermal-hanger shield insert indicated.

B. Welding Certificates: Copies of certificates for welding procedures and operators.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pipe Hangers:

a. B-Line Systems, Inc.

b. Grinnell Corp.
c. National Pipe Hanger Corp.

2. Thermal-Hanger Shield Inserts:

a. Carpenter & Patterson, Inc.
b. Pipe Shields, Inc.
c. Rilco Manufacturing Co., Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.

1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.

2. Material for Hot Piping: ASTM C 552, Type I cellular glass.

3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.

4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.

5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

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

C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.

2. Properties: Nonstaining, noncorrosive, and nongaseous.

3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

B. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. 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.

3. 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.

4. 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.

5. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

6. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

9. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

11. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.

12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

13. 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.

14. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

15. 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.

16. 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.

C. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

D. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. C-Clamps (MSS Type 23): For structural shapes.

6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

11. 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.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

F.

F. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support 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. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, strainers, 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.

C. Install mechanical-anchor fasteners in concrete. Install fasteners according to manufacturer's written instructions.

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. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

H. 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 B31.9.

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 arc of 180 degrees.

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.

5. Insert Material: Length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3. 3 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.4 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 0529

SECTION 23 0548 – MECHANICAL VIBRATION & SEISMIC CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: This provides requirements for vibration isolation and seismic control of the equipment as listed in the Vibration Isolation & Seismic Restraint Guide found in Part 4.00, TABLE B. This specification is part of the general conditions for the fire protection, plumbing, & HVAC contracts.

B. Intent: It is the intent of the seismic restraint portion of this specification to provide restraint of non-structural building components. Restraint systems are intended to withstand the stipulated seismic accelerations applied through the component center of gravity.

C. Project Specific information stated below. Identify and provide seismic restrains accordingly:

1. Use Group: B.
2. Seismic Hazard Exposure Group: # 1
3. Effective peak velocity related acceleration, Av: <0.15
4. Seismic Performance Category: C

D. The work in this section includes the following:

1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Certification of seismic restraint designs and installation supervision.
7. Certification of seismic attachment of housekeeping pads.

E. E. Definitions:

1. The term EQUIPMENT is used throughout this specification. It includes ALL non-structural components within the facility and/or serving facility, such as equipment located in outbuildings or outside of the main structure on grade within five feet of the foundation wall. Equipment buried underground are excluded but entry of services through the foundation walls are included. Below is a partial general list of equipment for reference, equipment not listed are still included in this specification. It shall be the responsibility of the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications) to review contract documents and establish a list of equipment which is actually part of the work of this project.

a. Ductwork
b. Piping
c. Fans (All types)

2. Life safety systems defined:

a. Systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust systems.
b. Systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all circuits to fire protection, smoke evacuation and/or emergency lighting systems.
c. Life support systems.
d. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.
e. HVAC, Plumbing and Fire Protection equipment supplied from the emergency power system.

3. Positive Attachment: Positive attachment is defined as a support location with a cast-in or wedge type expansion anchor, a double-sided beam clamp, a welded or through bolted connection to the structure.

4. Transverse Bracing: Restraint(s) applied to limit motion perpendicular or angular to the centerline of the pipe, duct, or conduit.

5. Longitudinal Bracing: Restraint(s) applied to limit motion along the centerline of the pipe, duct, conduit etc.

1.2 SEISMIC RESTRAINT/VIBRATION ISOLATION PROFESSIONAL ENGINEER OF RECORD

A. The Contractor shall obtain and pay for the services of a Professional Engineer, with at least 5 years of seismic Restraint/Vibration Isolation design experience, licensed to practice in the state in which this project is being constructed. This Professional Engineer shall be responsible for the implementation of requirements of this section of the specifications and is referred to herein as the "Seismic Restraint/Vibration Isolation Professional Engineer of Record".

B. As part of the requirements of this specification article, the Seismic Restraint/Vibration Isolation Professional Engineer of Record shall be responsible for the design and selection of all seismic restraint/vibration isolation elements of work as required by this specification section. This Seismic Restraint/Vibration Isolation Professional Engineer of Record shall obtain and pay for Errors and Omissions Insurance and shall submit a certificate of such insurance with the shop drawings required by this specification section.

C. The Seismic Restraint/Vibration Isolation Professional Engineer of Record shall certify the correctness of the entire installation of elements of seismic restraint/vibration isolation work required by this specification section upon the completion of work. Refer to PART 3 of this specification section for additional information.

D. In addition to other requirements of this specification section the Seismic Restraint/Vibration Isolation Professional Engineer of Record shall submit a letter (or letters depending on status of construction) in a format, essentially, as follows with highlighted entries to be completed on a job-specific basis.

" TO: *CONTRACTOR NAME AND ADDRESS*

RE: *PROJECT NAME AND ADDRESS*

Gentlemen:

_____, PE, is a Professional Engineer with over 5 years of professional seismic restraint/vibration isolation design experience (examples, reference, etc. are available on request). In my capacity as the Seismic Restraint/Vibration Isolation Professional Engineer of Record responsible for the seismic restraint and vibration isolation design and installation for this project, I have affixed my signature and seal below to certify and attest to the following:

1. I have personally checked the following data and calculations provided by *TO BE COMPLETED AS REQUIRED* and find all of same to be correct and in accordance with all requirements of *INDICATE ALL APPLICABLE CODES AND SPECIFICATION SECTIONS*. In addition, I have verified that all equipment weights indicated in the calculations are the correct weights for the equipment as actually installed.

LIST ALL DATA BEING SUBMITTED WITH DATES, SOURCE OF ORIGIN, ETC.

2. All seismic restraint cables are installed at an angle not exceeding those which are indicated in the calculations. All building attachments are made in accordance with the calculations.

3. I have personally reviewed drawings *PROVIDE APPROPRIATE LISTING*, as prepared by *PROVIDE SOURCE OF ORIGIN OF SUCH DRAWINGS* and attest to the following:

    a. All required seismic restraints are indicated thereon.

4. All elements of coordination with the project Structural Engineer have been accomplished.

    a. Attached to this letter is written confirmation of same from the project Structural Engineer.

5. All elements of all seismic restraint and vibration isolation systems, including housekeeping pads and all connections to all building and structural elements are properly installed. "

E. It is not the intent of this specification section to require (or preclude) the use of the exact same Seismic Restraint/Vibration Isolation Professional Engineer of Record for each trade. It is the intent of this specification to require that any Seismic Restraint/Vibration Isolation Professional Engineer of Record provided by any trade meet all requirements of this specification section.

1.3 OEM EQUIPMENT ISOLATION PACKAGES

A. Internal and/or External Systems:

1. Substitution of internally or externally isolated and restrained equipment supplied by the equipment vendor, in lieu of the isolation and restraints specified in this section, is acceptable provided all conditions of this section are met. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department signed and sealed by a Professional Engineer licensed to practice in the State in which this project is being constructed, stating that the seismic restraints are in full compliance with these specifications. Letters from field offices or representatives are unacceptable.

2. Costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment vendor in the event of non-compliance with the preceding.

3. Substitution using internal isolation is not acceptable for:

   a. Rooftop Equipment
   b. Critical office locations such as executive and conference areas.

4. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure. This attachment and certification thereof shall be by this section.

1.4 SUBMITTAL DATA REQUIREMENTS

A. Submittals:

1. Catalog cuts or data sheets on specific vibration isolators and restraints to be utilized detailing compliance with the specification including specification reference "TYPE" as per "PRODUCTS" section of this specification.

2. An itemized list of all isolated and non-isolated equipment with detailed schedules showing isolators and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.

3. Every sheet of every shop drawing associated with this section of the specification shall be signed and sealed by the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications). This Professional Engineer shall certify, by signing and sealing the submittals, that all requirements of this specification section are being met including vibration isolator selections. Submittals and shop drawings not meeting this requirement will be rejected.

B. Shop Drawings:

1. Show base construction for equipment; include dimensions, structural member sizes and support point locations.

2. When any new or existing element of the building, including but not limited to walls, slabs, any building structural elements, etc., are used for seismic restraint connections, details of acceptable methods of connection must be submitted along with supporting certified calculations. All details of all connections must be made in a manner and with methods as approved by the project Structural Engineer. Submit all details (signed and sealed as required hereinafter) to the Architect prior to proceeding with any work.

3. Indicate isolation devices selected with complete dimensional and deflection data before condition is accepted for installation.

4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

5. Coordinated drawings shall be marked-up with the specific locations and types of restraints indicated for all pipe, duct, conduit and cable tray.

6. For ceiling suspended equipment provide minimum/maximum installation angle allowed for restraint system.

7. Every sheet of every shop drawing associated with this section of the specification shall be signed and sealed by the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications). This Professional Engineer shall certify, by signing and sealing the submittals, that all requirements of this specification section are being met including vibration isolator selections. Submittals and shop drawings not meeting this requirement will be rejected.

C. Seismic Certification and Analysis:

1. Seismic restraint calculations certifying that all seismic restraint devices are capable of accepting, without failure, the "G" forces detailed in Table A below. Calculations must be provided for all connections of equipment to the structure. All performance of products (such as; strut, cable, anchors, clips, etc.) associated with restraints must be supported with manufacturer's data sheets or certified calculations. Note: For roof-mounted equipment both the seismic acceleration and wind loads shall be calculated, the highest load shall be utilized for the design of the restraints and isolators.

2. Every page of all calculations and analysis to support seismic restraint designs must be signed and sealed by the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications).

3. Calculations and analysis must indicate calculated dead loads, derived loads and materials utilized for connections to equipment and structure. Calculations and analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.

   a. The calculations and analysis shall include documentation indicating that all details of all seismic restraint loads and details of connections of vibration isolation and seismic restraint systems have been coordinated with the Project Structural Engineer. The Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications) shall clearly indicate that this coordination has taken place and that all building structural systems (new and existing) and all housekeeping pads have been reviewed by the Project Structural Engineer and determined to be capable of

accepting all seismic loads. As part of this requirement, it shall be the responsibility of the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications) to obtain written confirmation from the Project Structural Engineer that all seismic loads have been suitably accommodated by the building structural systems.

b. The analysis must clearly and specifically, on a case-by-case basis, detail all methods of connection and indicate all loads transmitted to the building structural systems.

4. A seismic design Errors and Omissions insurance certificate must accompany submittals from the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications). Manufacturer's product liability insurance certificates are not acceptable.

5. Table elevations refer to the structural point of attachment of the equipment support system. (i.e. Use floor slab for floor supported equipment and the elevation of the slab above for suspended equipment.)

TABLE A
DESIGN LEVEL OF ACCELERATION
AT EQUIPMENT CENTER OF GRAVITY

Elevation (Expressed in Feet Relative to Grade Level)	Rigid* Mounted Equipment	Flexible* Mounted Equipment	Pipe, Duct, Cable Trays, Conduit, etc.	Life Safety Equipment
Seismic Zone 1 A_V = 0.05 to 0.09				
Below Grade up to 20 Feet Above Grade	0.100 "G"	0.400 "G"	0.250 "G"	1.000 "G"
21 ft. - 300 ft.	0.200 "G"	0.450 "G"	0.400 "G"	
301 ft. - 600 ft.	0.350 "G"	0.500 "G"	0.500 "G"	
Seismic Zone 2 A_V = 0.10 to 0.19				
Below Grade up to 20 Feet Above Grade	0.125 "G"	0.500 "G"	0.350 "G"	1.000 "G"
21 ft. - 300 ft.	0.500 "G"	0.750 "G"	0.650 "G"	
301 ft. - 600 ft.	0.750 "G"	1.000 "G"	1.000 "G"	

* Rigid mounted equipment is any equipment mounted directly to structure. Flexible mounted equipment is any equipment mounted on resilient supports, ceiling suspended, roof supported or mounted on an independent frame with any primary natural frequency below 16 Hz.

1.5 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration and seismic control equipment shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide equipment vibration isolation and seismic restraints as specified.
3. Guarantee specified isolation system deflections.
4. Provide installation instructions, drawings and field supervision to insure proper installation and performance of systems.
5. Coordination of all details of vibration isolation and seismic restraint connections to the structure (new or existing). As part of this requirement, it shall be the responsibility of this section to clearly detail all connections to structure (new or existing).

1.6 RELATED WORK

A. Supplementary Support Steel: Structural support and connections for all equipment, including roof-mounted equipment, specified in other sections shall comply with the seismic requirements of this section.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Devices: Vibration isolation and seismic devices described in this section shall be the product of a single manufacturer. Vibration Mountings & Controls, Inc. East is the base manufacturer of these specifications. Products of other manufacturers are acceptable provided their systems strictly comply with intent, structural design, performance and deflections of the Base Manufacturer.

B. Attachments: Hardware and devices such as beam clamps, anchor bolts, cables and cast-in-place plates must be by this section's supplier to ensure seismic compliance and certification. The contractor has the option to utilize alternate fastening devices (anchor bolts) so long as the sizing and dimensions on seismic submittals are followed.

C. Isolators: The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness shall be out of resonance with equipment forcing frequencies or support structure natural frequency.

2.2 SEISMIC RESTRAINTS AND VIBRATION ISOLATION TYPES

A. General:

1. All isolation and seismic restraint devices shall be capable of accepting, without failure, the "G" forces as determined by the seismic certification and calculations as described in the "SUBMITTAL DATA REQUIREMENTS" section of these specifications.

2. Corrosion protection for both indoor and outdoor applications shall be as follows:

   a. Springs, Zinc electroplated or powder coat
   b. Hardware, Zinc electroplated
   c. All other metal parts, Zinc electroplated, powder coat, hot spray or hot dipped galvanized

3. All seismic restraint devices:

   d. Shall maintain the equipment in a captive position and not short circuit isolation devices during normal operating conditions.
   e. Shall have provisions for bolting and/or welding to the structure.

B. Seismic Restraint Types:

1. TYPE I: Same as Type B. Cast or aluminum housings, (except ductile iron) are not acceptable.

   Vibration Mountings & Controls, Inc. East, TYPE RS

2. TYPE II: Where required, each corner or side of equipment base shall incorporate a seismic restraint snubber having an all-directional resilient pad limit stop. Restraints shall be fabricated of plate, structural members or square metal tubing. Angle bumpers are not acceptable.

   Vibration Mountings & Controls, Inc. East, Type SSN

3. TYPE III: Restraints for suspended systems.

   a. Isolated systems braced with multiple steel cable type with approved fastening devices to equipment and structure.

      Vibration Mountings & Controls Inc. East, Type SCA

   b. Non-isolated systems braced with structural steel strut type with approved fastening devices to equipment and structure.

      Vibration Mountings & Controls Inc. East, Type SRA

4. TYPE IV: Double deflection neoprene isolator encased in ductile iron or steel casing.

   Vibration Mountings & Controls, Inc. East, Type SNCM

5. TYPE V: Rigid attachment to structure utilizing wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Powder shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with ICBO National standards for seismic anchorage.

C. Vibration Isolator Types:

1. TYPE A: Spring Isolator - Free Standing:

a. Spring shall have a minimum outer diameter to overall height ratio of 0.8 : 1 at rated deflection.

b. Reserve deflection (from that at published rated load to solid height) equal to 50% of the rated deflection.

c. Formed steel or ductile top cup with adjusting bolt and locking cap screw for securing to equipment.

d. Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.

Vibration Mountings & Controls Inc. East, Type FSS

2. TYPE B: Spring Isolator - Restrained: Shall be the same as TYPE A with the following additional features.

a. Leveling assembly which does not compromise the integrity of the restraint hardware.

b. Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.

c. Internal spring adjusting nut or bolt.

d. Capability of supporting equipment at fixed elevation during equipment installation.

e. Built-in all-directional limit stops with no less than 1/8" and no more than 1/4" clearance under normal operation.

Vibration Mountings & Controls, Inc. East, Type RS

3. TYPE C: Spring Hanger Isolator:

a. Spring element (same as Type A) with steel upper spring retainer and a lower elastomer retainer cup with an integral bushing to insulate lower support rod from the hanger box.

b. Steel hanger box shall be hinged to allow for a minimum of 30-degree misalignment between the rod attachment to structure and the connection to the supported equipment. Hanger boxes shall withstand three times the rated load without failure.

c. When used on ductwork, provide eyebolts for attachment to duct straps.

