City of Portsmouth

PORTSMOUTH CITY HALL
1 Junkins Avenue
Portsmouth, NH 03801

BOILER PLANT UPGRADES

PROJECT MANUAL
PEI Project No. 1109

May 2013

Petersen Engineering, Inc.
Building Mechanical Systems Consultants

PO Box 4774
Portsmouth, NH 03802

Portsmouth City Hall
Boiler Plant Upgrades
May 2013

Project Manual – Table of Contents

CONTRACT DOCUMENTS AND SPECIFICATIONS

for

Portsmouth City Hall Boiler Replacement 2013
Bid Proposal #36-13

John P. Bohenko, City Manager

City of Portsmouth
Portsmouth, NH
Department of Public Works

Portsmouth City Hall Boiler Replacement 2013

INVITATION TO BID

Sealed bid proposals, **plainly marked, Portsmouth City Hall Boiler Replacement 2013**, Bid Proposal #36-13 **on the outside of the mailing envelope as well as the sealed bid envelope,** addressed to the Finance/Purchasing Department, City Hall, 1 Junkins Avenue, Portsmouth, New Hampshire, 03801, will be accepted until **May 30th, 2013** at **2:00** p.m. at which time all bids will be publicly opened and read aloud. A mandatory pre-bid meeting will be held Monday, May 20th, 2013 at 10:00 a.m. at the Portsmouth City Hall complex, 1 Junkins Avenue, Portsmouth, N.H. Vendors are to meet at the City Hall boiler plant located in the lower parking lot.

The work shall consist of the removal of existing boilers, replacement with new condensing boilers, and installation of associated controls, plumbing, & wiring for the Portsmouth City Hall Boiler Plant building.

Completion date will be 90 calendar days from the date of the Notice to Proceed, but must be completed with boilers operational by October 1, 2013. Heat is required for the City Hall Complex by October 1, 2013. Contractor will be held responsible for all costs associated with supplying temporary heat to the City Hall Complex if schedule is not met, as well as all other associated damages allowed by law.

Contractors must have at least five (5) years of successful experience in the field of boiler and boiler system installations. Bidders must determine the quantities of work required and the conditions under which the work will be performed.

Specifications, drawings, and bid proposal forms may be obtained from the City website at http://www.cityofportsmouth.com/finance/purchasing.htm. Questions may be directed to Rick Dolce, P.E., Facilities Project Manager at (603) 766-1413. Addenda to this bid document, if any, including written answers to questions, will be posted on the City of Portsmouth website at http://www.cityofportsmouth.com/finance/purchasing.htm under the project heading. Addenda and updates will NOT be sent directly to vendors.

The City of Portsmouth reserves the right to reject any or all bids, to waive technical or legal deficiencies, to re-bid, and to accept any bid that it may deem to be in the best interest of the City.

Each Bidder shall furnish a bid security in the amount of ten percent (10%) of the bid. The Bid Security may be in the form of a certified check or a bid bond executed by a surety company authorized to do business in the State of New Hampshire, made payable to the City of Portsmouth, N.H.

INSTRUCTIONS TO BIDDERS

BIDDING REQUIREMENTS AND CONDITIONS

1. Special Notice to Bidders

Appended to these instructions is a complete set of bidding and general contract forms. These forms may be detached and executed for the submittal of bids. The plans, specifications, and other documents designated in the proposal form will be considered as part of the proposal, whether attached or not.

The bidders must submit a statement of bidder's qualifications, if requested, subsequent to bid opening but prior to award.

Addenda to this proposal, if any, including written answers to questions, will be posted on the City of Portsmouth website at http://www.cityofportsmouth.com/finance/purchasing.htm under the project heading. Addenda and updates will NOT be sent directly to firms. Contractors submitting a proposal should check the web site daily for addenda and updates after the release date. Firms should print out, sign and return addenda with the proposal. Failure to do so may result in disqualification

2. Interpretation of Quantities in Bid Schedules

The quantities appearing in the bid schedule are approximate only and are prepared for the comparison of bids. Payment to the contractor will be made only for actual work performed and accepted in accordance with the contract. Any scheduled item of work to be done and materials to be furnished may be increased, decreased or omitted as hereinafter provided, and no claim for loss, anticipated profits or costs incurred in anticipation of work not ultimately performed will be allowed due to such increase or decrease.

3. Examination of Plans, Specifications and Site Work

The bidder is expected to examine carefully the site of the proposed work, the plans, standard specifications, supplemental specifications, special provisions and contract forms before submitting a proposal. The submission of a bid shall be considered conclusive evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the contract. It will be conclusive evidence that the bidder has also investigated and is satisfied with the sources of supply for all materials.

Plans, surveys, measurements, dimensions, calculations, estimates and statements as to the condition under which the work is to be performed are believed to be correct, but the contractors must examine for themselves, as no allowance will be made for any errors or inaccuracies that maybe found therein.

4. Familiarity with Laws

The bidder is assumed to have made himself or herself familiar with all federal and state laws and all local by-laws, ordinances and regulations which in any manner affect those engaged or employed on the work or affect the materials or equipment used in the work or affect the conduct of the work, and the bidder, if awarded the contract, shall be obligated to perform the work in conformity with said laws, by-laws, ordinances and regulations notwithstanding its ignorance thereof. If the bidder shall discover any provision in the plans or specifications which is in conflict with any such law, by-law, ordinance or regulation the bidder shall forthwith report it to the engineer in writing.

5. Preparation of Proposal

a) The bidder shall submit its proposal upon the forms furnished by the Owner. The bidder shall specify a lump sum price in figures, for each pay item for which a quantity is given and shall also show the products of the respective prices and quantities written in figures in the column provided for that purpose and the total amount of the proposal obtained by adding the amount of the several items. All words and figures shall be in ink or typed. If a unit price or a lump sum bid already entered by the bidder on the proposal form is to be altered it should be crossed out with ink, the new unit price or lump sum bid entered above or below it and initialed by the bidder, also with ink.

b) The bidder's proposal must be signed with ink by the individual, by one or more general partners of a partnership, by one or more members or officers of each firm representing a joint venture; by one or more officers of a corporation, by one or more members (if member-managed) or managers (if manager-managed) of a limited liability company, or by an agent of the contractor legally qualified and acceptable to the owner. If the proposal is made by an individual, his or her name and post office address must be shown, by a partnership the name and post office address of each general and limited partner must be shown; as a joint venture, the name and post office address of each venturer must be shown; by a corporation, the name of the corporation and its business address must be shown, together with the name of the state in which it is incorporated, and the names, titles and business addresses of the president, secretary and treasurer.

6. Nonconforming Proposals

Proposals will be considered nonconforming and may be rejected in the Owner's sole discretion for any of the following reasons:

- If the proposal is on a form other than that furnished by the Owner, or if the form is altered or any portion thereof is detached;
- If there are unauthorized additions, conditional or altered bids, or irregularities of any kind which may tend to make the proposal or any portion thereof incomplete, indefinite or ambiguous as to its meaning;
- If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award; or
- If the proposal does not contain a unit price for each pay item listed except in the case of authorized alter pay items.

7. Proposal Guaranty

No proposal will be considered unless accompanied by a bid bond, surety, or similar guaranty of the types and in an amount not less than the amount indicated in the Invitation to Bid. All sureties shall be made payable to the "City of Portsmouth". If a bid bond is used by the bidder it shall be:

- In a form satisfactory to the Owner;
- With a surety company licensed, authorized to do business in, and subject to the jurisdiction of the courts of the State of New Hampshire; and
- Conditioned upon the faithful performance by the principal of the agreements contained in the sub-bid or the general bid.

In the event any irregularities are contained in the proposal guaranty, the bidder will have four business days (not counting the day of opening) to correct any irregularities. The corrected guaranty must be received by 4:00 p.m. If irregularities are not corrected to the satisfaction of the Owner, the Owner, in its sole discretion, may rejected the bid.

8. Delivery of Proposals

When sent by mail, the sealed proposal shall be addressed to the Owner at the address and in the care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and at the place specified in the invitation for bids. Proposals received after the time for opening of the bids will be returned to the bidder, unopened.

9. Withdrawal of Proposals

A bidder will be permitted to withdraw his or her proposal unopened after it has been submitted if the Owner receives a request for withdrawal in writing prior to the time specified for opening the proposals.

10. Public Opening of Proposals

Proposals will be opened and read publicly at the time and place indicated in the invitation for bids. Bidders, their authorized agents, and other interested parties are invited to be present.

11. Disqualification of Bidders

Any or all of the following reasons may be deemed by Owner in its sole discretion as being sufficient for the disqualification of a bidder and the rejection of his proposal:

- More than one proposal for the same work from an individual, firm, or corporation under the same or different name;
- Evidence of collusion among bidders;
- Failure to submit all required information requested in the bid specifications;
- **Contractor lacks sufficient experience in boiler and boiler system installations (5 years);**
- Lack of competency or of adequate machinery, plant or other equipment, as revealed by the statement of bidders qualification or otherwise;
- Uncompleted work which, in the judgment of the owner, might hinder or prevent the prompt completion of additional work if awarded;
- Failure to pay, or satisfactorily settle, all bills due for labor and materials on former contracts;
- Default or unsatisfactory performance on previous contracts; or
- Such disqualification would be in the best interests of the Owner.

12. Material Guaranty and Samples

Before any contract is awarded, the bidder may be required to furnish a complete statement of the origin, composition and manufacture of any or all materials to be used in the construction of the work, and the Owner may, in its sole discretion, reject the bid based on the contents of the statement or as a result of the failure of the bidder to submit the statement.

AWARD AND EXECUTION OF CONTRACT

1. Consideration of Proposals

a) After the proposals are opened and read, they will be compared on the basis of the total price for all sections of work to be charged to perform the work and any such additional considerations as may be identified in the bid documents. The results of such comparisons will be immediately available to the public. In case of a discrepancy between the prices written in words and those written figures, the prices written in words shall govern. In case of a discrepancy between the total shown in the proposal and that obtained by adding the products of the quantities of items and unit bid prices, the latter shall govern.

2. Award of Contract

Within 30 calendar days after the opening of proposals, if a contract is to be awarded, the award will be made to the lowest responsible and qualified bidder whose proposal complies with all the requirements prescribed. The successful bidder will be notified, in writing, mailed to the address on his or her proposal, that his or her bid has been accepted and that the bidder has been awarded the contract.

The award shall not be considered official until such time that a Purchase Order, fully executed contract or an award letter has been issued by the Finance Director. No presumption of award shall be made by the bidder until such documents are in hand. Verbal notification of award is not considered official. Any action by the bidder to assume otherwise is done so at his/her own risk and the City will not be held liable for any expense incurred by a bidder that has not received an official award.

Basis of award will be based on the Base Bid.

Contract award is dependent upon available funds.

Contractors may be requested to break down contract pricing for comparative purposes.