Vibration Mountings & Controls Inc. East, Type SASH

4. TYPE D: Double deflection neoprene isolator encased in ductile iron or steel casing.

Vibration Mountings & Controls, Inc. East, Type SNCM

5. TYPE E: Elastomer Hanger Isolator:

a. Molded neoprene element with an integral bushing to insulate lower support rod from the hanger box.

b. Steel hanger box shall be hinged to allow for a minimum of 30-degree misalignment between the rod attachment to structure and the connection to the supported equipment. Hanger boxes shall withstand three times the rated load without failure.

c. When used on ductwork, provide eyebolts for attachment to duct straps.

Vibration Mountings & Controls, Inc. East, Type SANH.

6.

6. TYPE F: Combination Spring/Elastomer Hanger Isolator: Spring and neoprene elements in a hinged steel hanger box with the features as described for TYPE C and E isolators.

Vibration Mountings & Controls, Inc. East, Type SANSH.

7. TYPE G: Pad type elastomer isolator:

a. Neoprene pad shall have 0.75" minimum thickness and shall have opposed cylindrical supports spaced on one-inch centers to provide uniform deflection of 0.1 inch under rated load. Supports shall be connected in the center by an 1/8" tear strip to facilitate trimming to desired size in one-inch increments. Supports will also have thru holes to accept up to 3/8" bolts without special drilling or coring.
b. 1/16" galvanized steel plate between multiple pad layers.
c. Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
d. When bolting is required for seismic and wind load compliance, neoprene and duck washers and bushings shall be provided to prevent short-circuiting of bolt.

Vibration Mountings & Controls, Inc. East, Type NP pad

8. TYPE H: Pad type elastomer isolator

a. Laminated canvas duck & neoprene, maximum loading 1000 psi, minimum 1/2" thick.
b. Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
c. When bolting is required for seismic and wind load compliance, neoprene and duck washers and bushings shall be provided to prevent short-circuiting.

Vibration Mountings & Controls, Inc. East, Type NIDP Pad.

9. TYPE I: Thrust Restraints:

a. A spring element same as TYPE A shall be combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting thrust movement of air moving equipment to 1/4".
b. Restraints shall be easily converted in the field from a compression type to tension type.
c. Unit shall be factory precompressed.

Vibration Mountings & Controls Inc. East, Type TR.

10. TYPE J: Telescoping Riser Guide - non isolated: Telescoping arrangement of two sizes of steel tubing

Vibration Mountings & Controls, Inc. East, Type TPG.

11.

11. TYPE K: Resilient Pipe Anchors and Guides:

a. All directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of TYPE H pad.
b. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction.
c. Allowable loads on neoprene pad shall not exceed 500 PSI and the design shall be balanced for equal resistance in any direction.

Vibration Mountings & Controls, Inc. East, Type RPTG and RPA.

12. TYPE L: Isolated Pipe Hanger System:

a. Precompressed spring and elastomer isolation hanger combined with pipe support into one assembly. Replaces standard clevis, single or double rod roller, or double rod fixed support.
b. Spring element (same as Type A) with steel lower spring retainer and an upper elastomer retainer cup with an integral bushing to insulate support rod from the isolation hanger.
c. The neoprene element under the lower steel spring retainer shall have an integral bushing to insulate the support rod from the steel spring retainer.
d. Hanger shall be hinged to allow for a minimum of 30-degree misalignment between the rod attachment to structure and the connection to the isolation hanger. Hangers shall be designed and constructed to support loads over three times the rated load without failure.
e. System shall be precompressed to allow for rod insertion and standard leveling.

Vibration Mountings & Controls, Inc. East, Type CIH, CIR, TIH, TIR and PIH.

13. TYPE M: Flashable restrained isolator:

a. Shall have all features of TYPE B isolator.
b. Shall have waterproof spring covers for adjustment or removal of springs.
c. Unit shall have a structural top plate for welding or bolting of supplementary support steel.
d. Isolator shall accept 2" roofing insulation and be flashed directly into the waterproofing membrane.
e. To be complete with wood nailer and flashing.

Vibration Mountings & Controls, Inc. East, Type FRS.

14. 14. TYPE P: Elastomer Isolator:

a. Double deflection neoprene compression mountings shall have all metal surfaces neoprene coated.
b. Non-skid top and bottom surfaces.
c. Threaded bolting sleeves shall be embedded in the isolator.
d. Drilled tie-down boltholes shall be provided in the base plate.

Vibration Mountings & Controls, Inc. East, Type NCM.

2.3 EQUIPMENT BASES

A. General: Curbs and roof rails are to be bolted or welded to the building steel or anchored to the concrete deck to attain specified acceleration criteria and shall also be capable of resisting a minimum 110 MPH wind loads (non-simultaneous).

B. Base Types:

1. TYPE B-1: Integral Structural Steel Base:

   a. Constructed of structural members as required to prevent base flexure at equipment startup and misalignment of driver and driven units. Centrifugal fan bases shall be complete with motor slide rails and drilled for drive and driven units.
   b. Height saving brackets shall be used to reduce operating height and maintain 2" operating clearance under base where required.
   c. Member depth shall be such that the maximum deflection of the longest side to be 1/360 of span, not to exceed 1/2".

   Vibration Mountings & Controls Inc. East, Type SB.

2. TYPE B-2: Concrete Base:

   a. Steel or removable concrete forms for floating foundations. Bases for pumps shall be large enough to support elbows and/or suction diffusers. The base depth shall be a minimum of 1/12 the longest unsupported span, but not less than 6" or greater than 12". Forms shall include concrete reinforcement consisting of steel bars or angles welded in place on 6" centers both ways. A layer 1-1/2" above the bottom.
   b. Isolators may be set into pocket housings which are an integral part of the base construction or utilize height saving brackets set at the proper height to maintain 2" clearance below the base. Base shall be furnished with templates for equipment attachment and anchor bolt sleeves.

   Vibration Mountings & Controls, Inc. East, Type CB or CBR (Formerly KIPWF)

3. TYPE B-3: Spring Roof Curb:

   a. Structural steel spring isolation curbs that bear directly on the roof support structure and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturer's or field fabricated curbs shall not be used.
   b. Spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Disassembly of the weather and air seal to gain access to the isolators is not acceptable.
   c. Springs shall have all of the features of TYPE B.
   d.
   d. Shall be sound attenuating type utilizing standard 2" roof insulation supplied as part of the work of this section of specifications and installed by the contractor installing the curb to act thermally outside and acoustically inside. Curbs supplied without this feature shall be factory acoustically lined with 2" duct liner.

e. An airtight neoprene seal shall be incorporated into the curb design to prevent air leakage or infiltration. Air Seal must not be exposed so that it could be damaged or that in the event of the air seal failure, water could leak into the curb's interior.
f. Wood nailer and flashing shall be provided.
g. Shall be manufactured to NRCA standards.
h. Shall include a means of incorporating a sound barrier package, consisting of two layers of waterproof gypsum board. The waterproof gypsum board shall be furnished and installed by the Contractor installing the curb.
i. Contractor shall have the option of ordering the curb built to the roof pitch or field leveled in accordance with all seismic provisions of this section.
j. Individual pier supported curbs are not acceptable. Curbs shall be bolted or welded to the building steel or anchored to the concrete deck to attain specified acceleration criteria and shall also be capable of resisting a minimum 110 MPH wind load. (Non-simultaneous)

Vibration Mountings & Controls, Inc. East, Type P.

4. TYPE B-4: Flashable Roof Rail System - Isolated:

a. Continuous structural support rails that combine equipment support and isolation mounting into one unitized assembly.
b. Rails shall incorporate TYPE B springs, adjustable, removable and interchangeable after equipment has been installed.
c. The system shall maintain the same installed and operating height with or without the equipment load and shall be capable of being utilized as a blocking device .
d. The entire assembly shall be an integral part of the roof's membrane waterproofing and shall be dry galvanized or plastic coated.
e. Supply unit with continuous upper and lower galvanized flashing.
f. Cross brace rails at support and equipment attachment points when used in seismic zones.
g. Rails shall be bolted or welded to the building steel or anchored to the concrete deck to attain specified acceleration criteria and shall also be capable of resisting a minimum 110 MPH wind load. (Non-simultaneous)

Vibration Mountings & Controls, Inc. East, Type R.

5. TYPE B-5: Transformer Base:

a. Base shall be constructed from structural steel angles or channels sized as required to prevent flexure and misalignment under load.

b. Each base shall be the full length of the supported equipment and be welded or bolted to a series of TYPE B isolators. Bolt-on cross ties at the ends and center shall form one rigid platform.

Vibration Mountings & Controls, Inc. East, Type TRAF and TRCF.

6. TYPE B-6: Non-isolated roof curb: Same as B-3 without spring isolation.

Vibration Mountings & Controls, Inc. East, Type P-6000.

7. TYPE B-7: Computer room Unit Base:

a. Computer room air conditioning units shall be welded or bolted to welded structural steel stands having a minimum 1/2 "G" certified lateral acceleration capabilities or if greater, the acceleration required per the seismic calculations required by the SUBMITTAL REQUIREMENTS section of these specifications.
b. Stand shall have + 1-1/2" of leveling adjustment.

Vibration Mountings & Controls, Inc. East, Type CRTF

8. TYPE B-8: Non-isolated: Same as continuous support rails, Type B-4 without the spring isolation.

Vibration Mountings & Controls, Inc. East, Type R-7000

9. TYPE B-9: Steel Rails:

a. Steel members of sufficient strength to prevent equipment flexure during operation.
b. Height saving brackets as required to reduce operating height.
c. Rails shall be cross-braced at support and equipment attachment points when used in seismic zones.

Vibration Mountings & Controls Inc. East, Type SR.

10. TYPE B-10: Flashable Covered Island Roof Curb - Isolated

a. Similar to Type B-4 except four sided with covered center section and complete with internal draining system.
b. Top of base shall be at least 22" above point of connection to existing roof deck.

Vibration Mountings & Controls, Inc. East, Type P-6300

2.4 FLEXIBLE CONNECTORS

A. All connectors shall be installed on the equipment side of shutoff valves; horizontal and parallel to equipment shafts whenever possible. Piping shall be supported and/or anchored to resist pipe movement beyond the allowable movement of the flexible connector. Installations must include check valves and/or other design and installation precautions to reduce the threat to life safety when subjected to the specified seismic accelerations. The manufacturer's submittal package must detail the design precautions included and/or the installation precautions required.

B. TYPE FC-1: Elastomer connector:

1. Manufactured of nylon tire cord and neoprene, both molded and cured in hydraulic presses.

2. Straight connectors to have two (2) spheres with stabilizing ring in between, for sizes 2" thru 24".

3. Rated at 220 psi at 150°F, dropping linearly to 150 psi at 220°F for sizes 1-1/2" to 12".

4. Standard connectors on isolated equipment and on unanchored piping to employ control rods with neoprene end fittings isolated from anchor plates by means of neoprene bushings when pressures exceed:

a. 170 PSI on pipe sizes to 8"

b. 150 PSI on pipe size 10"
c. 100 PSI on pipe sizes 12"-14"
d. 50 PSI on pipe sizes 16"-24"

5. Connectors installed on unanchored piping shall have control rods or cables.

6. Connectors shall be installed pre-extended per manufacturer's recommendations to prevent elongation under pressure.

7. Minimum safety factor of 3:1 at maximum pressure ratings.

8. Connectors bolted to victaulic type coupling or gate, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange.

Vibration Mountings & Controls, Inc. East, Type TSF

C. TYPE FC-2: Flexible Stainless-Steel Hose:

1. Stainless steel hose and braid rated with 3:1 safety factor.

2. 2" diameter and smaller with male nipples, 2-1/2" and larger with fixed steel flanges.

Vibration Mountings & Controls, Inc. East, Type SS.

D. TYPE FC-3: Wire Braid Reinforced Flexible Metal Hose:

1. Metal hose and braid rated with a minimum 3:1 safety factor. (Minimum 150 PSI)

2. Copper tube ends.

Vibration Mountings & Controls, Inc. East, Type RC.

PART 3 - EXECUTION

3.1 GENERAL

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all submittal data.

B. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

C. Do not proceed with work until details of connections to any building element (new or existing) have been reviewed and approved by the project Structural Engineer as required in Part 1 of this section of the specifications.

3.2 EQUIPMENT INSTALLATION

A. Equipment shall be isolated and restrained as indicated in TABLES B, C, & E at the end of this section.

B. Additional Requirements

1. The minimum operating clearance under bases shall be 2".
2. All bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment, isolators and restraints.
3. Spring isolators shall be installed after all equipment is installed without changing equipment elevations.
4. After the entire installation is complete and under full operational load, the spring isolators shall be adjusted so that the load is transferred from the blocks to the isolators.
5. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolators or the isolation system. The equipment shall be free to move in all directions.
6. Install equipment with flexibility in wiring.
7. Thrust restraints shall be installed on all cabinet fan heads, axial or centrifugal fans whose thrust exceeds 10% of unit weight.
8. Anchor equipment or isolators to housekeeping pads, see paragraph 1.5 - Related Work.
    a. Where housekeeping pads for equipment in this section are not properly doweled or bolted, using wedge type expansion anchors, to the structure to meet the acceleration criteria, it will be the responsibility of this section of the specifications to design and install attachment systems as required.

3.3 PIPING and DUCTWORK ISOLATION

A. Installation:

1. General:
    a. Hanger isolators shall be installed with the hanger box hung as close as possible to the structure. (without touching)
    b. Hanger rods shall not short circuit the hanger box.
    c. TYPE L hangers may be substituted for all other hangers listed below.
    d. Pre-compressed hangers shall only be used if installed along with piping.
2. Ceiling supported piping outside shafts connected to rotating or reciprocating equipment and pressure reducing stations, whether the equipment is isolated or not, shall be isolated as follows:
    a. Water and steam piping within 50 feet or 100 pipe diameters (whichever is greater) from equipment connection.
        1) Horizontal suspended water piping 1-1/4" to 2" and all steam piping larger than 1" shall be hung with TYPE E isolators with 0.3" deflection.
        2) Water pipe larger than 2" shall be hung with TYPE F isolators. The first three supports for piping connected to isolated equipment shall have deflection equal to the equipment isolators up to 2" deflection, all supports thereafter shall have 0.75" deflection isolators.

3. Floor supported piping outside shafts connected to isolated rotating or reciprocating equipment and pressure reducing stations shall be isolated as follows:
   a. Horizontal floor or roof mounted water piping 1-1/4" to 2" and all steam piping larger than 1" shall be supported by TYPE P isolators with a minimum 0.3" deflection.
   b. Water pipe larger than 2" shall be supported by TYPE B isolators with a minimum of 0.75" deflection.
4. Control air piping and vacuum piping from compressor discharge to receiver shall be suspended by TYPE E isolators with a minimum 0.3" deflection or supported by TYPE P isolators with a minimum 0.3" deflection.
5. All ductwork over four square feet face area located in the mechanical equipment room(s) shall be supported by TYPE C hangers with a minimum of 0.75" deflection.
6. Emergency generator exhaust shall be isolated with TYPE C isolators with a minimum of 0.75" deflection (all neoprene components shall be omitted).
7. Vertical riser supports for pipe 4" diameter and larger shall be isolated from the structure using TYPE K guides and anchors.
8. Install TYPE FC-1 flexible connectors at all connections of pipe to pumps and chillers, and to other isolated equipment only as shown on drawings. Where they are not installed on isolated equipment, insert spool pieces on the equipment side of shutoff valves.
9. Install FC-2 and FC-3 connectors only at locations which exceed temperature limitations of FC-1 or service requires stainless steel or bronze construction flex. (Such as gas, fuel oil, steam or refrigerant)

3.4 SEISMIC RESTRAINTS

A. Installation:

1. All equipment shall be isolated and restrained per TABLES B, C, & E at the end of this section.
2. All floor mounted equipment whether isolated or not shall be snubbed, anchored, bolted or welded to the structure to comply with the required acceleration. Calculations that determine that isolated equipment movement may be less than the operating clearance of snubbers (restraints) do not preclude the need for snubbers. All equipment must be positively attached to the structure.
3. All suspended equipment including, but not limited to fans, tanks, stacks, VAV boxes, unit heaters, fan powered boxes, cabinet unit heaters shall be two or four point independently braced with TYPE III restraints, installed taught for non-isolated equipment and slack with ½" cable deflection for isolated equipment. Support rod compressive stress resulting from seismic accelerations shall be included in the calculations and addressed accordingly. VAV Boxes attached directly to ductwork on the main supply side shall be considered as ductwork for seismic design purposes.

4. All horizontally suspended pipe, duct, cable trays, bus duct and conduit shall use RESTRAINT TYPE III or V. Support rod compressive stress resulting from seismic accelerations shall be included in the calculations and addressed accordingly. Spacing of seismic bracing shall be as per TABLE E at the end of this section:

5. For all trapeze supported piping and conduit, the individual pipes and conduits must be transversely and vertically restrained to the trapeze support at the designated restraint locations.