3. Reservation of Rights

The Owner reserves the right to reject any or all proposals, to waive technicalities or to advertise for new proposals, if, in the sole discretion of the Owner, the best interest of the City of Portsmouth will be promoted thereby.

The City reserves the right to make inquires regarding the qualifications and reputation of the bidder. By submitting a bid proposal, bidder agrees to hold harmless the Owner and its employees and agents from any and all claims, actions, and damages arising from such investigation. Bidder may be requested to execute releases.

The Owner reserves the right to cancel the award of any contract at any time before the execution of such contract by all parties without any liability of the Owner.

4. Return of Proposal Guaranty

All proposal guaranties, except those of the three lowest bidders, will be returned upon request following the opening and checking of the proposals. The proposal guaranties of the three lowest bidders will be returned within ten days following the award of the contract if requested.

5. Contract Bonds

At the time of the execution of the contract, the successful bidder shall furnish:

- A performance bond in the amount of 100 percent of the contract amount.
- Labor and materials payment bond in the sum equal to 100 percent of the contract amount.

At the time of project completion, the Owner may, in its sole discretion, permit the Contractor to substitute a maintenance bond in lieu of holding retainage for the entire guaranty period. If a bond is furnished it shall meet the following criteria:

- The bond shall be in an amount equal to 20 percent of the contract amount. Such bond shall guarantee the repair of all damage due to faulty materials or workmanship provided or done by the contractor. The guarantee shall remain in effect for a period of one year after the date of final acceptance of the job by the Owner.

Each bond shall be: (1) in a form satisfactory to the Owner; (2) with a surety company licensed and authorized to do business and with a resident agent designated for services of process in the State of New Hampshire; and (3) conditioned upon the faithful performance by the principal of the agreements contained in the original bid. All premiums for the contract bonds are to be paid by the contractor.

6. Execution and Approval of Contract

The successful bidder is required to present all contract bonds, to provide proof of insurance, and to execute the contract within 10 days following receipt of the City's notification of acceptance of the bid. No contract shall be considered as in effect until it has been fully executed by all parties.

7. Failure to Execute Contract

Failure to execute the contract and file acceptable bonds within 10 days after notification of acceptance of bid shall be just cause for the cancellation of the award and the forfeiture of the proposal guarantee which shall become the property of the Owner, not as a penalty, but in liquidation of damages sustained. Award may then be made to the next lowest responsible bidder, or the City may exercise its reserved rights including the rejection of all bids or re-advertisement.

PROPOSAL FORM

PORTSMOUTH CITY HALL BOILER REPLACEMENTS 2013

CITY OF PORTSMOUTH, N.H.

To the City of Portsmouth, New Hampshire, herein called the Owner.

The undersigned, as Bidder, herein referred to as singular and masculine declares as follows:

1. All interested in the Bid as Principals are named herein.

2. This bid is not made jointly, or in conjunction, cooperation or collusion with any other person, firm, corporation, or other legal entity;

3. No officer, agent or employee of the Owner is directly or indirectly interested in this Bid.

4. The bidder has carefully examined the sites of the proposed work and fully informed and satisfied himself as to the conditions there existing, the character and requirements of the proposed work, the difficulties attendant upon its execution and the accuracy of all estimated quantities stated in this Bid, and the bidder has carefully read and examined the Drawings ("Portsmouth City Hall Boiler Plant Replacement" by Petersen Engineering, Inc.), Agreement, Specifications and other Contract Documents therein referred to and knows and understands the terms and provisions thereof;

5. The bidder understands that the quantities of work calculated in the Bid or indicated on the Drawings or in the Specifications or other Contract Documents are approximate and are subject to increase or decrease or deletion as deemed necessary by the Portsmouth City Engineer. Any such changes will not result in or be justification for any penalty or increase in contract prices; and agrees that, if the Bid is accepted the bidder will contract with the Owner, as provided in the Contract Documents, this Bid Form being part of said Contract Documents, and that the bidder will supply or perform all labor, services, plant, machinery, apparatus, appliances, tools, supplies and all other activities required by the Contract Documents in the manner and within the time therein set forth, and that the bidder will take in full payment therefor the following item prices;

6. It is the intention of this contract that the items listed above describe completely and thoroughly the entirety of the work as shown on the plans and as described in the specifications. All other items required to accomplish the above items are considered to be subsidiary work, unless shown as a pay item, to wit:

THIS PROJECT SHALL BE BID BY LUMP SUM WITH ALTERNATES:

Total Amount of Base Bid compiled by the Bidder.

In Figures $_____

In Words _____ Dollars

Basis of award will be based on the Base Bid

Contract award is contingent upon available funding.

Contractors may be requested to break down contract pricing for comparative purposes.

PROPOSAL FORM (Continued)

To Bidder: It is the intention of this contract that the items listed above describe completely and thoroughly the entirety of the work as shown on the plans and as described in the specifications. All other items required to accomplish the above items are considered to be subsidiary work, unless shown as a pay item.

The undersigned agrees that for extra work, if any, performed in accordance with the terms and provisions of the Contract Documents, the bidder will accept compensation as stipulated therein.

_____	_____
DATE	COMPANY
BY: _____	_____
SIGNATURE	TITLE

_____
STREET ADDRESS, CITY, STATE, ZIPCODE, TELEPHONE NUMBER

The Bidder has received and acknowledged Addenda No._____through _____.

All Bids are to be submitted on this form and in a sealed envelope, plainly marked on the outside with the Bidder's name and address and the Project name as it appears at the top of the Proposal Form.

BID SECURITY BOND

(This format provided for convenience, actual Bid Bond is acceptable in lieu of, if compatible.)

KNOW ALL MEN BY THESE PRESENTS, that we the undersigned

_____, as Principal, and

_____, as Surety, are hereby

held and firmly bound unto _____

IN THE SUM OF _____

as liquidated damages for payment of which, well and truly to be made we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

The condition of this obligation is such that whereas the Principal has submitted to the _____
A CERTAIN Bid attached hereto and hereby made a part hereof to enter into a contract in writing, hereinafter referred to as the "AGREEMENT" and or "CONTRACT", for
_____
_____
_____

NOW THEREFORE,

(a) If said Bid shall be rejected or withdrawn as provided in the INFORMATION FOR BIDDERS attached hereto or, in the alternative,

(b) If said Bid shall be accepted and the Principal shall duly execute and deliver the form of AGREEMENT attached hereto and shall furnish the specified bonds for the faithful performance of the AGREEMENT and/or CONTRACT and for the payment for labor and materials furnished for the performance of the AGREEMENT and or CONTRACT,

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

BID SECURITY BOND (continued)

The Surety, for value received, hereby agrees that the obligation of said surety and its bond shall be in no way impaired or affected by any extensions of the time within such BID may be accepted, and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the parties hereto have duly executed

this bond on the _____ day of _____, 20__.

_____L.S.
(Name of Principal)

(SEAL)

BY _____

_____
(Name of Surety)

BY _____

STATEMENT OF BIDDER'S QUALIFICATIONS

Supply with Bid

All questions must be answered and the data given must be clear and comprehensive. Add separate sheets if necessary

1. Name of Bidder

2. Permanent Main Office Address

3. Form of Entity

4. When Organized

5. Where Organized

6. How many years have you been engaged in the contracting business under your present name; also state names and dates of previous firm names, if any.

7. Contracts on hand; (schedule these, showing gross amount of each contract and the approximate anticipated dates of completion).

8. General character of work performed by your company.

9. Have you failed within the last seven years to complete any work awarded to you?
_____(no)____(yes). If so, where and why?

10. Have you defaulted on a contract within the last seven years?
_____(no)_____(yes). If so, where and why?

11. Have you ever failed to complete a project in the time allotment according to the Contract Documents?
_____(no)_____(yes). If so, where and why?

12. List the most important contracts recently executed by your company, stating approximate cost for each, and the month and year completed.

13. List your major equipment available for this contract.

14. List your key personnel such as project superintendent and foremen available for this contract.

15. List any subcontractors whom you would expect to use for the following (unless this work is to be done by your own organization).
a. Mechanical & Plumbing Work_____
b. Fire Systems Work_____
c. Electrical Work (if Alternate is selected) _____

(The City reserves the right to approve or disapprove subcontractors for this project)

STATEMENT OF BIDDERS QUALIFICATIONS (continued)

16. Contractor must have at least five years prior experience in commercial/municipal mechanical construction projects. Describe that prior experience, identifying projects/contracts that have been successfully completed within the last five years.

_____

_____

_____

_____

Latest Financial Statements: The City reserves the right to request Bidders' latest Financial Statements. Certified audited statements if available, prepared by an independent certified public accountant, may be requested by Owner. If requested, such statements must be provided within five (5) business days or the bid proposal will be rejected. Certified Audited Statement are preferred. Internal statements may be used only if independent statements were not prepared.

Dated at _____ this _____ day of _____, 20___.

_____
Name of Bidder

BY_____

TITLE_____

State of_____

County of_____

_____being duly sworn, deposes and

says that the bidder is _____of_____
(Name of Organization)

and answers to the foregoing questions and all statements contained therein are true and correct.

Sworn to before me this ____day of _____, 20__.

_____
Notary of Public

My Commission expires_____

CONTRACT AGREEMENT

PORTSMOUTH CITY HALL BOILER REPLACEMENT 2013

THIS AGREEMENT made as of the ___ day of _____ in the year **2013,** by and between the City of Portsmouth, New Hampshire (hereinafter call the Owner) and _____ (hereinafter called the Contractor),

WITNESSETH; that the Owner and Contractor, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE I- Work - The Contractor shall perform all work as specified or indicated in the Contract Documents for the completion of the Project. The Contractor shall provide, at his expense, all labor, materials, equipment and incidentals as may be necessary for the expeditious and proper execution of the Project.

ARTICLE II - ENGINEER - The City Engineer shall mean the Director of Public Works, or his authorized representative will act as engineer in connection with completion of the Project in accordance with the Contract Documents.

ARTICLE III - CONTRACT TIME - The work will commence and finish in accordance with the Notice to Proceed and shall be completed within **90 days**, but must be completed with boilers operational by **October 1, 2013.**

ARTICLE IV - CONTRACT PRICE - Owner shall pay Contractor for performance of the work in accordance with the Contract Documents.

ARTICLE V - PAYMENT - Partial payments will be made in accordance with the percentage of work completed at time of payment application. Upon final acceptance of the work and settlement of all claims, Owner shall pay the Contractor the unpaid balance of the Contract Price, subject to additions and deductions provided for in the Contract Documents.

ARTICLE VI - RETAINAGE – To insure the proper performance of this Contract, the Owner shall retain ten percent of the Contract Price as specified in the Contract Documents.

ARTICLE VII - LIQUIDATED DAMAGES - Not applicable. Heat is required for the City Hall Complex by October 1, 2013. Contractor will be held responsible for all costs associated with supplying temporary heat to the City Hall Complex if schedule is not met, as well as all other associated damages allowed by law.

CONTRACT AGREEMENT (continued)

ARTICLE VIII – CONTRACT DOCUMENTS – The Contract Documents which comprise the contract between Owner and Contractor are attached hereto and made a part hereof and consist of the following:

8.1 This Agreement
8.2 Contractor's Bid and Bonds
8.3 Notice of Award, Notice to Proceed
8.4 Instruction to Bidders
8.5 General Requirements, Control of Work, Temporary Facilities, Measurement and Payment, Standard Specifications
8.6 Insurance Requirements
8.7 Specifications
8.8 Attachment A - RPF Environmental Testing & Consulting Services – City Hall Boiler House Limited Survey Findings
8.9 Drawings: "Portsmouth City Hall Boiler Replacement 2013" by Petersen Engineering, Inc.
8.10 Special Provisions
8.11 Any modifications, including change orders, duly delivered after execution of this Agreement.

ARTICLE IX – TERMINATION FOR DEFAULT – Should contractor at any time refuse, neglect, or otherwise fail to supply a sufficient number or amount of properly skilled workers, materials, or equipment, or fail in any respect to prosecute the work with promptness and diligence, or fail to perform any of its obligations set forth in the Contract, Owner may, at its election, terminate the employment of Contractor, giving notice to Contractor in writing of such election, and enter on the premises and take possession, for the purpose of completing the work included under this Agreement, of all the materials, tools and appliances belonging to Contractor, and to employ any other persons to finish the work and to provide the materials therefore at the expense of the Contractor.

ARTICLE X – INDEMNIFICATION OF OWNER – Contractor will indemnify Owner against all suits, claims, judgments, awards, loss, cost or expense (including without limitation attorneys' fees) arising in any way out of the Contractor's negligent performance of its obligations under this Contract. Contractor will defend all such actions with counsel satisfactory to Owner at its own expense, including attorneys' fees, and will satisfy any judgment rendered against Owner in such action.

ARTICLE XI – PERMITS – The Contractor will secure at its own expense, all permits and consents required by law as necessary to perform the work and will give all notices and pay all fees and otherwise comply with all applicable City, State, and Federal laws, ordinances, rules and regulations.

ARTICLE XII – INSURANCE – The Contractor shall secure and maintain, until acceptance of the work, insurance with limits not less than those specified in the Contract.

ARTICLE XIII – MISCELLANEOUS –

A. Neither Owner nor Contractor shall, without the prior written consent of the other, assign, sublet or delegate, in whole or in part, any of its rights or obligations under any of the Contract Documents; and, specifically not assign any monies due, or to become due, without the prior written consent of Owner.

B. Owner and Contractor each binds himself, his partners, successors, assigns and legal representatives, to the other party hereto in respect to all covenants, agreements and obligations contained in the Contract Documents.

C. The Contract Documents constitute the entire Agreement between Owner and Contractor and may only be altered amended or repealed by a duly executed written instrument.

D. The laws of the State of New Hampshire shall govern this Contract without reference to the conflict of law principles thereof.

E. Venue for any dispute shall be the Rockingham County Superior Court unless the parties otherwise agree.

IN WITNESS WHEREOF, the parties hereunto executed this

AGREEMENT the day and year first above written.

BIDDER:

BY:_____

TITLE:_____

CITY OF PORTSMOUTH, N.H.

BY:_____
John P. Bohenko

TITLE: City Manager

NOTICE OF INTENT TO AWARD

Date:

To:

IN AS MUCH as you were the low responsible bidder for work entitled:

PORTSMOUTH CITY HALL BOILER REPLACEMENTS 2013

You are hereby notified that the City intends to award the above referenced project to you.

Immediately take the necessary steps to execute the Contract and to provide required bonds and proof of insurance within ten (10) calendar days from the date of this Notice.

The City reserves the right to revoke this Notice if you fail to take the necessary steps to execute this Contract.

City of Portsmouth
Portsmouth, New Hampshire

Judie Belanger,
Finance Director

NOTICE TO PROCEED

DATE:

PORTSMOUTH CITY HALL BOILER REPLACEMENTS 2013

TO:

YOU ARE HEREBY NOTIFIED TO COMMENCE WORK IN ACCORDANCE

WITH THE AGREEMENT DATED, _____

WORK SHALL BE COMPLETED PRIOR TO _____.

CITY OF PORTSMOUTH, N.H.

_____

BY: _____

TITLE: Public Works Director

ACCEPTANCE OF NOTICE

RECEIPT OF THE ABOVE NOTICE TO
PROCEED IS HEREBY ACKNOWLEDGED BY

_____

This the _____day of_____ 20__

By:_____

Title:_____

CHANGE ORDER

Change Order Number: Date of Issuance:

Owner: CITY OF PORTSMOUTH, N.H

Contractor:

You are directed to make the following changes in the Contract Documents:

Purpose of Change Order:

Attachments:

CHANGE IN CONTRACT PRICE	CHANGE IN CONTRACT TIME
Original Contract Price: $	Original Completion Date:
Contract Price prior to this Change Order: $	Contract Time prior to this Change Order: days
Net Increase of this Change Order: $	Net Increase of this Change Order: days
Contract Price with all approved Change Orders: $	Contract Time with all approved Change Orders: days

RECOMMENDED:	APPROVED:	APPROVED:	
by_____	by_____	by_____	by_____
PW Director	City Finance	City Manager	Contractor

PERFORMANCE BOND

(This format provided for convenience, actual Performance Bond is acceptable in lieu, if compatible)

Bond Number _____

KNOW ALL MEN BY THESE PRESENTS

that _____as principal, hereinafter called Contractor, and _____ (Surety Company) a [corporation] organized and existing under the laws of the State of_____ and authorized to do business in the State of New Hampshire as surety, hereinafter called Surety, are held and firmly bound unto the City of Portsmouth, N.H., hereinafter called Owner, in the amount of _____ Dollars ($_____), for the payment whereof Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents. WHEREAS, Contractor has by written agreement dated _____ entered into a contract with Owner for The Portsmouth City Hall Boiler Replacements 2013 in accordance with drawings and specifications prepared by **Petersen Engineering Inc.** on behalf of the City of Portsmouth , 1 Junkins Avenue, Portsmouth, N.H. 03801; which contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if the Contractor shall well and faithfully do and perform the things agreed by him to be done and performed, according to the terms of said Contract and such alterations as may be made in said Contract during progress work, and shall further indemnify and save harmless the said Owner in accordance with the Contract, and shall remedy without cost to the Owner any defect which may develop within one year from the time of completion and acceptance of the work.

The Surety hereby waives notice of any alteration in work or extension of time made by the Owner or any of its agents or representatives.

Whenever Contractor shall be, and declared by Owner to be, in default under the Contract, the Owner having performed Owner's obligations thereunder, the Surety may promptly remedy the default, or shall promptly:

(1) Complete the Contract in accordance with its terms and conditions, or

(2) Obtain a bid or bids for submission to the Owner for completing the Contract in accordance with its terms and conditions, and upon determination by Owner and Surety of the lowest responsible Bidder, arrange for a contract between such Bidder and Owner and make available as work progresses (even though there should be a default or a succession of defaults under the contract of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the contract price; but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term "balance of the contract price", as used in this paragraph, shall mean the total amount payable by the Owner to Contractor under the Contract and any amendments thereto, less the amount paid by Owner to Contractor.

Any suit under this bond must be instituted before the expiration of (2) years from the date on which final payment under the contract falls due.

PERFORMANCE BOND (continued)

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

Signed and sealed this _____ day of _____

A.D., 20___ .

In the presence of:
_____ BY: _____
(Witness) (Principal) (Seal)

_____
(Surety Company)

_____ BY: _____
(Witness) (Title) (Seal)

Note:
If the Principal (Contractor) is a partnership, the Bond should be signed by each of the partners.

If the Principal (Contractor) is a corporation, the Bond should be signed in its correct corporate name by its duly authorized Officer or Officers.

If this bond is signed on behalf of the Surety by an attorney-in-fact, there should be attached to it a duly certified copy of his Power of Attorney showing his authority to sign such Bonds.

There should be executed an appropriate number of counterparts of the bond corresponding to the number of counterparts of the Agreement.

LABOR AND MATERIAL PAYMENT BOND

(This format provided for convenience, actual Labor and Material Bond is acceptable in lieu, if compatible)

Bond Number _____

KNOW ALL MEN BY THESE PRESENTS:

that _____

as Principal, hereinafter called Contractor, and _____ (Surety Company) a corporation organized and existing under the laws of the State of

_____ and authorized to do business in the State of New Hampshire hereinafter called Surety, are held and firmly bound unto the City of Portsmouth, N.H. Obligee, hereinafter called Owner, for the use and benefit of claimants as herein below defined, in the

amount of _____ Dollars ($_____), for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, Principal has by written agreement dated _____ entered into a contract with Owner for _____ in accordance with drawings and specifications prepared by **Petersen Engineering, Inc.** on behalf of the City of Portsmouth, 1 Junkins Avenue, Portsmouth, N.H. 03801; which contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that the Principal shall promptly make payment to all claimants as hereinafter defined, for all labor and material used or reasonably required for use in the performance of the Contract and for the hire of all equipment, tools, and all other things contracted for or used in connection therewith, then this obligation shall be void, otherwise it shall remain in full force and effect, subject however, to the following conditions:

(1) A claimant is defined as one having a direct contract with the Principal or, with a subcontractor of the Principal for labor, material, equipment, or other things used or reasonably required for use in the performance of the Contract. "Labor and material" shall include but not be limited to that part of water, gas, power, light, heat, oil and gasoline, telephone service or rental of equipment applicable to the Contract.

(2) The above named Principal and Surety hereby jointly and severally agree with the Owner that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such a claimant, may sue on this bond for the use of such claimant, prosecute the suit by final judgment for such sum or sums as may be justly due claimant, and have execution thereon. The Owner shall not be liable for the payment of any such suit or any costs or expenses of any such suit, and principal and surety shall jointly and severally indemnify, defend and hold the Owner harmless for any such suit, costs or expenses.

(3) No suit or action shall be commenced hereunder by any claimant:

LABOR AND MATERIAL PAYMENT BOND (continued)

(a) Unless Claimant, other than one having a direct contract with the Principal, shall have given notice to all the following:

The Principal, the Owner and the Surety above named, within six (6) calendar months after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the Principal, Owner, and Surety, at any place where an office is regularly maintained for the transaction of business, or served in any manner in which legal process may be served in the State of New Hampshire save that such service need not be made by a public officer.

(b) After the expiration of one (1) year following the date on which Principal ceased all work on said contract, it being understood , however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof, such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

(c) Other than in a State court of competent jurisdiction in and for the county or other political subdivision of the State in which the project, or any part thereof, is situated, or in the United States District Court for the district in which the project, or any part thereof, is situated, and not elsewhere. (4) The amount of this bond may be reduced by and to the extent of any payment of payments made in good faith hereunder, inclusive of the payment by Surety of mechanics' liens which may be filed on record against said improvement, whether or not claim for the amount of such lien by presented under and against this bond.