6. For all supported equipment, over stress of the building structure must not occur. Bracing may occur from:

    a. Flanges of structural beams.
    b. Upper truss chords in bar joists.
    c. Cast in place inserts or drilled and shielded inserts in concrete structures.

7. Pipe Risers:

    a. Where pipes pass through cored holes, core diameters to be a maximum of 2" larger than pipe O.D., including insulation. Cored holes must be packed with resilient material or fire stop as specified in other sections of this specification and/or state and local codes. No additional horizontal seismic bracing is required at these locations.
    b. Non-isolated, constant temperature pipe risers through cored holes require a riser clamp at each floor level on top of the slab attached in a seismically approved manner for vertical restraint.
    c. Non-isolated, constant temperature pipe risers in pipe shafts require structural steel attached in a seismically approved manner at each floor level and a riser clamp at each floor level on top of and fastened to the structural steel. The riser clamp and structural steel must be capable of withstanding thermal, static and seismic loads.
    d. Isolated and/or variable temperature risers through cored holes require Type K riser resilient Guides and Anchors installed to meet both thermal expansion and seismic acceleration criteria. Each floor level must have either a riser clamp that does not interfere with the thermal expansion/contraction of the pipe or a riser clamp/cable assembly (also non-interfering) capable of supporting the weight of the pipe between floors in the event of pipe joint failure. Riser guides and anchors must also be selected to serve as seismic restraints.
    e. Isolated and/or variable temperature risers in pipe shafts require Type K resilient riser guides and Anchors installed on structural steel to meet both thermal expansion and seismic acceleration criteria. Each floor level must have a riser clamp/cable assembly that does not interfere with the thermal expansion/contraction of the pipe capable of supporting the weight of the pipe between floors in the event of pipe joint failure. Riser guides and anchors must also be selected to serve as seismic restraints.

8. Chimneys, stacks and boiler breeching passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps.

9. Lay-in ceilings in compliance with seismic zone requirements may use earthquake clips or other approved means of positive attachment to secure fixtures such as panel light and diffusers to T-bar structure.

10. Non-isolated floor or wall mounted equipment and tanks shall use RESTRAINT TYPE III or V.

11. Where base anchoring of equipment is insufficient to resist seismic forces, restraint TYPE III shall be located above the units center of gravity to suitably resist "G" forces specified.

    a. Vertically mounted tanks and up-blast tubular centrifugal fans, tanks, or similar equipment, may require this additional restraint.

B. Exclusions:

1. Exclusions which DO NOT apply for Life Safety equipment regardless of governing code

    a. Piping:

        1) Sizes of fuel oil, natural gas, and sizes of any piping, containing hazardous or corrosive materials.

        2) Sizes of fire protection piping standpipe, risers, mains and branches.

    b. Duct: Smoke evacuation duct or fresh air make-up connected to emergency system, and any duct associated with Life Safety Systems identified in Part 1 of this section of the specifications.

2. Exclusions for equipment in governed by Code

    a. Curb mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded unless specifically detailed in the schedules or drawings.

    b. Duct:

        1) Rectangular, Square, and Oval air handling ducts (other than ducts described in paragraph 1.c. above) less than six square feet in cross sectional area.

        2) Round air handling duct (other than ducts described in paragraph 1.c. above) less than 28 inches in diameter.

        3) Duct (other than ducts described in paragraph 1.c. above) supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork with positive support to the structure.

    c. Piping

        1) Piping (other than piping described in paragraph 1.b. above) less than 2-1/2" diameter.

        2) Clevis or trapeze supported piping (other than piping described in paragraph 1.b. above) suspended by hanger rods less than 12 inches in length (6 inches or less for fire sprinkler piping) with positive attachment to structure.

3) PVC or Fiberglass suspended waste or vent pipe 6 inch diameter or smaller.

3.5 INSPECTION

A. Upon completion of installation of vibration isolation and seismic restraint devices, a certification report prepared, signed and sealed by the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications) shall be submitted in writing to the contractor indicating that all systems, including those furnished as OEM equipment, are installed properly, and are in accordance with all codes, rules, and regulations, and are in compliance with the specifications. The report must identify those areas that require corrective measures or certify that none exists. If corrective measures required, follow-up reports shall be prepared by the Seismic Restraint/Vibration Isolation Professional Engineer of Record (see paragraph 1.2 of this section of specifications) until all systems, including those furnished as OEM equipment, are in complete compliance with all aforementioned criteria. Any field coordination type changes to the originally submitted seismic restraint designs must be clearly defined and detailed in this report. Copies of each report shall be submitted to the Engineer, and shall be included by the Contractor in the Installation, Operation and Maintenance Manuals.

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PART 2 - CHARTS AND REFERENCE DATA

TABLE B Vibration Isolation & Seismic Restraint Guide for HVAC Equipment				EQUIPMENT INSTALLATION ATTACHMENT POINT								
				ON GRADE					ABOVE GRADE			
EQUIPMENT		SIZE (5) (8)	MOUNTING	ISOL	DEFL	BASE	RESTR		ISOL	DEFL	BASE	RESTR
Air Handling/Conditioning Units & Cabinet Type Fans		To 10 hp	Floor	D	0.30	(1)	V		B	0.75	(1)	V
			Ceiling	- -	- -	- -	- -		F	0.75	(1)	III
		Over 10 hp	Floor	D	0.30	(1)	V		B	(2)	(1)	V
			Ceiling	- -	- -	(1)	III		F	(2)	(1)	III
Air or Refrigerant Compressors	Tank	To 10 hp	Floor	D	0.30	- -	V		B	0.75	- -	V
		Over 10 hp		B	0.75	- -	V		B	1.50	B-2	V
	Unitary	To 10 hp		D	0.30	- -	V		B	0.75	B-2 (3)	V
		Over 10 hp		B	0.75	- -	V		B	1.50	B-2 (3)	V
Air Cooled Condensers		All	Roof	- -	- -	- -	- -		B	1.50	B-8	V
Axial Fans		To 15 hp	Floor (roof)	D	0.30	- -	V		B	(2)	(B-3 or 4)	V
			Ceiling	- -	- -	- -	- -		F		- -	III
		Over 15 hp	Floor (roof)	B	0.75	- -	V		B		(B-3 or 4)	V
			Ceiling	- -	- -	- -	- -		F		- -	III
Boilers & Steam Generators		All	Floor	- -	- -	- -	V		B	0.75	- -	V
		Electric		- -	- -	- -	V		G	0.10	- -	V
Centrifugal Fans	Arrg't 1 & 3	All	Floor (roof)	B	0.75	B-1	V		B		B-1(B-4)	V
			Ceiling	- -	- -	- -	- -		F	(2)		III
	Arrg't 4, 9 & 10		Floor (roof)	D	0.30	- -	V		B	(6)	(B-4)	V
			Ceiling	- -	- -	- -	- -		F		- -	III
Chillers & Condensing Units	Absorb.	All	Floor	G	0.10	- -	V		B	0.75	- -	V
	Centrif.		Floor	G	0.10	- -	V		B	0.75	- -	V
	Recipr.	(8)	Floor (roof)	B	0.75	- -	V		B	1.50	(B-4)	V
	Rotary		Floor (roof)	G	0.10	- -	V		B	0.75	(B-4)	V
Computer Room Units		All	Floor	- -	- -	B-7	V		- -	- -	B-7	V
			Ceiling	- -	- -	- -	- -		F	0.75	- -	III
Cooling Towers		To 200 Tons	Floor or Roof	G	0.10	- -	V		B	1.50	- -	V
		Over 200 Tons				- -				2.50	- -	V
Curb Mounted Fans		All (7)	Roof	- -	- -	- -	- -		- -	- -	B-6	V
Fan Coil Units Fan Powered Boxes Cabinet Unit Heaters Unit Ventilators		All	Ceiling	- -	- -	- -	- -		F	0.75	- -	III
Pumps	Base Mounted	To 15 hp	Floor	D	0.30	B-2	V		B	0.75	B-2	V
		15--30 hp		B	0.75	B-2	V		B	0.75	B-2	V
		Over 30 hp		B	0.75	B-2	V		B	1.50	B-2	V
	In line		Floor	- -	- -	- -	- -		D	0.30	- -	V

TABLE B Vibration Isolation & Seismic Restraint Guide for HVAC Equipment				EQUIPMENT INSTALLATION ATTACHMENT POINT								
				ON GRADE					ABOVE GRADE			
EQUIPMENT		SIZE (5) (8)	MOUNTING	ISOL	DEFL	BASE	RESTR		ISOL	DEFL	BASE	RESTR
		All	Ceiling	- -	- -	- -	- -		F	0.75	- -	III
	Condensate		Floor	D	0.30	B-9	V		D	0.30	B-9	V
	Boiler Feed			D	0.30	- -	V		D	0.30	- -	V
*Packaged Roof Top Air Handling Units		To 15 Tons	Curb Mounted	- -	- -	- -	- -		- -	0.75	B-3	V
		Over 15 Tons		- -	- -	- -	- -		- -	2.50	B-3	V
		To 15 Tons	Point Supported	- -	- -	- -	- -		B	0.75	- -	V
		Over 15 Tons		- -	- -	- -	- -		B	2.50	- -	V
Unit Heaters		All	Ceiling	- -	- -	- -	- -		E	0.30	- -	III

* with or without compressor/condenser section.
Table Note: Bases shown in "( )" indicate roof mounted system.

TABLE C Vibration Isolation & Seismic Restraint Requirements for Plumbing Equipment				EQUIPMENT INSTALLATION ATTACHMENT POINT								
				ON GRADE					ABOVE GRADE			
EQUIPMENT		SIZE (5) (8)	MOUNTING	ISOL	DEFL	BASE	RESTR		ISOL	DEFL	BASE	RESTR
Air Compressors & Vacuum Pumps	Tanks	To 10 hp	Floor	D	0.30	- -	V		B	0.75	- -	V
		Over 10 hp		B	0.75	- -	V		B	1.50	B-2	V
	Unitary	To 10 hp		D	0.30	- -	V		B	0.75	B-2 (3)	V
		Over 10 hp		B	0.75	- -	V		B	1.50	B-2 (3)	V
Pumps	Base Mounted	To 15 hp	Floor	D	0.30	- -	V		B	0.75	B-2	V
		Over 15 hp	Floor	B	0.75	- -	V		B	0.75	B-2	V
	Inline	All	Floor	- -	- -	- -	- -		D	0.30	- -	V
				- -	- -	- -	- -		F	0.75	- -	III

TABLES B, C & NOTES:
GENERAL : ISOL = Isolator, DEFL = Deflection, RESTR = Seismic Restraint - All deflections indicated are in inches.

(1) If a unit is not capable of point support and a base is not provided by that section, refer to the separate Air Handling or Air Conditioning Unit specification section, if base is not provided by that section and external isolation is required, provide Type B-1 base by this section for entire unit.

(2) Static deflection shall be based on the deflection guide. Deflections indicated are minimums at actual load and shall be selected from manufacturer's nominal 4", 3", 2" and 1" deflection spring series.

R.P.M. is defined as the *slowest possible operating speed* of the equipment.

(3) Single stroke compressors may require inertia bases with thickness greater than 12" max. as described for base B-2. Inertia base mass shall be sufficient to maintain maximum double amplitude of 1/8".

(4) For floor mounted fans substitute base type B-2 for class 2 or 3 or any class fan with static pressure over 5".

(5) Equipment with less than or equal to one hp are excluded from vibration requirements. (Seismic requirements still apply)

(6) Utility sets with wheel diameters less than 24" need not have deflections greater than 0.75".

(7) Curb mounted fans with curb area less than nine (9) square feet are excluded.

(8) For equipment with multiple motors, hp Classification applies to largest single motor.

DEFLECTION GUIDE	
R.P.M.	DEFLECTION
Less Than 400	3.50"
400 To 599	2.50"
600 To 900	1.50"
Over 900	0.75"

TABLE E SEISMIC BRACING TABLE			
EQUIPMENT	ON CENTER SPACING		WITHIN EACH CHANGE OF DIRECTION (LARGER OF. . .)
	TRANSVERSE	LONGITUDINAL	
DUCT	30 Feet	60 Feet	15 Feet
PIPE (Threaded, Welded, Soldered or Grooved)			
To 16"	40 Feet	80 Feet	10 Feet or 15 Diameters
18" - 28"	30 Feet	60 Feet	10 Feet or 15 Diameters
30" - 40"	20 Feet	60 Feet	10 Feet or 15 Diameters
42" & Larger	10 Feet	30 Feet	10 Feet or 15 Diameters
PIPE (No-Hub Bell & Spigot, Cast Iron)			
2.5" & Larger	10 Feet	20 Feet	4 Feet
CHIMNEYS & STACKS	30 Feet	60 Feet	10 Feet or 15 Diameters
BUS DUCT	20 Feet	40 Feet	4 Feet

END OF SECTION 230548

SECTION 23 0553 - MECHANICAL IDENTIFICATION

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 mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Access panel and door markers.
   4. Pipe markers.
   5. Duct markers.
   6. Valve tags.
   7. Valve schedules.
   8. Warning tags.

1.3 SUBMITTALS

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

B. Valve numbering scheme.

C. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

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

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.

3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.

2. Data:

a. Name.
b. Equipment service.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.

2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.

4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

1. Material: 3/32-inch- thick laminated plastic with 2 black surfaces and white inner layer.

2. Valve-Tag Fasteners: Brass S-hook.

2.5 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.

2. Frame Extruded aluminum.

3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum Approximately 4 by 7 inches.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 & 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fans, blowers and primary balancing dampers.

2. Packaged HVAC units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment.

1. Letter 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. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
b. Fans, blowers and primary balancing dampers..
c. Packaged HVAC units.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.

4. At access doors, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

5. Letter 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.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

    a. Cold Water: 1-1/2 inches round.
    b. Hot Water: 1-1/2 inches, round.
    c. Gas: 1-1/2 inches round.

2. Valve-Tag Color:

    a. Cold Water: Blue.
    b. Hot Water: Red.
    c. Gas: Black.

3. Letter Color:

    a. Cold Water: White.
    b. Hot Water: White.
    c. Gas: White.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in mechanical equipment room.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 230553

SECTION 23 0593 - TESTING, ADJUSTING AND BALANCING

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. Include in balancing scope one pulley, sheave and belt change per fan as needed to balance fans.

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.

8. Contract shall include one pulley, belt and sheave change for each fan system.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.

2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

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. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 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.

C. Strategies and Procedures Plan: Within 60 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.

D. 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.

E. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

F. Mechanical Contractor shall submit three Testing and Balancing Contractors for review and approval before awarding contract.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

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 7 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."

E. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

F. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.

G. 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."

H. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. 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. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC 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:

B. Special Guarantee: Provide a guarantee on NEBB forms stating that 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 Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine 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.

F. 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.

G. Examine system and equipment test reports.

H. 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.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. 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.

K. 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.

L. Examine strainers for clean screens and proper perforations.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine equipment for installation and for properly operating safety interlocks and controls.

O. 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 variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including 2-way valves.

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.

P. 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 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 national standards and this Section.

B. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

C. 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.

D. 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 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 heat recovery equipment 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 with the approval of the Engineer. 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, sub-main 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 sub-mains 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. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-mains 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 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

3. Manufacturer, model, and serial numbers.

4. Motor horsepower rating.

5. Motor rpm.

6. Efficiency rating if high-efficiency motor.

7. Nameplate and measured voltage, each phase.

8. Nameplate and measured amperage, each phase.

9. Starter thermal-protection-element rating.

3.7 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.

3.8 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 non-grounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.9 TOLERANCES

A. Let 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.

3.10 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.

3.11 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. Fan drive settings, including settings and percentage of maximum pitch diameter.
    d. 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. Duct, outlet, and inlet sizes.

3. Pipe and valve sizes and locations.

4. Terminal units.

5. Balancing stations.

F. Air-Handling Equipment Test Reports: For air-handling equipment, include the following:

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.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Sheave dimensions, center-to-center and amount of adjustments in inches.

j. Number of belts, make, and size.
k. Number of filters, type, and size.

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.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.

G. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.

e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.

H. Gas Fired Heat Apparatus Test Reports: In addition to the manufacturer's factory startup equipment reports, include the following:

1. Unit Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in inches.

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.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Design airflow rate in cfm.
h. Design velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Test apparatus used.
    d. Area served.
    e. Air-terminal-device make.
    f. Air-terminal-device number from system diagram.
    g. Air-terminal-device type and model number.
    h. Air-terminal-device size.
    i. Air-terminal-device effective area in sq. ft. ((sq. m)).