Signed and sealed this _____ day of _____, 20____. In the presence of:

_____ BY: _____
(Witness) (Principal) (Seal)

_____
(Surety Company)

_____ BY: _____
(Witness) (Title) (Seal)

Note:
If the Principal (Contractor) is a partnership, the Bond should be signed by each of the partners.

If the Principal (Contractor) is a corporation, the Bond should be signed in its correct corporate name by its duly authorized Officer or Officers.

If this bond is signed on behalf of the Surety by an attorney-in-fact, there should be attached to it a duly certified copy of his Power of Attorney showing his authority to sign such Bonds.

There should be executed an appropriate number of counterparts of the bond corresponding to the number of counterparts of the Agreement.

MAINTENANCE BOND

At the Owner's election, a maintenance bond may be substituted for retainage at the completion of the project. If the Owner permits a maintenance bond, it shall be in the amount of **Twenty Percent (20%)** of the contract price with a corporate surety approved by the Owner. Such bond shall be provided at the time of Contract completion and shall guarantee the repair of all damage due to faulty materials or workmanship provided or done by the Contractor. This guarantee shall remain in effect for a period of one year after the date of final acceptance of the job by the Owner.

CONTRACTOR'S AFFIDAVIT

STATE OF _____:

COUNTY OF _____:

Before me, the undersigned, a _____
(Notary Public, Justice of the Peace)

in and for said County and State personally appeared, _____
(Individual, Partner, or duly authorized representative of Corporate)

who, being duly sworn, according to law deposes and says that the cost of labor, material, and equipment and outstanding claims and indebtedness of whatever nature arising out of the performance of the Contract between

CITY OF PORTSMOUTH, NEW HAMPSHIRE

and _____
(Contractor)

of _____

Dated: _____

has been paid in full for Construction of: **Portsmouth City Hall Boiler Replacement 2013**

_____
(Individual, Partner, or
duly authorized
representative of
Corporate Contractor)

Sworn to and subscribed
before me this _____day
of _____ 20____

_____

CONTRACTOR'S RELEASE

KNOW ALL MEN BY THESE PRESENTS that

I, _____ {insert name},
in my capacity as _____{insert title}
of _____ {insert name of Contractor}

agree that upon receipt of the sum of $_____ from the CITY OF PORTSMOUTH NEW HAMPSHIRE as final and completed payment for the construction of: _____ {insert name of project}

do hereby on behalf of _____{name of Contractor} and its successors and assigns release, quit-claim and forever discharge the City of Portsmouth, New Hampshire, its successors and assigns, of and from all claims and demands arising from or in connection with the construction of the above-referenced project and the contract dated _____. All claims and demands shall include without limitation all actions, causes, suits, debts, dues, duties, sums of money, accounts, reckonings, bonds, bills, specifications, covenants, contracts, agreements, promises, damages and judgments whatsoever in law or equity against the City of Portsmouth, New Hampshire which Contractor ever had, now has or may have, for, upon or by reason of any matter, cause, or thing whatsoever; from the beginning of record time to the date of these presents.

IN WITNESS WHEREOF,

Witness Contractor:

_____ By: _____
print name :_____ Its Duly Authorized _____

Dated: _____

GENERAL REQUIREMENTS

SCOPE OF WORK

1. INTENT OF CONTRACT

The intent of the Contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the terms of the Contract. The Contractor shall be required to conform to the intent of the plans and specifications. No extra claims shall be allowed for portions of the work not specifically addressed in the plans and specifications but required to produce a whole and complete project, such work will be considered subsidiary to the bid items.

2. INCIDENTAL WORK

Incidental work items for which separate payment is not measured includes, but is not limited to, the following items:

a. General clean up
b. Cleaning boiler plant building
c. Signs & barricades
d. Mobilization/Demobilization
e. Restoration of property
f. Cooperation with other contractors, abutters and utilities.
g. Clearing, grubbing and stripping
h. Steel and/or wood sheeting as required.
i. Accessories and fasteners or components required to make items complete and functional.
j. Maintaining current EPA standards and practices when removing asbestos.

3. ALTERATION OF PLANS OR OF CHARACTER OF WORK

The Owner reserves the right, without notice to Surety, to make such alterations of the plans or of the character of the work as may be necessary or desirable to complete fully and acceptably the proposed construction; provided that such alterations do not increase or decrease the contract cost. Within these cost limits, the alterations authorized in writing by the Owner shall not impair or affect any provisions of the Contract or bond and such increases or decreases of the quantities as a result from these alterations or deletions of certain items, shall not be the basis of claim for loss or for anticipated profits by the contractor. The contractor shall perform the work as altered at the contract unit price or prices.

4. EXTRA WORK ITEMS

Extra work shall be performed by the Contractor in accordance with the specifications and as directed, and will be paid for at a price as provided in the Contract documents or if such pay items are not applicable than at a price negotiated between the contractor and the Owner or at the unit bid price. If no agreement can be negotiated, the Contractor will accept as payment for extra work, cost plus 15% (overhead & profit). Costs shall be substantiated by invoices and certified payroll. If the Owner determines that extra work is to be performed, a change order will be issued.

5. CHANGE ORDERS

The Owner reserves the right to issue a formal change order for any increase, decrease, deletion, or addition of work or any increase in contract time or price. The contractor shall be required to sign the change order and it shall be considered as part of the Contract documents.

6. FINAL CLEANING UP

Before acceptance of the work, the contractor shall remove from the site all machinery, equipment, surplus materials, rubbish, temporary buildings, barricades and signs. All parts of the work shall be left in a neat and presentable condition. On all areas used or occupied by the contractor, regardless of the contract limits, the bidder shall clean-up all sites and storage grounds.

The items prescribed herein will not be paid for separately, but shall be paid for as part of the total contract price.

7. ERRORS AND INCONSISTENCY IN CONTRACT DOCUMENTS

Any provisions in any of the Contract Documents that may be in conflict with the paragraphs in these General Requirements shall be subject to the following order of precedence for interpretation.

1. Drawings, Technical Specifications, and Special Provisions will govern General Requirements.

CONTROL OF WORK

1. AUTHORITY OF ENGINEER

(a) All work shall be done under supervision of the City Engineer and to his satisfaction. The City Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions that may arise as to the interpretation of the plans and specifications; and all questions as to the acceptable fulfillment of the Contract by the Contractor.

(b) The City Engineer will have the authority to suspend the work wholly or in part for such periods as he may deem necessary due to the failure of the Contractor to correct conditions unsafe for workers or the general public; for failure to carry out provisions of the Contract; for failure to carry out orders; for conditions considered unsuitable for the prosecution of the work, including unfit weather; or for any other condition or reason deemed to be in the public interest. The Contractor shall not be entitled any additional payments arising out of any such suspensions.

(c) The Owner reserves the right to demand a certificate of compliance for a material or product used on the project. When the certificate of compliance is determined to be unacceptable to the City Engineer the Contractor may be required to provide engineering and testing services to guarantee that the material or product is suitable for use in the project, at its expense (see Sample of Certificate of Compliance).

2. PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPES

(a) The Contractor shall use every precaution to prevent injury or damage to wires, poles, or other property of public utilities; trees, shrubbery, crops, and fences along and adjacent to the right-of-way, all underground structures such as pipes and conduits, within or outside of the right-of-way; and the Contractor shall protect and carefully preserve all property marks until an authorized agent has witnessed or otherwise referenced their location.

(b) The Contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing the work, or at any time due to defective work or materials, and said responsibility will not be released until the project shall have been completed and accepted.

(c) When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or as a result of the failure to perform work by the Contractor, the Contractor shall restore, at its own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing rebuilding, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner.

(d) The Contractor shall paint with tree paint all scars made on fruit or ornamental trees by equipment, construction operations, or the removal of limbs larger than one inch in diameter. Damaged trees must be replaced if so determined by the City Arborist, in his or her sole discretion.

(e) If the Contractor fails to repair, rebuild or otherwise restore such property as may be deemed necessary, the Owner, after 48 hours notice, may proceed to do so, and the cost thereof may be deducted from any money due or which may become due the Contractor under the contract.

CONTROL OF WORK (continued)

(f) It is the intent of the Parties that the Contractor preserves, to as great an extent as possible, the historic & natural features of the site.

(g) The Contractor shall follow all US Environmental Protection Agency's and State of New Hampshire current standards for asbestos removals during this project. This includes protection of area within the existing building as required by the US EPA standards. A copy of the contractor's asbestos removals certification shall be provided to the Owner prior to start of construction.

3. MAINTENANCE DURING CONSTRUCTION

The Contractor shall maintain the work during construction and until the project is accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and workers to ensure that the structure is kept in satisfactory conditions at all times.

4. SAFETY PRECAUTIONS

Upon commencement of work, the Contractor shall be responsible for initiating, maintaining and supervising all safety precautions necessary to ensure the safety of employees on the site, other persons who may be affected thereby, including the public, and other property at the site or adjacent thereto. This includes meeting current EPA asbestos removal standards.

5. PERMITS

It will be the responsibility of the Contractor to obtain all permits required for the operation of equipment in, or on, all city streets and public ways.

6. BARRICADES, WARNING SIGNS AND TRAFFIC OFFICERS

(a) The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs and other traffic control devices, and shall take all necessary precautions for the protection of the work and safety of the public. Roadway closed to traffic shall be protected by effective barricades. Obstructions shall be illuminated during hours of darkness. Suitable warning signs shall be provided to control and direct traffic in a proper manner, as approved by the engineer.

(b) The Contractor will be held responsible for all damage to the work from traffic, pedestrians, animals or any other cause due to lack of adequate controlling devices.

The work prescribed herein will not be paid for separately but will be paid for as part of the Contract Price unless specifically appearing as a bid item.

INSURANCE REQUIREMENTS

Insurance shall be in such form as will protect the Contractor from all claims and liabilities for damages for bodily injury, including accidental death, and for property damage, which may arise from operations under this contract whether such operation by himself or by anyone directly or indirectly employed by him.

AMOUNT OF INSURANCE

A) Comprehensive General Liability:
Bodily injury or Property Damage - $2,000,000
Per occurrence and general aggregate

B) Automobile and Truck Liability:
Bodily Injury or Property Damage - $2,000,000
Per occurrence and general aggregate

Coverage requirements can be met with excess policies

Additionally, the Contractor shall purchase and maintain the following types of insurance:

A) Full Workers Comprehensive Insurance coverage for all people employed by the Contractor to perform work on this project. This insurance shall at a minimum meet the requirements of the most current laws of the State of New Hampshire.

B) Contractual Liability Insurance coverage in the amounts specified above under Comprehensive General Liability.

C) Product and Completed Operations coverage to be included in the amounts specified above under Comprehensive General Liability.

D) Builder's Risk in the amount of the contract.

ADDITIONAL INSURED

All liability policies (including any excess policies used to meet coverage requirements) shall include the City of Portsmouth, New Hampshire as named Additional Insureds.

1) The contractor's insurance shall be primary in the event of a loss.
2) The Additional Insured endorsement must include language specifically stating that the entity is to be covered for all activities performed by, or on behalf of, the contractor, including the City of Portsmouth's general supervision of the contractor.
3) City of Portsmouth shall be listed as a Certificate Holder. The City shall be identified as follows:

City of Portsmouth
Attn: Legal Department
1 Junkins Avenue
Portsmouth, NH 03801

TEMPORARY FACILITIES

1. STORAGE FACILITIES

(a) The Contractor shall not store materials or equipment in a public right-of-way beyond the needs of one working day. Equipment and materials shall be stored in a location approved by the Owner.

(b) The Contractor shall protect all stored materials from damage by weather or accident and shall insure adequate drainage at and about the storage location.

(c) Prior to final acceptance of the work all temporary storage facilities and surplus stored materials shall be removed from the site.

2. SANITARY FACILITIES

The Owner shall provide the Contractor with reasonable access to toilet facilities for the use of the workers employed on the work.

3. WATER FACILITIES

The Owner shall provide the Contractor with reasonable access to water facilities for construction operations.

4. TEMPORARY ELECTRICITY

The Owner shall provide the Contractor with reasonable access to electrical power necessary for construction operation at the site.

MEASUREMENT AND PAYMENT

1. MEASUREMENT OF QUANTITIES

(a) All work completed under the contract will be measured according to the United States standard measure.

(b) The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice. Unless otherwise stated all quantities measured for payment shall be computed or adjusted for "in place" conditions.

(c) Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the dimensions shown on the plans or ordered in writing.

(d) Structures will be measured according to lines shown on the plans or as ordered unless otherwise provided for elsewhere in the specifications.

(e) In computing volumes of excavation, embankment, and borrow, the average end area method will be used. Where it is impracticable to measure by the cross-section method, acceptable methods involving three-dimensional measurement may be used. When measurement of borrow in vehicles is permitted, the quantity will be determined as 80 percent of the loose volume.

(f) In computing volumes of concrete, stone and masonry, the prismoidal method will be used. The term "ton" will mean the short ton consisting of 2,000 pounds avoirdupois.

(g) Except as specified below, all materials that are measured or proportioned by weight shall be weighed on scales which the Contractor has had sealed by the State or by a repairman registered by the Commissioner of Agriculture. All weighing shall be performed in a manner prescribed under the Rules and Regulations of the Bureau of Weights and Measures of the New Hampshire Department of Agriculture.

(h) Weighing of materials on scales located outside New Hampshire will be permitted for materials produced or stored outside the state, when requested by the Contractor and approved. Out-of-state weighing in order to be approved, must be performed by a licensed public weigh master or a person of equal authority in the state concerned on scales accepted in the concerned state.

(i) Each truck used to haul material being paid for by weight shall bear a plainly legible identification mark, and if required, shall be weighed empty daily at such times as directed.

(j) When material is weighed, the individual weight slips, which shall be furnished by the Contractor, for trucks, trailers, or distributors, shall show the following information: the date; the project; the material or commodity; the dealer or vendor; the Contractor or Subcontractor; the location of the scales; the vehicle registration number or other approved legible identification mark; the tare and net weights, with gross weights when applicable; and the weigher's signature or his signed initials.

(k) The right is reserved to weight any truck, trailer, or distributor, at locations designated, before and after making deliveries to the project.

MEASUREMENT AND PAYMENT (continued)

(l) Bituminous materials will be measured by the gallon or ton.

(m) When material is specified to be measured by the cubic yard but measurement by weight is approved, such material may be weighed and the weight converted to cubic yards for payment purposes. Necessary conversion factors will be determined by the Owner.

(n) The term "lump sum" when used as an item of payment will mean complete payment for the work described in the item.

(o) When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories, so as to provide the item complete and functional. Except as may be otherwise provided, partial payments for lump sum items will be made approximately in proportion to the amount of the work completed on those items.

(p) Material wasted without authority will not be included in the final estimate.

2. SCOPE OF PAYMENT

(a) The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials and for performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof.

(b) The Contractor shall be liable to the Owner for failure to repair, correct, renew or replace, at his own expense, all damage due or attributable to defects or imperfections in the construction which defects or imperfections may be discovered before or at the time of the final inspection and acceptance of the work.

(c) No monies, payable under the contract or any part thereof, shall become due or payable if the Owner so elects, until the Contractor shall satisfy the Owner that the Contractor has fully settled or paid all labor performed or furnished for all equipment hired, including trucks, for all materials used, and for fuels, lubricants, power tools, hardware and supplies purchased by the Contractor and used in carrying out said contract and for labor and parts furnished upon the order of said Contractor for the repair of equipment used in carrying out said contract; and the Owner, if he so elects, may pay any and all such bills, in whole or in part.

3. PAYMENT PROCEDURES

Submit Application for Payment after completion of Project closeout procedures with release of liens and supporting documentation. Include consent of surety to final payment and insurance certificates.

4. COMPENSATION FOR ALTERED QUANTITIES

(a) Except as provided for under the particular contract item, when the accepted quantities of work vary from the quantities in the bid schedule the Contractor shall accept as payment in full, so far as contract items are concerned, at the original contract unit prices for the accepted quantities of work done. No allowance will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the Bidder and subsequent loss of expected reimbursements therefore or from any other cause.

MEASUREMENT AND PAYMENT (continued)

(b) Extra work performed will be paid for at the contract bid prices or at the price negotiated between the Owner and the Contractor if the item was not bid upon. If no agreement can be negotiated, the Contractor will accept as payment for extra work, cost plus 15% (overhead and profit). Costs shall be substantiated by invoices and certified payroll.

5. PARTIAL PAYMENTS

Partial payments will be made on a monthly basis during the contract period, and based on the percentage of work completed. From the total amount ascertained as payable, an amount equivalent to ten percent (10%) of the whole will be deducted and retained by the Owner until such time as the work receives final acceptance.

6. FINAL ACCEPTANCE

Upon due notice from the Contractor of presumptive completion of the entire project, the Owner and City Engineer will make an inspection. If all construction provided for and contemplated by the contract is found complete to their satisfaction, this inspection shall constitute the final inspection and the Owner or City Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of the final inspection.

If, however, the City Engineer's inspection discloses any work in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of such work, and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, the City Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

7. ACCEPTANCE AND FINAL PAYMENT

(a) When the project has been accepted and upon submission by the Contractor of all required reports, completed forms and certifications, the Owner will review the final estimate of the quantities of the various classes of work performed. The Contractor may be required to certify that all bills for labor and material used under this contract have been paid.

(b) The Contractor shall file with the Owner any claim that the Contractor may have regarding the final estimate at the same time the Contractor submits the final estimate. Failure to do so shall be a waiver of all such claims and shall be considered as acceptance of the final estimate. From the total amount ascertained as payable, an amount equal to ten percent (10%) of the whole will be deducted and retained by the Owner for the guaranty period. This retainage may be waived, at the discretion of the City, provided the required Maintenance Bond has been posted. After approval of the final estimate by the Owner, the Contractor will be paid the entire sum found to be due after deducting all previous payments and all amounts to be retained or deducted under the provisions of the contract.

(c) All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

MEASUREMENT AND PAYMENT (continued)

8. GENERAL GUARANTY AND WARRANTY OF TITLE

(a) Neither the final certification of payment nor any provision in the contract nor partial or entire use of the improvements embraced in this Contract by the Owner or the public shall constitute an acceptance of work not done in accordance with the Contract or relieve the Contractor of liability in respect to any express or implied warranties or responsibility for faulty materials or workmanship. The Contractor shall promptly remedy any defects in the work and pay for any damage to other work resulting there from which shall appear within a period of twelve (12) months from the date of final acceptance of the work. The Owner will give notice of defective materials and work with reasonable promptness.

(b) No material, supplies or equipment to be installed or furnished under this Contract shall be purchased subject to any chattel mortgage or under a conditional sale, lease purchase or other agreement by which an interest therein or in any part thereof is retained by the Seller or supplier. The Contractor shall warrant good title to all materials, supplies and equipment installed or incorporated in the work and upon completion of all work, shall deliver the same together with all improvements and appurtenances constructed or placed thereon by him to the Owner free from any claims, liens or charges. Neither the Contractor nor any person, firm or corporation furnishing any material or labor for any work covered by this Contract shall have the right to a lien upon any improvements or appurtenances thereon.

Nothing contained in this paragraph, however, shall defeat or impair the right of persons furnishing materials or labor to recover under any bond given by the Contractor for their protection or any rights under any law permitting such persons to look to funds due the Contractor in the hands of the Owner. The provisions of this paragraph shall be inserted in all subcontractors and material contracts and notice of its provisions shall be given to all persons furnishing materials for the work when no formal contract is entered into for such materials.

(c) At completion of project, Contractor to provide to Owner, written guarantee of one (1) year Workmanship warranty; and one (1) year Manufacturer’s warranty on burner components and ten (10) year Manufacturer’s warranty on pressure vessels.

9. NO WAIVER OF LEGAL RIGHTS

(a) Upon completion of the work, the Owner will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance, however, shall not preclude or stop the Owner from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Owner be precluded or be stopped from recovering from the Contractor or his Surety, or both, such overpayment as it may sustain by failure on the part of the Contractor to fulfill his obligations under the contract. A waiver on the part of the Owner of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

(b) The Contractor, without prejudice to the Contract shall be liable to the terms of the Contract, shall be liable to the Owner for latent defects, fraud or such gross mistakes as may amount to fraud, and as regards the Owner's right under any warranty or guaranty.

10. TERMINATION OF CONTRACTOR'S RESPONSIBILITY

Termination of Contractor’s responsibilities will occur whenever the improvement provided for by the Contract shall have been completely performed on the part of the Contractor and all parts of the work have been released from further obligations except as set forth in his bond and as provided in Section 8 above.

SHOP DRAWINGS

The Contractor shall submit working and detail drawings, well in advance of the work, to the City's Consulting Mechanical Engineer for review.

The Contractor's drawings shall consist of shop detail, erection and other working plans showing dimensions, sizes and quality of material, details and other information necessary for the complete fabrication and erection of the pertinent work.

The Contractor shall submit two sets of drawings to the City's Consulting Mechanical Engineer, and one set of drawings to the Owner for review.

Prior to the approval of the drawings, any work done or materials ordered for the work involved shall be at the Contractor's risk.

One set of the drawings will be returned to the Contractor approved or marked with corrections to be made by the City's Consulting Mechanical Engineer. After approval has been given, the Contractor shall supply the City's Consulting Mechanical Engineer with two sets of the revised detail working drawings.

The City's Consulting Mechanical Engineer's approval of the Contractor's working drawings will not relieve the Contractor from responsibility for errors in dimensions or for incorrect fabrication processes, or from responsibility to complete the contract work.