2. Test Data: Include design and actual values for the following:

    a. Airflow rate in cfm (L/s).
    b. Air velocity in fpm (m/s).
    c. Preliminary airflow rate as needed in cfm (L/s).
    d. Preliminary velocity as needed in fpm (m/s).
    e. Final airflow rate in cfm (L/s).
    f. Final velocity in fpm (m/s).
    g. Space temperature in deg F (deg C).

L. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data: Include the following:

    a. Unit identification.
    b. Location.
    c. Unit make and model number.
    d. Manufacturer's compressor serial numbers.
    e. Compressor make.
    f. Compressor model and serial numbers.
    g. Refrigerant weight in lb.
    h. Low ambient temperature cutoff in deg F.

2. Test Data: Include design and actual values for the following:

    a. Inlet-duct static pressure in inches wg.
    b. Outlet-duct static pressure in inches wg.
    c. Entering-air, dry-bulb temperature in deg F.
    d. Leaving-air, dry-bulb temperature in deg F.
    e. Condenser entering-water temperature in deg F.
    f. Condenser leaving-water temperature in deg F.
    g. Condenser water temperature differential in deg F.
    h. Condenser entering-water pressure in feet of head or psig.
    i. Condenser leaving-water pressure in feet of head or psig.

j. Condenser water pressure differential in feet of head or psig.
k. Control settings.
l. Unloader set points.
m. Low-pressure-cutout set point in psig.
n. High-pressure-cutout set point in psig.
o. Suction pressure in psig.
p. Suction temperature in deg F.
q. Condenser refrigerant pressure in psig.
r. Condenser refrigerant temperature in deg F.
s. Oil pressure in psig.
t. Oil temperature in deg F.
u. Voltage at each connection.
v. Amperage for each phase.
w. The kW input.
x. Crankcase heater kW.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

M. 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.

3.12 ADDITIONAL TESTS

A. Within 90 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.

END OF SECTION 230593

SECTION 23 0700 - DUCT 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 semi rigid and flexible duct, plenum; insulating cements; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.

2. Division 22 & 23 Section "Pipe Insulation" for insulation for piping systems.

3. Division 23 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets for each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for the following:

1. Removable insulation sections at access panels.

2. Applications at linkages for control devices.

1.4 QUALITY ASSURANCE

A. 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. 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 clearance requirements with duct Installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

a. CertainTeed Manson.
b. Owens-Corning Fiberglas Corp.
c. Schuller International, Inc.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.

2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.3 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.

2. Galvanized Steel: 0.005 inch thick.

3. Aluminum: 0.007 inch thick.

4. Brass: 0.010 inch thick.

5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

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 surfaces to receive insulation. 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; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

E. Keep insulation materials dry during application and finishing.

F. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

G. Apply insulation with the least number of joints practical.

H. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

I. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

J. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

K. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.

2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.

3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

M. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.

2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

N. 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. Seal insulation to roof flashing with vapor-retarder mastic.

O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.

4. Impale insulation over anchors and attach speed washers.

5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.

8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.

10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Space anchor pins as follows:

a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.

8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

C. Insulate the following plenums and duct systems:

1. Indoor concealed supply.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Fibrous-glass ducts.

2. Metal ducts with duct liner.

3. Factory-insulated flexible ducts.

4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.

5. Flexible connectors.

6. Vibration-control devices.

7. Testing agency labels and stamps.

8. Nameplates and data plates.

9. Access panels and doors in air-distribution systems.

3.6 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Supply, return & exhaust ducts, outside air ducts from ERV& exhaust air ducts to ERV.

1. Material: Mineral-fiber blanket.

2. Thickness: 2 inches.

3. Number of Layers: One.

4. Vapor Retarder Required: Yes.

END OF SECTION 23 0700

SECTION 230900 – HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 Related Documents

A. All work of this Division shall be coordinated and provided by the Building Automation System (BAS) Contractor.

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Drawings for details.

C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

D. If the BAS Contractor believes there are conflicts or missing information in project documents, the Contractor shall promptly request clarification and instruction from design team.

1.2 DEFINITIONS

A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.

B. Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.

C. Building Automation System (BAS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BAS Contractor and to be interfaced to the associated work of other related trades.

D. BAS Contractor: The Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BAS work.

E. Control Sequence: A BAS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

F. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BAS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.

G. BAS Network: The total digital on-line real-time interconnected configuration of BAS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

H. Node: A digitally programmable entity existing on the BAS network.

I. BAS Integration: The complete functional and operational interconnection and interfacing of all BAS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BAS as required by this Division.

J. Provide: The term “Provide” and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.

K. PC: IBM-compatible Personal Computer from a recognized major manufacturer

L. Furnish: The term “Furnish” and its derivatives when used in this Division shall mean supply at the BAS Contractor’s cost to the designated third party trade contractor for installation. BAS Contractor shall connect furnished items to the BAS, calibrate, test, commission, warrant and document.

M. Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the BAS wiring and terminations.

N. Install: The term “Install” and its derivatives when used in this Division shall mean receive at the jobsite and mount.

O. Protocol: The term “protocol” and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BAS network nodes.

P. Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BAS industry for real-time, on-line, integrated BAS configurations.

Q. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.

R. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

S. The following abbreviations and acronyms may be used in describing the work of this Division:

ADC	-	Analog to Digital Converter
AI	-	Analog Input
AN	-	Application Node
ANSI	-	American National Standards Institute
AO	-	Analog Output
ASCII	-	American Standard Code for Information Interchange
ASHRAE		American Society of Heating, Refrigeration and Air Conditioning Engineers
AWG	-	American Wire Gauge
CPU	-	Central Processing Unit
CRT	-	Cathode Ray Tube
CZC	-	Commercial Zone Control
DAC	-	Digital to Analog Converter
DC	-	Digital Controller
DCX	-	Digital Controller with extension capability
DCXM	-	Digital Controller Master with extension capability
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electronically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
EV	-	Commercial Zone Control
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface
HOA	-	Hand-Off-Auto
ID	-	Identification
IEEE	-	Institute of Electrical and Electronics Engineers

I/O	-	Input/Output
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
MD	-	Master Display Controller
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open
OWS	-	Operator Workstation
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
NAC	-	Network Area Controller
SI	-	Systems Integrator
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TEC	-	Networked Thermostat Equipment Controller
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
UNT	-	Unitary Controller
VAC	-	Volts, Alternating Current
VAV	-	Variable Air Volume
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

1.3 BAS DESCRIPTION

A. BAS contractor shall integrate new controllers for AHM Youth Center to provide a new central BAS system. BAS contractor shall provide Niagara 4 Site Supervisor software.

B. BAS contractor shall provide new graphics for the new HVAC equipment, two propane fired furnaces with cooling and one existing furnace with cooling along with local and remote alarms. Remote alarms via email and text messages to cell phones.

C. This specification for a Building Automation System (BAS) as detailed herein shall be strictly enforced. Provide a Building Automation System (BAS) incorporating BACnet Testing Laboratories (BTL) certified BACnet devices communicating over a Master-Slave Token Passing (MSTP) network at the field level and Niagara 4 based network managers at the network level. The Niagara 4 based network managers shall bridge the BACnet/MSTP field communications network to the owner's Local and/or Wide Area Network, as designated by owner.

D. The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (BC), network management tools, programming tools, web browser based Graphical User Interface, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other building related systems as described within these specifications.

E. The BAS Contractor shall manage and coordinate the BAS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.

F. BACnet components not supplied by the primary manufacturer of the BAS shall be integrated to share common software for network communications, time scheduling, alarm handling, and history logging.

G. The documentation contained in this section and other contract documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement functions shown or as implied in contract documents.

H. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.

I. Open Systems Design - It is the owners expressed goal to implement an open Building Automaton System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system The BAS provided shall maintain open interoperability in the following areas.

J. Network Management - Network management tools shall be based upon Niagara Framework technology as developed by the Tridium Corporation. All tools and hardware provided shall comply with current release of the Niagara 4 Framework platform.

K. User Access - The supplied system must incorporate ability to access data using standard Web browsers without requiring a proprietary operator/user interface and configuration programs.

L. Databases - All controller program graphics and network databases shall be provided in a Niagara Framework 4 format. The database shall be stored on owner's PC and provide on a separate CD upon final acceptance of project. An updated database shall be provided on a CD at the end of the warranty period.

M. Building Controllers (BC) - BCs (devices that provide for communication between the field level controllers and owner's wide and/or local area network, and manage facility global functions such as alarms, trends, schedules and normalization of data) shall conform to the current release of the Niagara 4 Framework. BCs shall be furnished with extended memory. No BC shall be provided with less than 128 MB of RAM. The number of BACnet or Lonworks nodes (controllers) attached to any Niagara 4 based network manager shall not exceed the following limits:

COMBINED MEMORY	MINIMUM NUMBER OF NODES
128 MB SDRAM/64 MB SERIAL FLASH	25
256 MB DDR RAM/128 MB SERIAL FLASH	50
1 GB DDR2 RAM/1 GB SERIAL FLASH	125

Regardless of minimum number of nodes indicated above, it is ultimately the exclusive responsibility of the systems integrator/building controls contractor to ensure that the BC has adequate resources for the number of nodes (controllers) attached to it.

N. Remote Data Access: The system shall support the Internet Browser-based remote access to building data. The BAS contractor shall coordinate with the Owner's IT department to insure all remote browser access (if desired by the owner) are protected with the latest Niagara Software updates and a VPN (Virtual Private Network) must be installed to protect owner's network from cyber attacks.

O. Direct Digital Controllers (DDC) - DDC devices for HVAC control, with exception of DDC device furnished as part of the OEM control package, shall be certified to the current LONMARK and BTL standards appropriate to their application provided an appropriate LONMARK or BTL Certification standard exist. All points within a controller including hard I/O and software based points shall be available for viewing, management, and manipulation through the Niagara Framework tools.

P. Software Tools - All software tools needed for full functional use, including programming of BCs and DDC, network management and expansion, and graphical user interface development, of the BAS described within these specifications, shall be provided to the owner or his designated agent. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.

Q. Programming Tools - Provide freely available Niagara 4 Wizards to facilitate the programming and configuration of all of the DDC devices that are provided for the HVAC and lighting control. Wizards shall be provided free of charge and be compatible with the current published versions of the network management tool that is provided as part of this project. The wizard software shall be available for public access from the manufacturer's web site. These wizard programming tools shall be compatible with at least 3 other brands of the Niagara Framework network management tools. The SI shall demonstrate as part of their prequalification as to how they intend to comply with these requirements.

R. Software License Agreement - The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights as it relates to disclosure of trade secrets contained within said software. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code, databases and documentation for all configuration and programming that is generated for a given project and/or configured for use with the BC, BAS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

S. The System Integrator shall provide as part of the submittals a copy of the Niagara Compatibility Statement (NiCS) verifying that all aspect of the Niagara Framework as provided maintain an Open System Design. The System as provided shall confirm with the following NiCS

Property	Value
STATION COMPATIBILITY IN	All
STATION COMPATIBILITY OUT	All
TOOL COMPATIBILITY IN	All
TOOL COMPATIBILITY OUT	All

T. Provide remote access via WEB/Mobile Brower and mobile applications for unlimited users without requiring proprietary software fees, seat licensing or restricted/annual licensing.

U. All building automation controllers and peripherals are required to be readily available from multiple local sources for direct purchase. Single source availability of said devices is not acceptable.

V. The BAS system must be programmed utilizing a non-proprietary software tool such as Niagara Workbench. Additional software for configuration is not permitted. Proprietary software configuration tools are not acceptable. Copy of Niagara Workbench to be provided to owner after project completion.

W. Owner to receive administration rights to all features, functionality and configuration of the building automation system

1.4 Quality Assurance

A. General - The HVAC Control System shall be furnished, engineered, and installed by a licensed Controls Contractor or System Integrator (SI). All work provided under this section shall be provided by direct employees of the SI or under the direct supervision of the SI personnel.

B. System Integrator Qualifications

1. The SI must be regularly engaged in the service and installation of JCI N2, BACnet, and Niagara 4 based systems as specified herein, The SI shall have a minimum of 5 years' experience in the sales, installation, engineering, programming servicing and commissioning of the Niagara 4 platform and the field controllers as proposed
2. The system integrator must be an authorized factory direct representative in good standing of the manufacturer of the proposed hardware and software components. Provide a letter dated within the last 6 months, from the manufacture certifying that the System Integrator is an authorized factory direct representative.
3. The SI shall have an office within 50 miles of the Building site that is staffed with a minimum of five (5) technicians who have successfully completed the factory authorized training of the proposed manufactures hardware and software components and have successfully completed a Niagara 4 certification course. Supplying complete maintenance. SI must provide proof of required training. The SI capabilities shall include engineering and design of control systems, programming, electrical installation of control systems, troubling shooting and service. **SI shall be staffed to provide support services on a 24 hour, 7-day-a-week basis**.
4. The SI shall submit a list of no less than three (3) similar projects, which have similar Building Automation Systems as specified herein installed by the SI. These projects must be on-line and functional such that the Owner's/User's representative can observe the system in full operation.

C. Hardware and Software Component Manufacturer Qualifications

1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of both LonWorks and BACnet based systems as specified herein, and must have been so for a minimum of five (5) years. The manufacturer shall demonstrate that they are the manufacturer of all DDC devices and Niagara 4 products provided.
2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International, and the BACnet Manufacturers Association.
3. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel,

capable of providing instruction and technical support service for networked control systems.

1.5 Submittals

A. Submit 6 complete sets of documentation in the following phased delivery schedule:

1. Valve and damper schedules
2. Equipment data cut sheets
3. System schematics, including:
   a. sequence of operations
   b. point names
   c. point addresses
   d. point to point wiring
   e. interface wiring diagrams
   f. panel layouts
   g. system riser diagrams
4. Visio® or AutoCAD compatible as-built drawings

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

1. Index sheet, listing contents in alphabetical order
2. Manufacturer's equipment parts list of all functional components of the system, disk of system schematics, including wiring diagrams
3. Description of sequence of operations
4. As-Built interconnection wiring diagrams
5. User's documentation containing product, system architectural and programming information.
6. Trunk cable schematic showing remote electronic panel locations, and all trunk data
7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
8. Copy of the warranty
9. Recommended spare parts list

1.6 Training - Meet all applicable Training requirements of Division 23, and the following:

A. Instruct the operators how to accomplish control of the system. Include basic troubleshooting and override of equipment and controls in the event of system failure.

B. Training Allowance: Provide not less than (8) hours formal training to the Owner's designated operations personnel.

C. Trainers - Persons conducting the training shall hold a Niagara certification, be knowledgeable in the workings of the system, and shall be regularly engaged in training exercises, so as to provide effective training.

D. Training Classes - Prior to conducting training, prepare and submit for approval the proposed training literature and topics. Submit this information at least two weeks prior to the first class.

1.7 Warranty

A. The HVAC Control System shall be free from defects in workmanship and material under normal use and service. If within twelve (12) months from the date of substantial completion or the owner receives beneficial use of the system, the installed equipment is

found to be defective in operation, workmanship or materials, the building systems contractor shall replace, repair or adjust the defect at no cost. Service shall be provided within the next business day upon notice from Owner's designated Representative.

B. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.

C. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

1.8 Ownership of Proprietary Material

A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation
6. Provide to the owner the highest level administrative password for the system. This password is to be filed away by the owner and not used during the warranty period. This is to protect the owners' interest in the system they purchased.

1.9 References

A. All work shall conform to the following Codes and Standards, as applicable:

1. National Electric Code (NEC) and all other applicable local Electric Codes.
2. Underwriters Laboratories (UL) listing and labels.
3. UL 916 Energy Management
4. NFPA 70 - National Electrical Code.
5. NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
6. American National Standards Institute (ANSI).
7. National Electric Manufacturer's Association (NEMA).
8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
9. Institute of Electrical and Electronic Engineers (IEEE).
10. American Standard Code for Information Interchange (ASCII).
11. Electronics Industries Association (EIA).
12. Occupational Safety and Health Administration (OSHA).
13. Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices
14. Americans with Disabilities Act (ADA)
15. ANSI/EIA 909.1-A-1999 (LonWorks)
16. ANSI/ASHRAE Standard 195-2004 (BACnet)

B. In the case of conflicts or discrepancies, the more stringent regulation shall apply.

C. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

PART 2 - PRODUCTS

2.1 Acceptable Manufactures

A. Acceptable Tridium Niagara manufacturers of the hardware and software components as specified herein.

B. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.