ATTACHMENT A:

RPF ENVIROMENTAL TESTING & CONSULTING SERVICES
CITY HALL BOILER HOUSE LIMITED SURVEY FINDINGS

RPF Environmental
TESTING & CONSULTING SERVICES
Hazardous Materials Inspection & Assessment
Asbestos, Mold, Lead Paint, Radon, PCBs
Air Quality Testing and Investigations
Industrial Hygiene, Safety & Training

April 25, 2013

Mr. Rick Dolce
City of Portsmouth
Department of Public Works
680 Peverly Hill Road
Portsmouth, NH 03801

Re: City Hall Boiler House
Limited Survey Findings
RPF File No. 135375

Dear Mr. Dolce:

On March 28, 2013, RPF Environmental, Inc. (RPF) conducted a limited survey of the accessible mechanical systems insulation associated with the boilers in the lower level at the City Hall Boiler House located at 1 Junkins Avenue, Portsmouth, New Hampshire The survey was performed as designated by you for asbestos containing material (ACM) as indicated herein. Below is a summary of findings, discussion of the results and preliminary recommendations for proper management of the identified ACM. Attached to this report are the survey data tables, laboratory results, survey methodologies and limitations. This report is not intended to be used as an abatement specification or work plan.

Summary of Findings

The City Hall Boiler House is a two story brick building with a large room on the ground floor which houses three Cleaver Brooks boilers.

Several types of suspect ACM insulation and gaskets were observed by RPF, including friable and nonfriable suspect material. Based on the testing performed by RPF asbestos was detected in non-friable gasket materials associated with the exhaust ducts running above each of the three boilers.

Depending on the extent of renovation and final construction plans, proper abatement and/or management of the materials will be required in accordance with applicable State and federal regulations. Renovation and demolition plans should be reviewed by a certified industrial hygienist and a licensed project designer for possible asbestos impact issues. Based on the impact assessment and planned usage, technical specifications should be prepared for abatement, as applicable. A management plan should also be prepared to address any asbestos or other hazardous material scheduled to remain after construction.

Discussion of Findings

Asbestos is the name for a group of naturally occurring minerals that separate into strong, very fine fibers. The adverse health effects associated with asbestos exposure have been extensively studied for many years. Results of these studies and epidemiological investigations have demonstrated that inhalation of asbestos fibers may lead to increased risk of developing one or more diseases. In all cases, extreme care must be used not to disturb asbestos-containing materials or to create fiber release episodes.

In the accessible locations surveyed, RPF identified ten (10) homogeneous groups of accessible suspect insulation and gaskets. Suspect materials were identified based on current industry standards, EPA, and other guideline listings of potential suspect ACBM. A total of eighteen (18) samples were extracted from the different groups of suspect material in accordance with EPA sampling protocols. Of the samples collected by RPF, asbestos was detected in one group of suspect gasket material associated with the exhaust ducts leading from each of the three boilers to the exterior exhaust stack.

Table 1 below Appendix A includes a list of ACM identified, EPA category listings, and asbestos content. A listing of the different homogenous groups of suspect material identified, samples collected, and analytical results is included in Table 2 of Appendix A.

TABLE 1
SUMMARY OF INTERIOR ACBM IDENTIFIED

Building Material	Location	Approximate Quantity	EPA Category	Asbestos Results
Exhaust Duct Gasket	Ground Floor, installed in duct work from three boilers to exterior exhaust stack	3 round and 1 square gasket, 18”-24” diameter	Category II Nonfriable	80% Chrysotile

Table 1 Notes:

- Table 1 does not include a listing of all ACM and suspect ACM present at the site, only the materials found to be ACM during the limited testing of boiler related insulation and gasket.
- Please note that Category 1 and Category 2 nonfriable ACM are recategorized as friable and/or RACM under certain conditions. Current State asbestos regulations are more strict and comprehensive than the EPA NESHAPs requirements.
- All quantities are approximate only and should be confirmed during abatement project design and abatement bidding. Contingencies should also be included for possible concealed ACM.
- It is possible that some concealed or inaccessible ACM is present. Care should be used when renovating/demolishing inaccessible building space. Further explorative survey work may be necessary during design and/or in conjunction with demolition.

The ACBM identified during this survey consists of nonfriable gasket material within the exhaust duct above the three boilers, which was observed to be in good to fair condition and, left undisturbed and properly managed, is unlikely to cause any major fiber release episodes. As previously discussed with you, should these materials be impacted by the upcoming boiler replacement project, they would need to be properly removed and disposed of by qualified personnel.

Three round and one square ACM gaskets were observed in the exhaust duct leading from each of the three boilers to the exterior exhaust stack. However, as two of the three boilers were still active at the time of this survey, it was not possible to determine if any additional gaskets were present inside the hot portions of the exhaust duct. As such, proper inspections should be made by qualified personnel during the dismantling of the exhaust duct to determine if any additional suspect ACBM gaskets are present.

As reviewed with you, two of the three boilers were still actively being used and the interiors could not be accessed to determine the presence of any suspect ACM. The internal gaskets and insulation of both of the active boilers should be assumed to be ACM until such time as the boiler interiors can be safely accessed and sampled. Please coordinate with our office to arrange for the internal materials to be sampled once the remaining boilers are deactivated and made accessible.

The scope of this survey was limited to the materials and components associated with the three boilers in the ground floor of the Boiler House. A complete survey of the remainder of the building, and actual building structure materials and finishes, was outside of the scope of this survey. Any other materials within the building that are not specifically referenced in this survey or by other existing survey data should be assumed to be ACM until it can properly sampled and tested for asbestos content.

Conclusions

Based on the survey findings, gasket material associated with the boilers were found to contain ACM and it is possible that additional concealed ACM or suspect ACM is also present.

In accordance with current regulatory requirements, ACBM that may be impacted or disturbed (such that asbestos fiber release occurs) by renovation, demolition or other such activity must be removed by qualified, licensed firms. Although regulations for removal of nonfriable ACBM are somewhat less stringent than the requirements for friable ACBM, it should be noted that nonfriable ACBM that is subjected to grinding, abrasion, and other forces, could be rendered friable. In this event, the nonfriable ACBM would be re-categorized friable ACBM.

ACBM that will not be impacted by renovation or demolition activity may be left in place if managed properly and if the materials are maintained in good condition. ACBM to remain in the building should be included in an asbestos management plan and operations and maintenance (O&M) program detailing the measures to be used to safely occupy the building until the ACBM is fully removed. An accredited Management Planner should prepare the O&M Program in accordance with the guidelines set forth in 40 CFR Part 763 (AHERA).

Sufficiently in advance of the start of renovation and/or remediation work, abatement project design should be completed. As part the initial design steps any planned renovation and demolition activity should be reviewed for potential impact on ACBM. Asbestos removal is highly regulated at the State and federal level, and in some cases, at the local level also.

Notification to NH Air Resources is required 10-days prior to the start of interior abatement work and demolition. Only qualified, trained, and licensed firms, as applicable, should be engaged to complete asbestos removal or other abatement activity. Asbestos abatement work must be designed (abatement specifications or work plan prepared) by accredited personnel.

All employees and contractors that may access or otherwise disturb areas with suspect ACBM present should be notified of the presence of ACBM and possible hidden ACBM, and the need to use caution when proceeding with work. Appropriate notifications, labeling and other hazard communications should be completed to all employees, contractors and others in accordance with US OSHA regulations and other applicable requirements (including asbestos labeling in accordance with 29 CFR Part 1926). The scope of RPF services for this survey did not include labeling of ACBM or hazard communications to other employees, building occupants, contractors, or subcontractors.

Documentation of current ACBM conditions and in-depth hazard assessment is beyond the scope-of-work for this initial survey. With the exception of the specific testing and analysis detailed herein, no other samples of materials, oil, water, ground water, air, or other suspect hazardous materials were collected in the course of this inspection that supports or denies these conclusions. No additional services beyond those explicitly stated herein were performed and none should be inferred or implied. The summary and conclusions are based on reasonably ascertainable information as described in this report. RPF Environmental, Inc. makes no guarantees, warranties, or references regarding this property or the condition of the property after the period of this report.

If you have any questions at this time, or if you would like to discuss the remediation process, please call our office.

Sincerely,
RPF ENVIRONMENTAL, INC.

Allan D. Mercier
Licensed Inspector

Enclosures:
Appendix A: Data and Analytical Tables
Appendix B: Sketch showing sample locations
Appendix C: Survey Photographs
Appendix D: Summary of Methodology and Limitations

135375 042513 rpt

APPENDIX A

TABLE 2

CITY OF PORTSMOUTH
City Hall, Boiler House
Limited Survey

SUMMARY OF BULK MATERIAL SAMPLING AND RESULTS
Polarized Light Microscopy – EPA 600/R-93/116 Method

Samples Collected: March 28, 2013

Sample ID	Sample Description	Asbestos Content	Other Content
032813-HG01	Jacket insulation (fiberglass), white, boiler #1	No Asbestos Detected	95% Fiber Glass 5% Non-fibrous
032813-HG02	Gasket (fiberglass), white, boiler #1, front	No Asbestos Detected	95% Fiber Glass 5% Non-fibrous
032813-HG03	Gasket, tan, square duct, over boiler #3	80% Chrysotile	15% Synthetic Fibers 5% Non-fibrous
032813-HG03b	Gasket, tan, round duct, over boiler #2	*SFP	*SFP
032813-HG05	Door insulation, white, boiler #3, rear	No Asbestos Detected	100% Non-fibrous
032813-HG05b	Door insulation, white, boiler #3, right door	No Asbestos Detected	100% Non-fibrous
032813-HG05c	Door insulation, white, boiler #3, left door	No Asbestos Detected	50% Fiber Glass, 30% Cellulose, 20% Non-fibrous
032813-HG06	Fire brick, white, boiler #3, rear	No Asbestos Detected	100% Non-fibrous
032813-HG06b	Fire brick, white, boiler #3, rear	No Asbestos Detected	100% Non-fibrous
032813-HG07	Pipe insulation, white, pipe from boiler #2	No Asbestos Detected	5% Synthetic Fibers 95% Non-fibrous
032813-HG07b	Pipe insulation, white, pipe from boiler #2	No Asbestos Detected	5% Synthetic Fibers 95% Non-fibrous
032813-HG07c	Pipe insulation, white, pipe from boiler #2	No Asbestos Detected	5% Synthetic Fibers 95% Non-fibrous
032813-HG08-Insulation	Valve insulation, blue, valve over boiler #1	No Asbestos Detected	3% Fiber Glass, 3% Synthetic Fibers, 94% Non-fibrous
032813-HG08-Wrap	Valve insulation, blue, valve over boiler #1	No Asbestos Detected	80% Cellulose 20% Non-fibrous
032813-HG08b	Valve insulation, blue, valve over boiler #2	No Asbestos Detected	3% Fiber Glass, 3% Synthetic Fibers, 94% Non-fibrous
032813-HG09-Insulation	Fitting insulation, white, pipe over boiler #1	No Asbestos Detected	5% Synthetic Fibers, 95% Non-fibrous

Notes:

- Trace means less than 1%. SFP Means analysis was terminated because asbestos was detected on a previous homogenous sample during the survey work. Please reference the "HG" group number.
- Please reference the full report for discussions and additional information and limitations pertaining to these results.