C. Controls shall be microprocessor based Interoperable Niagara4 Controllers. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.

1. The Contractor shall use only operator workstation software, controller software, custom application programming language, and controllers from the corresponding manufacturer and product line. The use of field level controllers from multiple manufacturers is acceptable provided no proprietary configuration or programming software is needed. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

2.2 Networks

A. Any required Niagara 4 based network managers supplied under this section shall bridge the Lonworks, BACnet or ModBus field bus to the owner's Local Area Network (LAN) and/or Wide Area Network (WAN) as designated by the owner. The network managers shall communicate at no less than 100 Megabits/sec over the Ethernet network and shall support BACnet over IP, Java, XML, HTTP, Fox and SOAP for m4imum flexibility as it relates to the integration of building data with enterprise information systems. The system shall provide support for multiple network managers, Building Controllers (BC), user workstations and, if specified, a local server. The WAN and/or LAN will be provided by others. The SI shall coordinate with the General Contractor for the access to the WAN and/or LAN.

A. Network minimum physical and media access requirements:
   a. Ethernet; IEEE standard 802.3
   b. Cable; 100 Base-T, UTP-8 wire, category 5 Minimum throughput; 100 Mbps

B. Network Access - Remote Access - For Local Area Network installations; provide access to the WAN and/or LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). The Owner agrees to pay monthly access charges for connection and ISP.

2.3 Network Field Level Controllers – The communication network between the field level controllers shall be Lonworks TP/FT 10 bus topology, BACnet MSTP, BACnet/IP, Modbus RS-485 or Modbus/IP. All wiring shall be provided in accordance with the standards for the appropriate protocol. The number of devices on any one network shall not exceed 90% of capacity.

2.4 Network Management Devices – These various devices will service multiple functions on the network depending on network design, communication medium and needed task.

These functions can include: management of traffic on the network, reconfiguring and strengthening of signals, the conversion of protocols, normalizing of data, global management of alarms, trends and schedules, control logic, protocol conversion and web page hosting for use as a Graphical User Interface.

A. Building Controller (BC) – This Niagara Framework based device shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the BC.

1. It shall be provided with these features
   a. Web page hosting
   b. Extended memory
   d. Appropriate hardware and driver(s) associated with the protocol it manages
   e. Din rail mounted power supply
2. Provide multiple Building Controllers as necessary. In order to maintain peak performance of the network, limit the m4imum consumed resources to 80 percent as indicated by the resource meter resident in the network management tools.
3. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc. Manage alarms as defined in the points list.
4. Provide timed (schedule) routing of alarms by class, object, group, or node.
5. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control. Control equipment and network failures shall be treated as alarms and annunciated.
6. Alarms shall be annunciated in any of the following manners as defined by the user:
   a. Screen message text
   b. Email of the complete alarm message to multiple recipients.
      Provide the ability to route and email alarms based on:
      1.Day of week
      2.Time of day
      3.Recipient
   c. Mobile phone text message.
   d. Graphic with flashing alarm object(s)
   e. Printed message, routed directly to a dedicated alarm printer
7. The following shall be recorded by the BC for each alarm (at a minimum):
   a. Time and date
   b. Location (building, floor, zone, office number, etc.)
   c. Equipment (air handler #, access way, etc.)
   d. Acknowledge time, date, and user who issued acknowledgement.
   e. Number of occurrences since last acknowledgement.
8. Alarm actions may be initiated by user defined programmable objects created for that purpose.
9. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
10. A log of all alarms shall be maintained by the BC and/or a server (if configured in the system) and shall be available for review by the user.
11. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
12. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
13. Data Collection and Storage - The BC shall collect data for any property of any object and store this data as defined in the points list.
14. The data collection shall be performed by log objects, resident in the BC that shall have, at a minimum, the following configurable properties:

15. Designating the log as interval or deviation.
16. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
17. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
18. For all logs, provide the ability to set the m4imum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
19. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
20. Audit Log - Provide and maintain an Audit Log that tracks all activities performed on the BC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the BC), to another BC on the network, or to a server. For each log entry, provide the following data:
    a. Time and date
    b. User ID
    c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.5 BUILDING AUTOMATION SYSTEM CONTROLLERS

A. All controllers shall be designed for easy installation and servicing including removable **enclo-**sures, removable terminals, and factory applied labels for all I/O. All internal points within the Programmable Controllers shall be fully supported by the Graphical User Interface (GUI), allowing the user to easily modify them and monitor them. All of the internal programming points (e.g. variables, constants, PID's, timers, inputs and outputs) shall be exposed to the network on dedicated network variable outputs. All controllers programs and schedules shall contain non-volatile flash memory. Upon a loss of power all controllers shall perform a self restart.

B. Programmable Controllers (PC) – a controller designed for more complex sequences of **opera-**tions such as built up AHU, central plant operations, electrical monitoring, and control and management for chillers, boilers and generators. The PCs are to allow for the flexibility of custom control programming to meet the needed sequences of operation.

2.6 Performance

A. Each PC shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with a 8 bit processor. The PC shall have a minimum ambient operating temperature range of -0°C to 70°C or 32°F to 158°F.

B. Inputs – Analog inputs shall have the following minimum level of performance: 16-bit A to D resolution; allow monitoring of platinum 100 ohms, platinum 1000 ohm, nickel 1000 ohms, thermistor 10K type II, thermistor 10K type III, voltage input 0-10VDC, current input 4-20mA, digital input, pulsed input minimum 2 Hz.

C. Outputs – Outputs shall be either software configurable to be either analog or digital or dedicated digital only - Analog outputs shall be selectable as voltage of 0-10 VDC (linear) or 4-20mA or Digital outputs shall be 0-12 VDC (off/on), floating or PWM. Outputs shall have an adjustable range of 2 seconds to 15 minutes. Output Resolution shall be a minimum 8 bits digital / analog converter. All individual outputs and power supply shall be protected by an auto reset fuse. There shall be an LED status indicator on each of the outputs.

D. Programmable Controller Features

1. Provide an onboard network communication jack
2. The PC shall be provided with a diagnostic indicator lights for power and network communication of transmit and receive along with a light indication position for each output
3. Hand/Off/Auto Switches – For all controllers applied to a AHU, Chiller, Pumps Cooling Tower or Boiler, provide for the manual override and adjustment of all Analog and Digital outputs through a three position switch giving the selection of Hand, Off and Auto (HOA). A HOA shall be provided for each separate digital and analog output from the controller and be an integral part of the controller. HOA switches external from the controller shall not be accepted. For the Analog outputs the Hand position of the switch shall provide for the adjustment of the output signal through a linear scaled potentiometer. The position of the HOA shall be monitored and an alarm shall be delivered to the Graphical User Interface should the switch be in an Off or Hand position. An indicating LED shall be provided on the controller for each HOA indicating position of the switch. For all Analog outputs, the indicating LED shall provide a linear indication of the position of the Potentiometer through a variation in the intensity of the indicator LED and be provided as a numerical value that can be viewed at the Graphical User Interface.
4. Enclosures – Provide for an enclosure with a separate back plate with terminals such that the electronic portion of the controller can be easily removed for ease of installation and servicing.

2.7 BAS SOFTWARE TOOLS

A. Controller Programming Software

B. Provide Wizards or objects that facilitate the programming and configuration of the Configurable Controllers (CC), Programmable Controller (PC) and or the Special Purpose Configurable Controllers (SPCC) sequence of operation through menu driven wizard. The programming tools shall perform the following functions:

C. PC programming shall be accomplished by graphical programming language (GPL) where objects are used to define different portions of the control sequence. All control sequences programmed into the PC shall be stored in non-volatile memory. Systems that only allow selection of sequences from a library or table are not acceptable. All code must be exportable to a library for future use.

D. CC and SPCC – Provide for the programming of the required sequence of operation through an intuitive configuration menu driven selection process. The configuration tools menu shall define items such as I/O configurations, set point, delays, PID loops, optimum start stops, and network variables settings. The configuration tool must indicate the device status and allows system override. Graphical programming language as described for the PC is acceptable.

2.8 USER INTERFACES

A. Provide for a series of browser accessible graphical screens that are resident on the BC and Server that represent the systems controllers and managed by that BC and its associated controllers.

B. The Web browser client shall support at a minimum, the following functions:

1. Unlimited concurrent users shall be able to simultaneously login without the need of any additional user licenses or fees.

2. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

3. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

4. HTML programming shall not be required to display system graphics or data on a Web page

5. Storage of the graphical screens shall be in the Building Controller (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

6. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

7. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

    a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
    b. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    c. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
    d. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
    e. View logs and charts
    f. View and acknowledge alarms

8. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

9. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.9 Reports and Summaries

A. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
    a. All points in the BAS
    b. All points in each BAS application
    c. All points in a specific controller
    d. All points in a user-defined group of points
    e. All points currently in alarm
    f. All BAS schedules

g. All user defined and adjustable variables, schedules, interlocks and the like.

B. Reports shall be exportable to .pdf, .txt, or .csv formats.

C. The system shall allow for the creation of custom reports and queries.

D. Schedules

- A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
  a. Regular schedules
  b. Repeating schedules
  c. Exception Schedules
- Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
- It shall be possible to define one or more exception schedules for each schedule including references to calendars
- Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days. Holidays and special days shall be user-selected with the pointing device or keyboard.

5. Password

- Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and data manipulation capabilities deemed appropriate for each user, based on an assigned password.
- Each user shall have the following: a user name, a password, and access levels.
- The system shall provide the capability to require a password of minimum length and require a combination of characters and numerical or special characters.
- When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- The system shall provide unlimited flexibility with access rights. A minimum of four levels of access shall be provided along with the ability to customize the system to provide additional levels.
- A minimum of 100 unique passwords shall be supported.
- Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- The system shall automatically generate a report of log-on/log-off and system activity for each user.
- All log data shall be available in .pdf, .txt, and .csv formats.

6. Historical Data Collection

- All numeric, binary or data points in the system data shall allow their values to be logged over time (trend log). Each historical record shall include the point's name, a time stamp including time zone, and the point's value.
- The Network Area Controller (NAC) shall have the ability to store its historical data records locally and periodically to a remote server on the network (archiving).

- The configuration of the historical data collection shall allow for recording data based on change of value or on a user-defined time interval.

- The configuration of the historical data collection shall allow for the collection process to stop or rollover when capacity has been reached.
- A historical data viewing utility shall be provided with access to all history records. This utility shall allow historical data to be viewed in a table or chart format.
- The history data table view shall allow the user to hide/show columns and to filter data based on time and date. The history data table shall allow exporting to .txt, .csv, or .pdf file formats.
- The historical data chart view shall allow different point histories to be displayed simultaneously, and also provide panning and zooming capabilities.

7. Audit Log
   - For each log entry, provide the following data;
     a. Time and date
     b. User ID
     c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

8. Database Backup and Storage
   - The user shall have the ability to backup the System Controller databases.

2.10 INPUT DEVICE CHARACTERISTICS

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. General Requirements:
   - Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
   - The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
   - The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Room Temp	± .5°F.
Duct Temperature	± .5°F.
All Others	± .75°F.

2. Offices/Conference Spaces
   - Room sensors shall be constructed for either surface or wall box mounting.
   - Room sensors shall have the following options when specified:
     a. Setpoint Adjustment – with override button. Honeywell TR-42 is the basis of design

C.Thermo wells

- When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
- Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
- Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
- Thermo wells shall be constructed of 316 stainless steel.

D. Outside Air Sensors

- Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

E. Duct Mount Sensors

- Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

F. Averaging Sensors

- For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
- For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
- Capillary supports at the sides of the duct shall be provided to support the sensing string.

G. Smoke Detectors

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 15 for installation under Division 16. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

H. Status and Safety Switches

1. General Requirements

- Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

- The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed

through the window of the device. It shall accept over-current up to twice its trip point range.

- Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- Acceptable manufacturers: Veris Industries Hawkeye H100, 500, 600, 800, 900 Series

3. Air Filter Status Switches
   - Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
   - A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
   - Provide appropriate scale range and differential adjustment for intended service.
4. Air Flow Switches
   - Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
5. Low Temperature Limit Switches
   - The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
   - The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
   - For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

2.11 OUTPUT DEVICE CHARACTERISTICS

A. Actuators

General Requirements

a. Damper and valve actuators shall be electronic, as specified in the System Description section.

B. Electronic Damper Actuators

- Electronic damper actuators shall be direct shaft mount.
- Belimo is the basis of design. No others will be acceptable.
- Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
- Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10

VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

- Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

C. Control Dampers

1. The BAS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BAS Contractor or as specifically indicated on the Drawings. Ruskin is the basis of design.
2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. M4imum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

D. Control Relays

7. Control Pilot Relays
   - Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
   - Mounting bases shall be snap-mount.
   - SPDT, DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
   - Contacts shall be rated for 10 amps at 120VAC.
   - Relays shall have an integral indicator light, manual override and check button or integral H-O-A switch.
   - Acceptable manufacturers: Veris Industries VMD-F Series

2.12 MISCELLANEOUS DEVICE CHARACTERISTICS

A. Local Control Panels
1. All control panels supplied by the BAS Contractor, without exception, shall be pre-fabricated and tested by the BAS manufacturer, incorporating the BAS manufacturer's latest design standards and layouts. All control panels shall be of steel construction, UL inspected, and listed as a UL assembly and carry the UL 508 label listing. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch. The BAS Contractor shall provide as part of the project submittal written verification of the BAS manufacturer's panel facility ISO9001 and UL certifications.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. Provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic wire trough.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies
1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. Power disconnect switch shall be provided next to the power supply.

PART 3 - EXECUTION

3.1 BAS SPECIFIC REQUIREMENTS

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. At a minimum the contractor shall insure there are graphics depicting building floor plans, all central panels, boiler rooms, zone control, and animated 3-dimensional graphics for each unit ventilator, air handler, fan coil, etc.

2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Actuation / Control Type

1. Unit Mounted Equipment
   - Where control devices are indicated to be unit mounted, the BAS Contractor shall supply and ship all DDC controllers, relays, transformers, valves and damper actuators to the unit equipment manufacturer for mounting and wiring. The unit manufacturer shall mount and wire the controllers as per the BAS Contractor's control wiring diagrams and instructions.
   - All damper actuation shall be electric, spring return fail-safe and normally open or closed as specified herein.

2. Furnace Air Handling Equipment and Condensing Units
   - All Air Handling Equipment shall be 100% DDC controlled.
   - All damper actuation shall be electric.

3.2 INSTALLATION PRACTICES

A. BAS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Automation System, as herein specified, shall be provided by the BAS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.

2. All BAS wiring materials and installation methods without exception are to comply with the following BAS manufacturers recommended installation standards.
   - All Analog Input, Analog Output, Binary Input, Binary Output and 24VAC control cables shall be UL Plenum Rated and color coded as follows; Analog Input Cable – Yellow Jacket, Analog Output Cable – Tan Jacket, Binary Input Cable – Orange Jacket, Binary Output Cable – Violet Jacket, 24VAC Cable – Grey Jacket.
   - All Field Bus and Ethernet LAN communications cables shall be UL Plenum Rated and be color coded as follows; Field Bus – Blue Jacket with Yellow Stripe, Ethernet LAN Cable – Violet Jacket.
   - All Ethernet LAN communications cable be UL Plenum Rated and shall meet or exceed Category 6 rating.

3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BAS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BAS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

4. Class 2 Wiring
   - All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   - Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
   - Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
   - Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BAS Line Voltage Power Source
   1. 120-volt AC circuits used for the Building Automation System shall be taken from panel boards and circuit breakers provided by Division 26.
   2. Circuits used for the BAS shall be dedicated to the BAS and shall not be used for any other purposes.
   3. DDC terminal unit controllers may use AC power from motor power circuits.

C. BAS Raceway

1. All cables to be open plenum rated with EMT in exposed areas.
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

D. Penetrations
1. Provide fire stopping for penetrations used by dedicated BAS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

E. BAS Identification Standards
1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

F. BAS Panel Installation
1. The BAS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The BAS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

G. Input Devices
1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BAS in accessible local control panels wherever possible.

H. HVAC Input Devices – General
1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of BAS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, etc.
4. Outside Air Sensors
   - Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
   - Sensors shall be installed with a rain proof, perforated cover.
5. Duct Temperature Sensors:
   - Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   - The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
   - For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
   - The sensor shall be mounted to suitable supports using factory approved element holders.
6. Space Sensors:
   - Shall be mounted per ADA requirements.
   - Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
7. Air Differential Pressure Status Switches:
   - Install with static pressure tips, tubing, fittings and air filter.