TABLE 2 (continued)

CITY OF PORTSMOUTH
City Hall, Boiler House
Limited Survey

SUMMARY OF BULK MATERIAL SAMPLING AND RESULTS
Polarized Light Microscopy – EPA 600/R-93/116 Method

Samples Collected: March 28, 2013

Sample ID	Sample Description	Asbestos Content	Other Content
032813-HG09-Wrap	Fitting insulation, white, pipe over boiler #1	No Asbestos Detected	80% Cellulose 20% Non-fibrous
032813-HG10	End insulation, tan, top of boiler #1, at bottom of valve insulation	No Asbestos Detected	5% Synthetic Fibers, 95% Non-fibrous

135375

Notes:

- Trace means less than 1%. SFP Means analysis was terminated because asbestos was detected on a previous homogenous sample during the survey work. Please reference the "HG" group number.
- Please reference the full report for discussions and additional information and limitations pertaining to these results.

APPENDIX B

RPF ENVIRONMENTAL, INC.
Environmental Health & Safety

Page No. 1

Project: City of Portsmouth

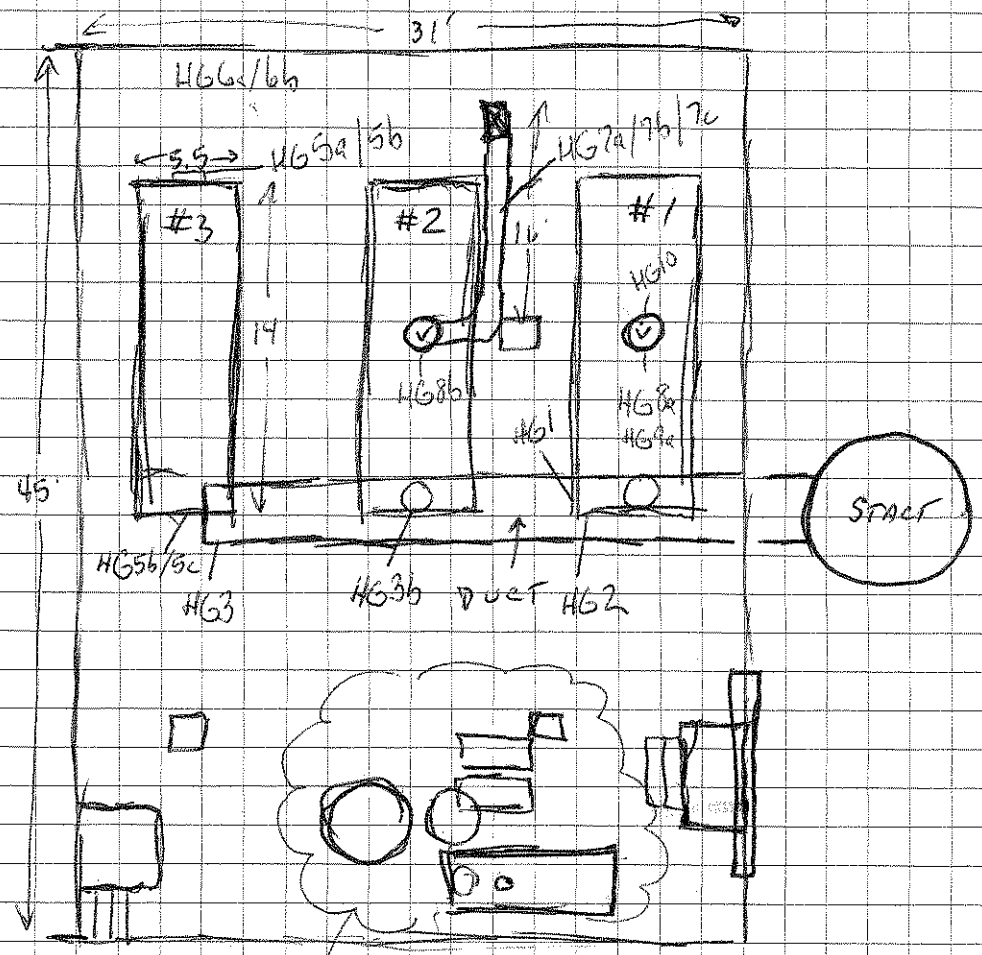
File No. 135375

Location: City Hall Boiler House | Date: 3-28-13 | By: ADA

Subject: | Checked: | By:

Based on: | Revised: | By:

15' High



FIBERGLASS INSULATED COMPONENTS

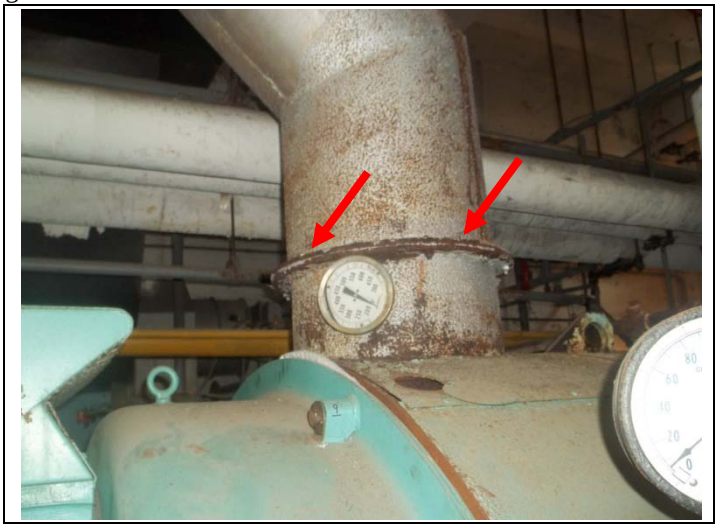
APPENDIX C

1. Exterior view of City Hall Boiler House. Overhead door access to lower level on left and exhaust stack on right.

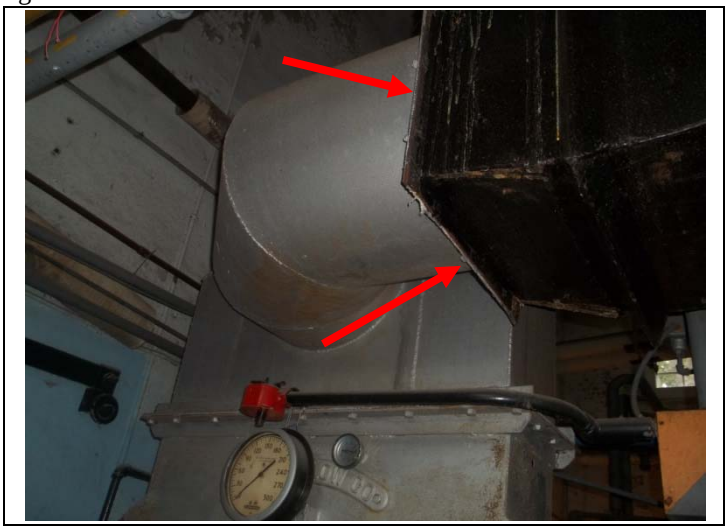
2. Overall boiler room with Cleaver Brooks Boilers.

3.Cleanout door in rear of inactive boiler #3 with non-asbestos gasket installed.

4. Front access doors in inactive boiler #3 with non-ACBM gaskets and door insulation.



5. Exhaust duct above boilers with ACBM gasket at flanges (arrow).



6. Square duct above boilers with ACBM gasket at flanges (arrow).

APPENDIX C: SITE PHOTOGRAPHS

Site Address: City Hall Boiler House

City of Portsmouth, NH.

RPF Environmental
TESTING & CONSULTING SERVICES

www.airpf.com
603-942-5432

Project No. 135373

APPENDIX D

Summary of Methodology: Asbestos-Containing Building Materials Survey

EPA accredited inspector(s) surveyed accessible space in the building or site areas included within the RPF Scope of Work (SOW) to identify suspect asbestos-containing building material (ACBM). Suspect ACBM was inventoried and categorized into homogeneous groups of materials. To the extent indicated in the report, samples were then extracted from the different groups of homogeneous materials in accordance with applicable State and federal rules and regulations. For surveys in which the SOW included full inspections of the affect space, sampling methodologies were based on the requirements set forth in 40 CFR Part 763 (EPA) and 29 CFR Part 1926.1101 (OSHA). For preliminary or limited surveys, findings apply to only the affected material or space as indicated in the RPF SOW and Report and additional inspection and testing will be required to satisfy regulatory obligations associated with renovation, demolition, maintenance and other occupational safety and health requirements.

Collected samples were individually placed into sealed containers, labeled, and submitted with proper chain of custody forms to the RPF NVLAP-accredited vendor laboratory. Sample containers and tools were cleaned after each sample was collected. Samples were analyzed for asbestos content using polarized light microscopy (PLM). Although PLM is the method currently recognized in State and federal regulations for asbestos identification in bulk samples, PLM may not be sensitive enough to detect all of the asbestos fibers in certain types of materials, such as floor tile and other nonfriable ACBM. In the event that more definitive results are requested in cases of with negative or trace results of asbestos are detected, RPF recommends that confirmation testing be completed using transmission electron microscopy.

For each homogeneous group of suspect material, a “stop at first positive” (SFP) method may have been employed during the analysis. The SFP method is based on current EPA sampling protocols and means that if one sample within a homogeneous group of suspect material is found to contain >1% asbestos, then further analysis of that specific homogenous group samples is terminated and the entire homogeneous group of material is considered to be ACBM regardless of the other sample results. This is based on the potential for inconsistent mix of asbestos in the product yielding varying findings across the different individual samples collected from the same homogeneous group. Unless otherwise noted in the report, sample groups found to have 1% to <10% asbestos content are assumed to be ACBM; to rebut this assumption further analysis with point count methods are required.

Inaccessible and hidden areas, including but not limited to wall/floor/ceiling cavity space, space with obstructed access (such as fiberglass insulation above suspended ceilings), sub floors, interiors of mechanical and process equipment, and similar spaces were not included in the inspection and care should be used when accessing these areas in the future. Unless otherwise noted in the RPF Report, destructive survey techniques were not employed during this survey.

In the event that additional suspect materials are encountered that are not addressed in this report, the materials should be properly tested by an accredited inspector. For example, during renovation and demolition it is likely that additional suspect material will be encountered and such suspect materials should be assumed to be hazardous until proper inspection and testing occurs.

RPF followed applicable industry standards; however, various assumptions and limitations of the methods can result in missed materials or misidentification of materials due several factors including but not limited to: inaccessible space due to physical or safety constraints, space that is difficult to reach to fully inspection, assumptions regarding the determination of homogenous groups of suspect material, assumptions regarding attempts to conduct representative sampling, and potential for varying mixtures and layers of material sampled not being representative of all areas of similar material. Also reference the Limitations document attached to the report.