I. HVAC Output Devices

1. Output devices shall be installed per manufacturer's recommendation. Mechanical contractor shall install in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the minimum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
   1. Provide (8) Hours of Training
   2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
   3. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 10 hours' dedicated instructor time on-site.
   4. Review data in maintenance manuals.
   5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.4 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION

SECTION 23 2300 - REFRIGERANT 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 refrigerant piping used for air-conditioning applications.

B. Related Sections include the following:

1. Division 22 & 23 Section "Hangers and Supports" for pipe supports and installation requirements.

2. Division 23 Section "Mechanical Identification" for labeling and identifying refrigerant piping.

3. Division 22 & 23 Section "Meters and Gages" for thermometers and pressure gages.

4. Division 23 Section "HVAC Instrumentation and Controls" for thermostats, controllers, automatic-control valves, and sensors.

1.3 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

1. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX; "Welding and Brazing Qualifications."

B. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

D. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

1.5 COORDINATION

A. Coordinate layout and installation of refrigerant 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 installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.

E. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Refrigerants:

    a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
    b. DuPont Company; Fluorochemicals Div.

2. Refrigerant Valves and Specialties:

    a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
    b. Danfoss Electronics, Inc.
    c. Emerson Electric Company; Alco Controls Div.

d. Henry Valve Company.
e. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B 280, Type ACR ASTM B 88, Type L.

B. Annealed-Temper Copper Tube: ASTM B 280, Type ACR ASTM B 88, Type K.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Bronze Filler Metals: AWS A5.8, Classification BAg-5 (silver)

2.3 VALVES

A. Diaphragm Packless Valves: 500-psig working pressure and 275 deg F working temperature; globe design with straight-through or angle pattern; forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.

B. Packed-Angle Valves: 500-psig working pressure and 275 deg F working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, and with solder-end connections.

C. Check Valves Smaller Than NPS 1: 400-psig operating pressure and 285 deg F operating temperature; cast-brass body, with removable piston, polytetrafluoroethylene seat, and stainless-steel spring; globe design. Valve shall be straight-through pattern, with solder-end connections.

D. Check Valves, NPS 1 and Larger: 400-psig operating pressure and 285 deg F operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained polytetrafluoroethylene seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.

E. Service Valves: 500-psig pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.

F. Solenoid Valves: Comply with ARI 760; 250 deg F temperature rating and 400-psig working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch conduit adapter and 24 or 120-V, normally closed holding coil.

G. Pressure-Regulating Valves: Comply with ARI 770; pilot operated, forged brass or cast bronze, stainless-steel bottom spring, pressure-gage tappings, 24-V dc standard coil, and wrought-copper fittings for solder-end connections; suitable for refrigerant specified.

H. Pressure-Regulating Valves: Comply with ARI 770; direct acting, brass; with pilot operator, stainless-steel diaphragm, standard coil, and solder-end connection; suitable for refrigerant specified.

I. Pressure Relief Valves: Straight-through or angle pattern, brass body and disc, neoprene seat, and factory sealed and ASME labeled for standard pressure setting.

J. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

K. Hot-Gas Bypass Valve: Pulsating-dampening design, stainless-steel bellows and polytetrafluoroethylene valve seat; adjustable; sized for capacity equal to last step of compressor unloading; with solder-end connections.

2.4 REFRIGERANT PIPING SPECIALITIES

A. Straight- or Angle-Type Strainers: 500-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches, 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.

B. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.

C. Replaceable-Core Filter-Dryers: 500-psig maximum working pressure; heavy gage protected with corrosion-resistant-painted steel shell, flanged ring and spring, ductile-iron cover plate with steel cap screws; wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets and the following:

1. Filter-Dryer Cartridge: Pleated media with solid-core sieve with activated alumina, ARI 730 rated for capacity.

D. Permanent Filter-Dryer: 350-psig maximum operating pressure and 225 deg F maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

E. Mufflers: 500-psig operating pressure, welded-steel construction with fusible plug; sized for refrigeration capacity.

2.5 RECEIVERS

A. Receivers, 6-Inch Diameter and Smaller: ARI 495, UL listed, steel, brazed, 400-psig pressure rating, with tappings for inlet, outlet, and pressure relief valve.

2.6 REFRIGERANTS

A. ASHRAE 34, R-22 For Medium Temperature: Monochlorodifluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground, within Building: Type ACR drawn-copper tubing Type L drawn-copper tubing.

3.2 VALVE APPLICATIONS

A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor, for gage taps at hot-gas bypass regulators, on each side of strainers.

B. Install check valves in compressor discharge lines and in condenser liquid lines on multiple condenser systems.

C. Install packed-angle valve in liquid line between receiver shutoff valve and thermostatic expansion valve for system charging.

D. Install diaphragm packless or packed-angle valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.

E. Install a full-sized, three-valve bypass around each dryer.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve.

1. Install solenoid valves in horizontal lines with coil at top.

2. Electrical wiring for solenoid valves is specified in Division 26 Sections. Coordinate electrical requirements and connections.

G. G. Install thermostatic expansion valves as close as possible to evaporator.

1. If refrigerant distributors are used, install them directly on expansion-valve outlet.

2. Install valve so diaphragm case is warmer than bulb.

3. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

4. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install pressure-regulating and pressure relief valves as required by ASHRAE 15. Pipe pressure relief valve discharge to outside.

3.3 SPECIALTY APPLICATIONS

A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.

B. Install strainers immediately upstream from each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.

C. Install strainers in main liquid line where multiple expansion valves with integral strainers are used.

D. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.

E. Install pressure relief valves on ASME receivers; pipe discharge to outdoors.

F. Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.

G. Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve.

H. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

I. Install receivers, sized to accommodate pump-down charge, on systems 5 tons and larger and on systems with long piping runs.

J. Install flexible connectors at or near compressors where piping configuration does not absorb vibration.

3.4 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Basic piping installation requirements are specified in Division 22 & 23 Section "Basic Mechanical Materials and Methods."

C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

F. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

G. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

H. Install bypass around moisture-liquid indicators in lines larger than NPS 2.

I. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.

J. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

K. Hanger, support, and anchor products are specified in Division 22 & 23 Section "Hangers and Supports."

L. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

3. Pipe rollers for multiple horizontal runs 20 feet or longer, supported by a trapeze.

4. Spring hangers to support vertical runs.

M. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.

2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.

3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.

5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

N. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

A. Braze joints according to Division 22 & 23 Section "Basic Mechanical Materials and Methods."

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.6 FIELD QUALITY CONTROL

A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.

1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.

2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.

   a. System shall maintain test pressure at the manifold gage throughout duration of test.
   b. Test joints and fittings by brushing a small amount of soap and glycerine solution over joint.
   c. Fill system with nitrogen to raise a test pressure of 150 psig or higher as required by authorities having jurisdiction.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of the conditioned air to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Check compressor oil level above center of sight glass.

2. Open compressor suction and discharge valves.

3. Open refrigerant valves, except bypass valves that are used for other purposes.

4. Check compressor-motor alignment and lubricate motors and bearings.

3.8 CLEANING

A. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

3.9 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter-dryer after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION 232300

SECTION 23 3113 - METAL DUCTS

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 metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2 to plus 10-inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.

2. Single-wall, round, spiral-seam ducts and formed fittings.

3. Duct liner.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4-inch equals 1 foot scale. Show fabrication and installation details for metal ducts.
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.

7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on approved shop drawings.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

B. Coordination Drawings:
Reflected ceiling plans, drawn to scale, on which following items are shown and coordinated with each other, based on input from installers of items involved:
1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Welding certificates.

D. Field quality-control test reports

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

D. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish.

E. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B, NAIMA AH124 and hospital grade.

1. Manufacturers:

a. CertainTeed Corp.; Insulation Group.
b. Johns Manville International, Inc.
c. Knauf Fiber Glass GmbH.
d. Owens Corning.

2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

a. Thickness: 1 inch
b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.

3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.4 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes open-weave fabric strips and mastics.

B. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

C. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

D. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

E. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

F. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.

3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.6 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:

a. Ductmate Industries, Inc.
b. Eastern Sheet Metal, Inc.
c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Manufacturers:

a. Ductmate Industries, Inc.
b. Lockformer.
c. Eastern Sheet Metal, Inc.

2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.

3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. 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.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharges.

2. Intervals of lined duct preceding unlined duct.

3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

H. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible.

1. Manufacturers:

    a. Eastern Sheet Metal, Inc.
    b. McGill AirFlow Corporation.
    c. SEMCO Incorporated.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.

3. Round Ducts: Prefabricated connection system consisting of, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

    a. Manufacturers:

        1) Eastern Sheet Metal, Inc.
        2) Lindab Inc.
        3) Ductmate Industries, Inc.

4. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

    a. Manufacturers:

        1) Eastern Sheet Metal, Inc.
        2) McGill AirFlow Corporation.
        3) SEMCO Incorporated.

E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:

a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.

3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:

a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.

4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.

5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single thickness turning vanes.

6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.

9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.

10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.

12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: 2-inch wg.

2. Supply Ducts (before Air Terminal Units): 2-inch wg.

3. Supply Ducts (after Air Terminal Units): 1-inch wg .

4. Return Ducts (Negative Pressure): 1-inch wg.

5. General Exhaust Ducts (Negative Pressure): 1-inch wg.

6. All ducts shall be galvanized steel.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."

O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." or NUSIG.

P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

Q. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

R. For exposed ductwork specified for field painting provide factory prep and finish (paintgrip) for proper paint adhesion. Factory galvanized finish shall not be acceptable.

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.

2. Disconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling equipment internal surfaces and components including coils , and filters.

4. Coils, Humidifiers and related components.

5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.

2. Where contaminants are discovered, re-clean and reinspect ducts.

END OF SECTION 233113

SECTION 23 3114 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

B. Related Sections include the following:

1. Section "Fire Alarm" for duct-mounting fire and smoke detectors.

2. Division 23 Section "HVAC Instrumentation and Controls" for electric damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:
1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Turning vanes.
6. Duct-mounting access doors.
7. Flexible connectors.
8. Flexible ducts.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Special fittings.
2. Manual-volume damper installations.
3. Motorized-control damper installations.
4. Fire-damper installations, including sleeves and duct-mounting access doors.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

A. Manufacturers:
1. CESCO Products.
2. Duro Dyne Corp.
3. Greenheck.
4. Prefco Products, Inc.
5. Ruskin Company.

B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.063-inch- thick extruded aluminum, with welded corners and mounting flange.

D. Blades: 0.050-inch- thick aluminum sheet.

E. Blade Seals: Vinyl.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:
1. McGill AirFlow Corporation.
2. METALAIRE, Inc.
3. Nailor Industries Inc.
4. Ruskin Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

2. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

3. Blade Axles: Nonferrous.

4. Bearings: Molded synthetic.

5. Tie Bars and Brackets: Aluminum.

D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.

2. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

3. Blade Axles: Nonferrous.

4. Bearings: Molded synthetic thrust or ball.

5. Blade Seals: Vinyl.

6. Jamb Seals: Cambered aluminum.

7. Tie Bars and Brackets: Aluminum.

E. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. CESCO Products.
2. Duro Dyne Corp.
3. Greenheck.
4. McGill AirFlow Corporation.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Ruskin Company.

B. General Description: AMCA-rated, parallel or opposed-blade design; minimum of 0.1084-inch-thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch- thick, galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.

3. Provide parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.6 FIRE DAMPERS

A. Manufacturers:
1. CESCO Products.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Prefco Products, Inc.
7. Ruskin Company.

B. Fire dampers shall meet the requirements of NFPA 90A and further shall be tested rated and labeled in accordance with the fourth edition of UL Standard 555. Fire dampers shall be Dynamic rated for closure against airflow.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Curtain type with blades inside airstream. Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.

2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 212 deg F rated.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Duro Dyne Corp.
   c. METALAIRE, Inc.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. CESCO Products.
   b. Ductmate Industries, Inc.
   c. Greenheck.
   d. McGill AirFlow Corporation.
   e. Nailor Industries Inc.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Provide number of hinges and locks as follows:

   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two sash locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles].
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Manufacturers:

   a. Flexmaster U.S.A., Inc.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Duro Dyne Corp.
   2. Ventfabrics, Inc.
   3. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

   1. Minimum Weight: 26 oz./sq. yd..

   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Laboratory Exhaust (Fume Hood) System, Flexible Connectors: Glass fabric with chemical-resistant coating.

   1. Minimum Weight: 14 oz./sq. yd..

   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.

   3. Service Temperature: Minus 67 to plus 500 deg F .

2.10 FLEXIBLE DUCTS

A. Manufacturers:
   1. Hart & Cooley, Inc.
   2. Flexmaster U.S.A., Inc.
   3. McGill AirFlow Corporation.

B. Noninsulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

   2. Maximum Air Velocity: 4000 fpm.

   3. Temperature Range: Minus 10 to plus 160 deg F.

C. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 10 to plus 160 deg F.

D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. Downstream from volume dampers and equipment.

2. Adjacent to fire dampers, providing access to reset or reinstall fusible links.

3. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches.

2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.

5. Body Access: 25 by 14 inches.

6. Body Plus Ladder Access: 25 by 17 inches.

J. Label access doors according to Division 22 & 23 Section "Mechanical Identification."

K. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

L. Connect flexible ducts to metal ducts with draw bands.

M. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233114

SECTION 26 0010 - GENERAL CONDITIONS FOR ELECTRICAL TRADES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in this Section of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions be assumed to be omitted if not repeated herein.

C. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division.

D. The following information contains specifications of Work in connection with, and in addition to, this Division:

1. All plans associated with the project.
2. All specifications associated with the project.

E. Work is not limited to this Division or the Drawings associated with this Division. Work is specified throughout all the plans and specifications associated with the Project.

F. Division of Work responsibilities are as defined and directed by the Bidding Agent and/or the Bidding General Contractor.

1.2 INTENT

A. It is the intent of the Drawings and Specifications to call for finished Work, tested and ready for operation.

B. Furnish, deliver and install any apparatus, appliance, material or Work not shown on the Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories necessary to make the Work complete and perfect in all respects and ready for operation, even if not particularly specified, under their respective Section without additional expense to the Owner.

C. Include in the Work minor details not shown or specified but necessary for proper installation and operation, as though they were hereinafter shown or specified.

D. Provide Engineer written notice of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction and any necessary items of Work omitted. In the absence of such written notice, it is mutually agreed that Work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

E. The Work indicated is diagrammatic. The Architect and/or Engineer may require, included as part of this Contract, the relocation of devices to reasonable distances from the general locations shown.

F. Verbal clarifications of the Drawings or Specifications during the bid period are not to be relied upon. Refer any questions or clarifications to the Engineer at least five Working days prior to bidding to allow for issuance of an addendum. After the five-day deadline, Bidder must make a decision and qualify the Bid, if the Bidder feels it necessary.

1.3 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and Work included in the Contract. (Do not scale the Drawings.) Consult the Architectural Drawings and Details for exact locations of fixtures and equipment; where same are not definitely located, obtain this information from the Architect.

B. Closely follow Drawings in layout of Work; check Drawings associated with other Divisions to verify spaces in which Work will be installed. Maintain maximum headroom. Where space conditions appear inadequate, notify Engineer before proceeding with installations.

C. Engineer may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with Work of other trades and for proper execution of the Work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, include the item or arrangement of better quality, greater quantity or higher cost in the Contract price. It is at the Engineer's discretion to decide on the item and the manner in which the Work will be installed.

1.4 SURVEYS AND MEASUREMENTS

A. Before submitting a Bid, visit the site and become thoroughly familiar with all conditions under which the Work will be installed. Contractor will be held responsible for any assumptions, omissions or errors made as a result of failure to become familiar with the site and the Contract Documents.

B. Base all measurements, both horizontal and vertical, from established benchmarks. Reference all Work from these established lines and levels. Verify all measurements at site and check the correctness of same as related to the Work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or the intent of the Drawings and Specifications, notify the Engineer and do not proceed with that Work until instructions have been received from the Engineer.

1.5 CODES AND STANDARDS

A. The Codes and Standards listed below apply to all electrical Work. Where Codes or Standards are mentioned in these Specifications, follow the latest edition or revision:

IES - Lighting Handbook
NEMA - Standards
ANSI C1 - National Electrical Code (NFPA 70)
ANSI C50 - Rotating Electrical Machinery
ANSI C51.1 - Construction and Guide for Selection, Installation and Use of Electric Motors
ANSI C52.1 - Motors and Generators (NEMA MG1)
FIPS Publication #94 - Guideline on Electrical Power for ADP Installations

B. The current adopted editions of the following State or local Codes apply:

State Building Code, Including all State Supplements and referenced publications
Life Safety Code NFPA 101 and State Supplements
Local Building Code
National Electric Code NFPA 70
National Fire Alarm Code NFPA 72
Current State Fire Safety Code

C. The following abbreviations are used within these Specifications:

IES - Illuminating Engineering Society
NEC - National Electrical Code
ANSI - American National Standards Institute
ASTM - American Society for Testing and Materials
EPA - Environmental Protection Agency
IEEE - Institute of Electrical and Electronic Engineers
NEMA - National Electrical Manufacturers Association
NFPA - National Fire Protection Association
OSHA - Occupational Safety and Health Administration
UL - Underwriters' Laboratories

D. All materials furnished and all Work installed comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and with the requirements of all Governmental departments having jurisdiction.

E. Include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations whether or not shown on Drawings and/or specified.

1.6 PERMITS AND FEES

A. Give all necessary notices, obtain all permits, pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Work. File all necessary Drawings, prepare all Documents and obtain all necessary approvals of

all Governmental and State departments having jurisdiction, obtain all required certificates of inspections for Work and deliver a copy to the Engineer before request for acceptance and final payment for the Work.

1.7 COORDINATION

A. Carry out all Work in conjunction with other trades and give full cooperation in order that all Work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the General Contractor, with information as to openings, chases, equipment locations and panels required by other trades.

B. Contractors are required to examine all of the Project Documents and mutually arrange Work so as to avoid interference. In general, ductwork, heating and sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. Final decisions will be made by the Engineer regarding the arrangement of Work which cannot be agreed upon by the Contractors.

C. Where the Work of the Contractor will be installed in close proximity to or will interfere with Work of other trades, assist in Working out space conditions to make a satisfactory adjustment.

D. If Work is installed before coordinating with other Divisions or so as to cause interference with Work of other Sections, the Contractor causing the interference will make necessary changes to correct the condition, without extra charge to the Owner.

E. Initial contact and coordination has been conducted with utility entities for the purposes of the preparation of Bid Documents. Coordinate all final specific utility requirements.

1.8 ACCEPTANCES

A. The equipment, materials, Workmanship, design and arrangement of all Work installed under the Electrical Sections are subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, submit to the Engineer for review a list of manufacturers of equipment proposed for the Work under the Electrical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.

1. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, notify the Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending review by the Engineer or Owner's representative.

C. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, verify the duty specified with the specific characteristics of

the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

D. If material or equipment is installed before shop drawing review, liability for its removal and replacement is assumed by the Contractor, at no extra charge to the Owner, if, in the opinion of the Engineer, the material or equipment does not meet the intent of the Drawings and Specifications.

E. Failure on the part of the Engineer to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance to the drawings and/or specifications. Correct Work and/or materials not in conformance with the drawings and/or specifications whenever non-conformance is discovered.

1.9 EQUIPMENT DEVIATIONS

A. Where the Contractor proposes to deviate (substitute or provide an equivalent) from the equipment as hereinafter specified, a request is to be made in writing. State in the request whether it is a substitution or an equivalent to that specified and the amount of credit or extra cost involved. Include a copy of said in the Electrical Base Bid with manufacturer's equipment cuts. The Base Bid must be based on using the materials and equipment as specified with no exceptions.

B. In these Specifications and on the accompanying Drawings, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. This has been done for convenience in fixing the standard of Workmanship, finish and design required for installation. In the event that only one (1) manufacturer of a product is specified and it is found that the manufacturer has discontinued the product, use an acceptable equivalent product that meets the requirements of an equivalent product, as noted below, and has all the features of the originally specified product.

C. The details of Workmanship, finish and design and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein must also conform to these standards. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be used providing it conforms, in the opinion of and meets with the acceptance of the Engineer, to the requirements of these Specifications.

D. Where two or more names are given as equivalents, the Contractor must use one of the named equivalents.

E. Where one name only is used and is followed by the words "or accepted as equivalent", the Contractor must use the item named, but he may apply for an equipment deviation through the prescribed manner in accordance with this Specification.

F. Equipment, material or devices submitted for review as an "equivalent" to such equipment, material or devices specified must meet the following requirements:

1. The equivalent must have the same construction features such as, but not limited to:

    a. Material thickness, gauge, weight, density, etc.
    b. Welded, riveted, bolted, etc., construction
    c. Finish, priming, corrosion protection

2. The equivalent must perform with the same or better efficiency of energy consumption.

3. Local representation by the manufacturer for service, parts and technical information must be available

4. The equivalent must bear the same labels of performance certification as is applicable to the specified item.

G. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new Drawings and detailing required are to, with the concurrence of the Engineer, be prepared by the Contractor at no cost to the Owner.

H. Where such accepted deviation or substitution requires a different quantity and arrangement of wiring, conduit and equipment from that specified or indicated on the Drawings, with the concurrence of the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the substitution.

I. The definition of "accepted equivalent" is a product that, in the opinion of the Engineer, is acceptable for the intended application in lieu of the product listed in the Specifications or noted on the Drawings and has no cost impact on the project.

J. The definition of substitution is a product that, in the opinion of the Engineer, is of a lesser quality and/or has cost impact on the project or requires other changes to meet the Specification.

1.10 CHANGES IN WORK

A. A Change Order is a written order to the Contractor signed by the Owner and the Architect, issued after execution of the Contract, authorizing a change in the Work or an adjustment in the Contract sum or the Contract time. A Change Order signed by the Contractor indicates his agreement therewith, including the adjustment in the Contract sum or the Contract time.

B. All changes in the Work follow the recommendations of Article 12 of AIA General Conditions of the Contract for Construction.

1.11 MANUFACTURERS' IDENTIFICATION

A. Manufacturer's nameplate, name or trademark and address must be attached permanently to all equipment and materials furnished under this Division. The nameplate must indicate the name of manufacturer, description, size, type, serial or model number, electrical characteristics and other information. Nameplates of a Contractor or distributor are not acceptable.

B. All material and equipment for the electrical portion of the mechanical systems must bear the label of or be listed by the Underwriters' Laboratories, Inc., or other accredited authoritative agencies or testing organizations approved by the authority having jurisdiction.

1.12 SHOP DRAWINGS

A. Refer to individual specification sections for additional submittal information.

B. Submit for review detailed shop drawings of all equipment and material required to complete the project. No material or equipment may be delivered to the job site or installed until the Contractor has in his possession reviewed shop drawings for the particular material or equipment.

C. Submit shop drawings as soon as practical, within 60 days after award of Contract and before any material or equipment is purchased. Submit for review copies of all shop drawings to be incorporated in the Electrical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

D. Submit shop drawings for all equipment and/or devices specified. Included in the shop drawings are manufacturer's names, catalog numbers, cuts, diagrams and other such descriptive data as may be required to identify the equipment. No consideration will be given to a partial shop drawing submittal.

1. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

2. Clearly indicate all specific options and/or alternatives. Failure to do so will be grounds for rejection.

3. Clearly mark all shop drawings with the specific associated specification section.

E. Failure of the Contractor to submit shop drawings in ample time for review is not an entitlement to an extension of Contract time and no claim for extension by reason of such default will be allowed. Also, it does not entitle the Contractor to purchase, furnish and/or install equipment that has not been reviewed by the Engineer. All costs associated with the delay of construction due to equipment and/or materials arriving late or shipped to the site at a premium cost due to late or improper shop drawing submittal are the responsibility of the Contractor.

F. Furnish all necessary templates, patterns, etc., for installation Work and for the purpose of making adjoining Work conform; furnish setting plans and shop details to other trades as required.

G. Review rendered on shop drawings will not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not indicate that drawings have been checked in detail; said review does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing Work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.

H. Review of shop drawings does not apply to quantity nor relieve the Contractor of responsibility for compliance with the intent of the Drawings and Specifications. Review of shop drawings is final; no further changes will be allowed without the written consent of the Engineer.

I. Shop drawings must be specific with items submitted for review clearly identified in red ink. Data of general nature will not be accepted.

J. Make any corrections required by Engineer and resubmit required number of corrected copies of shop drawings or new samples until accepted. Direct specific attention in writing or on resubmitted shop drawings to revisions other than corrections requested by Engineer on previous submissions. Engineer will review no more than one resubmittal of any shop drawing or sample at Owner's expense. The fees for review of additional resubmittals are to be paid by the Contractor at the Engineer's standard rates.

1.13 RECORD DRAWINGS

A. Maintain a record set of Electrical Drawings at the job site on which any changes in location of equipment, devices, panels and major conduits are recorded.

B. At the end of construction, provide the Owner with a complete set of As-Built Drawings, including all power, fire alarm, nurse call and lighting plans (indicating as-built circuiting), power and special systems riser diagrams and panel schedules and fire alarm use. As-Built documentation is drawn utilizing the most recent version of AutoCad. Provide the Owner with a "CD ROM" disk and one set of reproducible mylar documents.

C. Electronic copies of the contract documents will be made available to the Contractor for use in production of As-Built documentation for a minimal processing fee of $25.00 per drawing. The Contractor assumes responsibility for completeness and accuracy of the As-Built documents. Translation or manipulation of electronic documents provided to the Contractor by the Engineer is the responsibility of the Contractor.

1.14 MATERIALS AND WORKMANSHIP

A. All materials and apparatus required for the Work, except as otherwise specified, must be new and of first-class quality and be furnished, delivered, erected, connected and finished in every detail and so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, furnish a first-class standard article as accepted by the Engineer.

B. Furnish the services of an experienced superintendent who is constantly in charge of the installation of the Work, and present on site at all times during the Work. Furnish all skilled

Workmen, helpers and labor required to install, unload, transfer, erect, connect up, adjust, start, operate and test each system.

C. Unless otherwise specifically indicated on the Drawings or in the Specifications, all equipment and materials must be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

D. Quality of Work must be consistent with good trade practice and installed in a neat, Workmanlike manner. The Engineer reserves the right to reject any Work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. Replacement of said Work, in a satisfactory manner, will be at no extra charge to the Owner.

1.15 PROTECTION OF EQUIPMENT AND MATERIALS

A. Work under each Section includes protecting the Work and material of all other Sections from damage by Work or Workmen and includes making good all damage thus caused.

B. The Contractor is responsible for Work and equipment until final turn-over to the Owner. Protect Work and Equipment from water, dust and dirt, and against theft, injury or damage. Carefully store and secure material and equipment received on site that is not immediately installed. Close with temporary covers or plugs open ends of Work during construction to prevent entry of water, obstructing or other foreign materials.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and connecting up completely of any equipment supplied under each Section. Work under each Section also includes exercising special care in handling and protecting equipment and fixtures and includes the cost of replacing any of the above equipment and fixtures which are missing or damaged by reason of mishandling or failure on the part of the Contractor to protect.

1.16 SCAFFOLDING, RIGGING, HOISTING

A. Furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

1.17 EXCAVATION AND BACKFILLING

A. Excavation and backfilling will be coordinated with the Division 2 of the Specifications.

B. It is the responsibility of the Contractor to field coordinate sizes, depths, fill and bedding requirements and any other excavation Work required under this Division.

1.18 WATERPROOFING

A. Where any Work pierces waterproofing, including waterproof concrete and floors in wet areas, review the method of installation with the Engineer before Work is done. Furnish all necessary

sleeves, caulking, flashing and fittings required to make openings and penetrations absolutely watertight.

1.19 ACCESSIBILITY AND ACCESS PANELS

A. The Contractor is responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.

B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment includes, but is not limited to: motors, controllers, switchgear, etc. Furnish access doors if better accessibility is required. Minor deviations from Drawings may be made to allow for better accessibility, but changes of magnitude or which involve extra cost must not be made without review by the Engineer.

C. Field Coordinate access doors in walls, ceilings, floors, etc. It is the responsibility of the Electrical Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for the Work. Arrange Work in such a manner so as to minimize the quantity of access doors required. Locate all items requiring accessibility in already accessible areas, such as above lay-in ceilings, etc.

D. Upon completion of the Project, physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Relocate any equipment not so furnished or provide additional access panels at no additional cost to the Owner.

E. Furnish and install permanent ladders for access to equipment. Coordinate exact requirements in field.

1.20 TEMPORARY OPENINGS

A. Ascertain from examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus provided under this Division, and field coordinate the requirements accordingly. In the event of failure of the Contractor to give sufficient notice in time to arrange for these openings during construction, the Contractor assumes all costs of providing such openings thereafter.

1.21 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, perform the connection of the new system at such time as designated by the Owner's representative. Complete Work on premium time if required at no additional cost to the Owner.

B. Notify the Engineer and the Owner of the estimated duration of the shutdown period at least ten (10) days in advance of the date the Work is to be performed.

C. Arrange Work associated with the shutdown of existing systems for continuous performance. Provide all necessary labor, including overtime, if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.22 PAINTING

A. Refer to Division 9 for painting requirements.

B. All materials shipped to the job site under this Division such as panels, plates, etc., must have prime coat and standard manufacturer's finish, unless otherwise specified.

C. Perform all painting in areas in accordance with the following:

1. Paint all concealed, non-insulated hangers, supports and other ferrous metal Work, except that which is galvanized. Coat, prior to installation, inaccessible conduits, hangers, supports, anchors and ducts.

2. Do not paint over the manufacturer's nameplate data on equipment. Take special care to avoid covering or spattering paint on the nameplate.

3. Touch up damaged equipment shop coats in the field.

1.23 TEMPORARY SERVICES

A. Refer to the General Conditions and Special Conditions for a full description of the temporary services to be provided.

1.24 CLEANING

A. Thoroughly clean all equipment of all foreign substances inside and out before being placed in operation.

B. If any part of a system should be stopped or clogged by any foreign matter after being placed in operation, disconnect the system wherever necessary to locate and remove obstructions. Then clean and reconnect the system. Repair or replace any Work damaged in the course of removing obstructions when the system is reconnected at no additional cost to the Owner.

C. Upon completion of Work under the Contract, remove from the premises all rubbish, debris and excess materials left over from the Work. Remove any oil or grease stains on floor areas caused by the Contractor, all floor areas must be left clean.

1.25 GUARANTEES

A. Guarantee all materials and Workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by the Owner.

B. During this guaranteed period, correct or replace all defects developing through materials or Workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.

END OF SECTION 260010

SECTION 26 0500 – BASIC ELECTRICAL MATERIALS AND METHODS

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 SUUMMARY

A. This Section includes the following electrical materials and methods:

1. Supporting devices for electrical components.

2. Concrete equipment bases.

3. Electrical demolition.

4. Cutting and patching for electrical construction.

5. Touchup painting.

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 type of product specified.

C. Shop Drawings detailing fabrication and installation of supports and anchorage for electrical items.

D. Coordination Drawings for electrical installation.

1. Prepare Coordination Drawings according to Division 1 Section "Submittals" to a 1/4-inch-equals-1-foot scale or larger. Detail major elements, components, and systems of electrical equipment and materials in relation to each other and to other systems, installations, and building components. Indicate locations and space requirements for installation, access, and working clearance. Show where sequence and coordination of installations are important to the efficient flow of the Work. Coordinate drawing preparation with effort specified in other Specification Sections. Include the following:

a. Provisions for scheduling, sequencing, moving, and positioning large equipment in the building during construction.
b. Floor plans, elevations, and details, including the following:

1) Work with other trades and utilize ductwork, piping and fire protection fabrication (shop) drawings as a basis for these documents.
2) Indicate clearances to meet safety requirements and for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
3) Equipment support details.
4) Exterior wall, roof, and foundation penetrations of cable and raceway; and their relation to other penetrations and installations.
5) Fire-rated interior wall and floor penetrations by electrical installations.
6) Sizes and locations of required concrete pads and bases.

c. Reflected ceiling plans to coordinate and integrate installing air outlets and inlets, light fixtures, alarm and communication systems components, sprinklers, and other ceiling-mounted items.

E. Samples of color, lettering style, and other graphic representation required for each identification product for Project.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. 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.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

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

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning prior to closing in the building.

E. Coordinate connecting electrical power to components furnished under other Sections.

F. Coordinate connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where electrical items requiring access are concealed by finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."

H. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

I. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.

1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.

2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.

B. Steel channel supports have 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Fittings and accessories mate and match with channels and are from the same manufacturer.

C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets. Spring steel clamps or "click"- type hangers are not allowed.

D. Sheet-Metal Sleeves: 0.0276-inch or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.

E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable iron casting with hot-dip galvanized finish.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

I. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE EQUIPMENT BASES

A. Forms and Reinforcing Materials: As specified in Division 3 Section "Cast-in-Place Concrete."

B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.3 TOUCHUP PAINT

A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.

B. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

A. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.

B. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Give right of way to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING METHODS

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Conform to manufacturer's recommendations for selecting supports.

D. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb- minimum design load.

3.3 CONCRETE BASES

A. Unless otherwise specifically noted, the Contractor shall furnish all necessary supports, pads, bases and piers required for all equipment furnished under this Division.

B. Concrete pads are per the Division 3 Specification for switchboards, generators, motor control centers and other freestanding equipment. All pads extend six (6") inches beyond machine base in all directions with top edge chamfered. Insert steel dowel rods into floors to seismically anchor pads. Submit shop drawings of all foundations and pads to the Engineer for review before they are constructed. Field coordinate all required dimensional and necessary loading information.

C. Construction of foundations, supports, pads, bases and piers where mounted on the floor is of the same finish quality as the adjacent and surrounding flooring material.

D. Securely attach all equipment, unless otherwise shown, to the building structure in an acceptable manner. Attachments are of a strong and durable nature; replace any attachments that are insufficient, in the opinion of the Engineer, as directed without additional expense to the Owner.

3.4 INSTALLATION

A. Install wires in raceway according to manufacturer's written instructions and NECA's "Standard of Installation."

B. Connect outlets and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

C. Install devices to securely and permanently fasten and support electrical components.

D. Raceway Supports: Comply with NFPA 70 and the following requirements:

1. Conform to manufacturer's recommendations for selecting and installing supports.

2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

3. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.

5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.

6. Hanger Rods: 1/4-inch diameter or larger threaded steel, except as otherwise indicated.

7. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports, with no weight load on raceway terminals.

E. Vertical Conductor Supports: Install simultaneously with conductors.

F. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.

G. In open overhead spaces, cast boxes threaded to raceways need not be separately supported, except where used for fixture support; support sheet-metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

H. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:

1. Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring-tension clamps on steel.

2. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.

3. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.

4. In partitions of light steel construction use sheet-metal screws.

5. Drill holes in concrete beams so holes more than 1-1/2 inches deep do not cut main reinforcing bars.

6. Drill holes in concrete so holes more than 3/4-inch-deep do not cut main reinforcing bars.

7. Fill and seal holes drilled in concrete and not used.

8. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.

I. Install concrete pads and bases according to requirements of Division 3 Section "Cast-in-Place Concrete."

J. Provide, set in place and be held responsible for the location of all sleeves, inserts and anchor bolts required for the Work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at the Contractor's expense.

K. Provide all conduits passing through floors, walls or partitions with sleeves having an internal diameter of one (1") inch larger than the outside diameter of the conduit or insulation enclosing the conduit.

L. Solidly fill with mineral fiber or other acceptable fire-stopping material all penetrations through fire-rated walls, ceilings and all floors (except slab on grade) in which conduits, cables or busways pass.

M. Refer to Division 7 Specification for additional and more specific fire-stopping information.

N. Submit fire-stopping systems as a shop drawing.

O. Seal with a UL approved fire-stop fitting classified to an hourly rating equivalent to the fire rating of the wall, ceiling or floor all penetrations through fire-rated walls, ceiling or floors in which cables or conduits pass.

P. Install seal fittings on conduits and cables, as required by the NEC, which are in or pass through hazardous areas.

Q. Use sealing bushings on conduit and cable ends to effectively prevent the intrusion of water, a damp or corrosive atmosphere, hot or cold air, or dust.

R. Use thruwall and floor seals to provide a positive means of sealing pipes or conduits which pass through the concrete foundation of a structure below grade or below ground water level. Also use seals at entry points through concrete walls or floors which must be sealed.

3.5 DEMOLITION

A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provide complete and thorough removal of existing work.

B. Where electrical work or equipment to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

C. Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.

D. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove and properly dispose of all demolished material from the Project site not desired by the owner.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

G. Field verify all existing lighting fixtures, wiring devices, raceways, circuiting, feeders and related electrical equipment to be removed for exact quantities.

H. Remove all existing wiring and raceways located above ceilings and in walls that are not being reused.

I. Remove all wiring and raceways and mounting hardware being removed in their entireties back to the source panels.

J. Remove all existing light fixtures, electrical devices and/or equipment located in walls or ceilings being demolished. Abandon no fixtures, wiring or devices that have disconnected unless specifically noted.

K. Maintain electrical continuity of all existing electrical light fixture, devices and equipment not being removed.

L. The work includes removal, storage, protection and reinstallation of existing items noted.

M. The work includes removal, storage, protection and reinstallation of existing work as required to accommodate alteration indicated.

N. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.

O. Provide all slots, recesses, openings and holes in or through walls, slabs, floors, ceilings, partitions, and other structural or non-structural parts necessary for the installation of all work requiring same, whether or not specifically shown on the Drawings. Contractor is responsible to correct sizes, clearances, locations and coordination with work of all other Sections affected and provide all required information, templates, and supervision to fully coordinate all work requiring demolition, cutting, patching, chases and coring.

P. Coring or cutting of holes in steel or concrete will be done only after approval of schedule and on premium time if so required, at no additional cost to Owner.

3.6 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

C. Contractor is responsible for carrying out the requirements of this section at no additional cost to Owner. Costs of defective, conflicting, ill-timed work, or unnecessary cutting, coring, patching, and repairing are the sole responsibility of the Contractor.

D. Provide cutting and patching per Division 1 requirements. Furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.

E. Furnish, locate and set inserts and/or sleeves as required before the floors and walls are built. The Contractor is responsible for the cost of drilling, cutting and patching as required for conduits, etc., where sleeves and inserts were not installed or correctly located. Provide all drilling required for the installation of hangers.

F. Use extreme caution when installing all holes cut through concrete slabs to avoid cutting or damaging structural members. Cuts no structural members or structural slabs/floors without the written acceptance of the Engineer. Cut structural steel members in a manner directed by the Engineer.

3.7 TOUCHUP PAINTING

A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

END OF SECTION 260500

SECTION 26 0519 – CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of conductors and cables specified.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Samples: Upon request.

1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

B. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, & HANDLING

A. Deliver wires and cables according to NEMA WC 26.

1.5 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wires and Cables:

a. American Insulated Wire Corp.; Leviton Manufacturing Co.

b. Carol Cable Co., Inc.
c. Southwire Company.

2. Connectors for Wires and Cables:

a. AMP Incorporated.
b. General Signal; O-Z/Gedney Unit.
c. 3M Company; Electrical Products Division.

2.2 BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications" Article.

B. Rubber Insulation Material: Comply with NEMA WC 3.

C. Thermoplastic Insulation Material: Comply with NEMA WC 5.

D. Conductor Material: Copper.

E. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.

2.3 CONNECTORS AND SPLICES

A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRE AND INSULATION APPLICATION

A. Service Entrance: Type RHW or THWN, in raceway.

B. Feeders, Normal Power and Non-Life Safety Branch Homeruns (from first device backbox to panel): Type THHN/THWN, in raceway.

C. Feeders of any type connected to Emergency Power systems and Life Safety Branch Circuits: Type THHN/THWN, in raceway.

D. Normal and Non-Life Safety Emergency Branch Circuits: HCF Type MC cable, 75C insulation.

E. Fire Alarm Circuits: Type THHN/THWN, in raceway.

F. Class 1 Control Circuits: Type THHN/THWN, in raceway.

G. Class 2 Control Circuits: Plenum rated cable.

3.3 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."

G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Firestopping."

H. Install all branch circuit homeruns in raceway to first device backbox.

I. Identify wires and cables according to Division 26 Section "Electrical Identification."

3.4 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 260519

SECTION 26 0533 – RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1. Raceways include the following:

a. RMC.
b. EMT.
c. FMC.
d. LFMC.
e. Wireways.
f. Surface raceways.

2. Boxes, enclosures, and cabinets include the following:

a. Device boxes.
b. Floor boxes.
c. Outlet boxes.
d. Pull and junction boxes.
e. Cabinets and hinged-cover enclosures.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. LFMC: Liquidtight flexible metal conduit.

D. RMC: Rigid metal conduit.

1.3 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

B. Comply with NECA's "Standard of Installation."

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Metal Conduit and Tubing:

a. Alflex Corp.
b. Cole-Flex Corp.
c. Grinnell Co.; Allied Tube and Conduit Div.
d. Triangle PWC, Inc.
e. Wheatland Tube Co.

2. Nonmetallic Conduit and Tubing:

a. Cantex Industries; Harsco Corp.
b. Cole-Flex Corp.
c. Condux International; Electrical Products.
d. Electri-Flex Co.
e. Lamson & Sessions; Carlon Electrical Products.
f. Spiraduct, Inc.

3. Conduit Bodies and Fittings:

a. Crouse-Hinds; Div. of Cooper Industries.
b. Hubbell, Inc.; Killark Electric Manufacturing Co.
c. Lamson & Sessions; Carlon Electrical Products.

d. O-Z/Gedney; Unit of General Signal.

4. Metal Wireways:

a. Hoffman Engineering Co.
b. Keystone/Rees, Inc.
c. Square D Co.

5. Surface Metal Raceways:

a. Airey-Thompson Co., Inc.; A-T Power Systems.
b. American Electric; Construction Materials Group.
c. Wiremold Co. (The); Electrical Sales Division.

6. Boxes, Enclosures, and Cabinets:

a. Erickson Electrical Equipment Co.
b. Hoffman Engineering Co.; Federal-Hoffman, Inc.
c. Hubbell Inc.; Raco, Inc.
d. O-Z/Gedney; Unit of General Signal.
e. Spring City Electrical Manufacturing Co.
f. Thomas & Betts Corp.

2.2 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1. Galvanized.

B. EMT and Fittings: ANSI C80.3.

1. Fittings: Compression type.

C. FMC: Zinc-coated steel.

D. LFMC: Flexible steel conduit with PVC jacket.

E. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3 NONMETTALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Schedule 40 or 80 PVC.

B. RNC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.4 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Removable interior barrier which divides raceway section into two equal compartments. Finish with manufacturer's standard ivory scuff resistant coating. Finish is suitable for field repainting.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways. All terminations and changes in direction are made with manufactured fittings that maintain minimum bend ratio as recommended by tel/comm cable vendor. Fittings contain internal barriers to match raceway segments.

C. Cover Brackets and Face Plates: Device mounting brackets and faceplates install devices horizontally. Trim plates overlap and cover end seams in covers. Face plates are interchangable and accept a variety of power and tele/communication devices. Device mounting provisions maintain minimum bend radii as recommended by tel/comm cable vendor.

2.6 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.7 FLOOR BOXES

A. Floor Boxes: Cast metal, fully adjustable, rectangular.

2.8 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1.

B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.9 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch, for indoor dry locations unless indicated otherwise.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

3. NEMA 3R or Type 4 for damp and wet locations.

B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

1. Provide NEMA 3R or Type 4 enclosures for damp and wet locations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: Rigid Galvanized steel.

2. Concealed: Rigid Galvanized steel.

3. Underground, Single Run: RNC.

4. Underground, Grouped: RNC.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Indoors: Use the following wiring methods:

1. Exposed: EMT.

2. Concealed: EMT.

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.

4. Damp or Wet Locations: Rigid Galvanized steel conduit.

5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. All wiring methods not expressly mentioned above are Rigid Galvanized Steel.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Minimum Raceway Size: 3/4-inch trade size.

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and beneath floors.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All stub-ups are RMC.

J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated. Install a maximum 360° of bends between pull points.

M. Raceways Embedded in Slabs: Raceways are not to be installed in structural concrete slabs without express written instruction from structural engineer.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.

2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.

P. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

Q. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple, so no threads are exposed.

R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

S. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. All conduit bends are long radius manufactured sweeps.

T. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

U. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections. For stub up connections to equipment where the equipment elevation is below grade or is lower than any portion of the conduit run which may be exposed to moisture, provide rubber grommetted compression fittings at both ends of the conduit to prevent water flow from the conduit into the equipment.

V. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

W. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

X. Set floor boxes level and trim after installation to fit flush to finished floor surface.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.5 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533

SECTION 26 0553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.

2. Legend: Indicates voltage.

B. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Printed legend indicating type of underground line.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16-inch-thick for signs up to 20 sq. in. and 1/8-inch-thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Self adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by facility management or by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:

1. Bands: Colored adhesive tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

3. Apply the following colors to the systems listed below:

a. Fire Alarm System: Red.
b. Telecommunication System: Green and yellow.

F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

G. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single

line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

H. Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.

1. Color-code 208/120-V system as follows:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White.
e. Ground: Green.

2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

I. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, circuit number. Use color-coding to identify circuits' voltage and phase.

3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

J. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

K. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication,

signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards, electrical cabinets, and enclosures.
2. Access doors and panels for concealed electrical items.
3. Emergency system boxes and enclosures.
4. Disconnect switches.
5. Enclosed circuit breakers.
6. Motor starters.
7. Push-button stations.
8. Power transfer equipment.
9. Contactors.
10. Remote-controlled switches.
11. Dimmers.
12. Control devices.
13. Transformers.
14. Power-generating units.
15. Fire alarm master station or control panel.

END OF SECTION 260553

SECTION 26 2726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes receptacles, connectors, switches, and finish plates.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each product specified.

B. Shop Drawings: Legends for receptacles and switch plates.

C. Samples: For devices and device plates for color selection and evaluation of technical features.

D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wiring Devices:

    a. GE Company; GE Wiring Devices.
    b. Hubbell, Inc.; Wiring Devices Div.
    c. Pass & Seymour/Legrand; Wiring Devices Div.

2. Wiring Devices for Hazardous (Classified) Locations:

a. Crouse-Hinds Electrical Co.; Distribution Equipment Div.
b. Killark Electric Manufacturing Co.
c. Pyle-National, Inc.; an Amphenol Co.

2.2 RECEPTACLES

A. Straight-Blade and Locking Receptacles: Hospital grade.

B. GFCI Receptacles: Hospital Grade Terminal type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle. Design units for installation in a 2-3/4-inch- deep outlet box without an adapter.

2.3 SWITCHES

A. Snap Switches: Specification Grade, quiet type.

2.4 WALL PLATES

A. Single and combination types match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Unfinished Spaces: Stainless steel.

2.5 FINISHES

A. Color: Ivory, unless otherwise indicated or required by Code. Architect to verify.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies' plumb and secure.

B. Install wall plates when painting is complete.

C. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates. When installed horizontal neutral terminal of receptacle is on top.

D. Protect devices and assemblies during painting.

E. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 26 2816 – DISCONNECT SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes individually mounted switches and circuit breakers used for the following:

1. Feeder and equipment disconnect switches.
2. Feeder branch-circuit protection.
3. Motor disconnect switches.
4. Overcurrent device coordination study and test.

1.2 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 switches, circuit breakers, and accessories specified in this Section. Include the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for circuit breakers with current-limiting characteristics.
3. Coordination charts and tables and related data.

C. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

D. Field test reports indicating and interpreting test results.

E. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

F. Coordination Study Report: Include all overcurrent device curves and include overlayed plots for every fault path.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide disconnect switches and circuit breakers by one of the following:

1. Fusible Switches:
   a. General Electric Co.; Electrical Distribution and Control Division.
   b. Siemens Energy & Automation, Inc.
   c. Square D Co.

2. Molded-Case Circuit Breakers:
   a. General Electric Co.; Electrical Distribution and Control Division.
   b. Siemens Energy & Automation, Inc.
   c. Square D Co.

2.2 DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.

C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3R.
2. Kitchen Areas: Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Hazardous Areas Indicated on Drawings: Type 7C.

2.3 CIRCUIT BREAKERS

A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

E. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.

F. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

G. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3R.
2. Kitchen Areas: Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Hazardous Areas Indicated on Drawings: Type 7C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Provide fused disconnects switches for all mechanical equipment.

C. Install disconnect switches and circuit breakers level, plumb, within site of and no more than 20’ from equipment being served.

D. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

E. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Identify each disconnect switch and circuit breaker according to requirements specified in Division 26 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 COORDINATION TEST AND STUDY

A. Perform a complete overcurrent device coordination study and test for the entire facility:

1. Prior to installation or purchase of any overcurrent device perform a selective coordination study of every 3-phase fault path in the facility, both new and existing. Overcurrent device selection and installation will be based on this study.

2. Adjust new overcurrent devices to achieve selective coordination and recommend overcurrent device ratings for existing devices which do not coordinate.

3. Prepare a detailed report including all overcurrent device curves, fault path one lines, final overcurrent device ratings or settings, and note any unresolved conflicts.

3.4 ADJUSTING

A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

3.5 CLEANING

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

END OF SECTION 262816