LIMITATIONS

1. The observations and conclusions presented in the Report were based solely upon the services described herein, and not on scientific tasks or procedures beyond the RPF Environmental, Inc. Scope of Work (SOW) as discussed in the proposal and/or agreement. The conclusions and recommendations are based on visual observations and testing, limited as indicated in the Report, and were arrived at in accordance with generally accepted standards of industrial hygiene practice and asbestos professionals. The nature of this survey or monitoring service was limited as indicated herein and in the report or letter of findings. Further testing, survey, and analysis is required to provide more definitive results and findings.

2. For site survey work, observations were made of the designated accessible areas of the site as indicated in the Report. While it was the intent of RPF to conduct a survey to the degree indicated, it is important to note that not all suspect ACBM material in the designated areas were specifically assessed and visibility was limited, as indicated, due to the presence of furnishings, equipment, solid walls and solid or suspended ceilings throughout the facility and/or other site conditions. Asbestos or hazardous material may have been used and may be present in areas where detection and assessment is difficult until renovation and/or demolition proceeds. Access and observations relating to electrical and mechanical systems within the building were restricted or not feasible to prevent damage to the systems and minimize safety hazards to the survey team.

3. Although assumptions may have been stated regarding the potential presence of inaccessible or concealed asbestos and other hazardous material, full inspection findings for all asbestos and other hazardous material requires the use of full destructive survey methods to identify possible inaccessible suspect material and this level of survey was not included in the SOW for this project. For preliminary survey work, sampling and analysis as applicable was limited and a full survey throughout the site was not performed. Only the specific areas and /or materials indicated in the report were included in the SOW. This inspection did not include a full hazard assessment survey, full testing or bulk material, or testing to determine current dust concentrations of asbestos in and around the building. Inspection results should not be used for compliance with current EPA and State asbestos in renovation/demolition requirements unless specifically stated as intended for this use in the RPF report and considering the limitations as stated therein and within this limitations document.

4. Where access to portions of the surveyed area was unavailable or limited, RPF renders no opinion of the condition and assessment of these areas. The survey results only apply to areas specifically accessed by RPF during the survey. Interiors of mechanical equipment and other building or process equipment may also have asbestos and other hazardous material present and were not included in this inspection. For renovation and demolition work, further inspection by qualified personnel will be required during the course of construction activity to identify suspect material not previously documented at the site or in this survey report. Bordering properties were not investigated and comprehensive file review and research was not performed.

5. For lead in paint, observations were made of the designated accessible areas of the site as indicated in the Report. Limited testing may have been performed to the extent indicated in the text of the report. In order to conduct thorough hazard assessments for lead exposures, representative surface dust testing, air monitoring and other related testing throughout the building, should be completed. This type of in depth testing and analysis was beyond the scope of services for the initial inspection. For lead surveys with XRF readings, it is recommended that surfaces found to have LBP or trace amount of lead detected with readings of less than 4 mg/cm^2 be confirmed using laboratory analysis if more definitive results are required. Substrate corrections involving destructive sampling or damage to existing surfaces (to minimize XRF read-through) were not completed. In some instances, destructive testing may be required for more accurate results. In addition, depending on the specific thickness of the paint films on different areas of a building component, differing amounts of wear, and other factors, XRF readings can vary slightly, even on the same building component. Unless otherwise specifically stated in the scope of services and final report, lead testing performed is not intended to comply with other state and federal regulations pertaining to childhood lead poisoning regulations.

6. Air testing is to be considered a "snap shot" of conditions present on the day of the survey with the understanding that conditions may differ at other times or dates or operational conditions for the facility. Results are also limited based on the specific analytical methods utilized. For phase contrast microscopy (PCM) total airborne fiber testing, more sensitive asbestos-specific analysis using transmission electron microscopy (TEM) can be performed upon request.

7. For asbestos bulk and dust testing, although polarize light microscopy (PLM) is the method currently recognized in State and federal regulations for asbestos identification in bulk samples, some industry studies have found that PLM may not be sensitive enough to detect all of the asbestos fibers in certain nonfriable material, vermiculate type insulation, soils, surface dust, and other materials requiring more sensitive analysis to identify possible asbestos fibers. In the event that more definitive results are requested, RPF recommends that confirmation testing be completed using TEM methods or other analytical methods as may be applicable to the material. Detection of possible asbestos fibers may be made more difficult by the presence of other non-asbestos fibrous components such as cellulose, fiber glass, etc., by binder/matrix materials which may mask or obscure fibrous components, and/or by exposure to conditions capable of altering or transforming asbestos. PLM can show significant bias leading to false negatives and false positives for certain types of materials. PLM is limited by the visibility of the asbestos fibers. In some samples the fibers may be reduced to a diameter so small or masked by coatings to such an extent that they cannot be reliably observed or identified using PLM.

8. For hazardous building material inspection or survey work, RPF followed applicable industry standards; however, RPF does not warrant or certify that all asbestos or other hazardous materials in or on the building has been identified and included in this report. Various assumptions and limitations of the methods can result in missed materials or misidentification of materials due to several factors including but not limited to: inaccessible space due to physical or safety constraints, space that is difficult to reach to fully inspect, assumptions regarding the determination of homogenous groups of suspect material, assumptions regarding attempts to conduct representative sampling, and potential for varying mixtures and layers of material sampled not being representative of all areas of similar material.

9. Full assessments often requires multiple rounds of sampling over a period of time for air, bulk material, surface dust and water. Such comprehensive testing was beyond the scope of RPF services. In addition clearance testing for abatement, as applicable, was based on the visual observations and limited ambient area air testing as indicated in the report and in accordance with applicable state and federal regulations. The potential exists that microscopic surface dust remains with contaminant present even in the event that the clearance testing meets the state and federal requirements. Likewise for building surveys, visual observations are not sufficient alone to detect possible contaminant in settled dust. Unless otherwise specifically indicated in the report, surface dust testing was not included in the scope of the RPF services.

10. For abatement or remediation monitoring services: RPF is not responsible for observations and test for specific periods of work that RPF did not perform full shift monitoring of construction, abatement or remediation activity. In the event that problems occurred or concerns arouse regarding contamination, safety or health hazards during periods RPF was not onsite, RPF is not responsible to provide documentation or assurances regarding conditions, safety, air testing results and other compliance issues. RPF may have provided recommendations to the Client, as needed, pertaining to the Client's Contractor compliance with the technical specifications, schedules, and other project related issues as agreed and based on results of RPF monitoring work. However, actual enforcement, or waiving of, contract provisions and requirements as well as regulatory liabilities shall be the responsibility of Client and Client's Contractor(s). Off-site abatement activities, such as waste transportation and disposal, were not monitored or inspected by RPF.

11. For services limited to clearance testing following abatement or remediation work by other parties: The testing was limited to clearance testing only and as indicated in the report and a site assessment for possible environmental health and safety hazards was not performed as part of the scope of this testing. Client, or Client's abatement contractor as applicable, was responsible for performing visual inspections

of the work area to determine completeness of work prior to air clearance testing by RPF.

12. For site work, including but not limited to air clearance testing services, in which RPF did not provide full site safety and health oversight, abatement design, full shift monitoring of all site activity, RPF expresses no warranties, guarantees or certifications of the abatement work conducted by the Client or other employers at the job site(s), conditions during the work, or regulatory compliance, with the exception of the specific airborne concentrations as indicated by the air clearance test performed by RPF during the conditions present for the clearance testing. Unless otherwise specifically noted in the RPF Report, visual inspections and air clearance testing results apply only to the specific work area and conditions present during the testing. RPF did not perform visual inspections of surfaces not accessible in the work area due to the presence of containment barriers or other obstructions. In these instances, some contamination may be present following RPF clearance testing and such contamination may be exposed during and after removal of the containment barriers or other obstructions following RPF testing services. Client or Client's Contractor is responsible for using appropriate care and inspection to identify potential hazards and to remediate such hazards as necessary to ensure compliance and a safe environment.

13. The survey was limited to the material and/or areas as specifically designated in the report and a site assessment for other possible environmental health and safety hazards or subsurface pollution was not performed as part of the scope of this site inspection. Typically, hazardous building materials such as asbestos, lead paint, PCBs, mercury, refrigerants, hydraulic fluids and other hazardous product and materials may be present in buildings. The survey performed by RPF only addresses the specific items as indicated in the Report.

14. For mold and moisture survey services, RPF services did not include design or remediation of moisture intrusion. Some level of mold will remain at the site regardless of RPF testing and Contractor or Client cleaning efforts. RPF testing associated with mold remediation and assessments is limited and may or may not be representative of other surfaces and locations at the site. Mold growth will occur if moisture intrusion deficiencies have not been fully remedied and if the site or work areas are not maintained in a sufficiently dry state. Porous surfaces in mold contaminated areas which are not removed and disposed of will likely result in future spore release, allergen sources, or mold contamination.

15. Existing reports, drawings, and analytical results provided by the Client to RPF, as applicable, were not verified and, as such, RPF has relied upon the data provided as indicated, and has not conducted an independent evaluation of the reliability of these data.

16. Where sample analyses were conducted by an outside laboratory, RPF has relied upon the data provided, and has not conducted an independent evaluation of the reliability of this data.

17. All hazard communication and notification requirements, as required by U.S. OSHA regulation 29 CFR Part 1926, 29 CFR Part 1910, and other applicable rules and regulations, by and between the Client, general contractors, subcontractors, building occupants, employees and other affected persons were the responsibility of the Client and are not part of the RPF SOW.

18. The applicability of the observations and recommendations presented in this report to other portions of the site was not determined. Many accidents, injuries and exposures and environmental conditions are a result of individual employee/employer actions and behaviors, which will vary from day to day, and with operations being conducted. Changes to the site and work conditions that occur subsequent to the RPF inspection may result in conditions which differ from those present during the survey and presented in the findings of the report.

SECTION 15400

BASIC PLUMBING SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.01. SUMMARY

A) The work pertaining to this Section occurs within the confines of building line and extending up to 5'-"0 from building line as required to make connections to utility work described in other divisions.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 Specifications.

PART 2 - PRODUCTS

2.01. PIPING SPECIALTIES

A) Where it is desirable or necessary to support the pipe hangers to concrete, inserts shall be placed in the forms by the Plumbing Contractor prior to the time concrete is poured.

B) Simpson or Hilti Drop-ins may be used when installed in a concrete or masonry wall or other like vertical surface to support a vertical hanger. Lead Drop-ins will not be permitted to support hangers to the underside of concrete slab.

C) For parallel runs of above ground suspended piping, an acceptable trapeze-type hanger may be used. Provide permanent, non-conductive type wrapping between copper pipe and steel trapeze hangers.

D) Fire-Stopping: Fire stop and air seal all pipe penetrations through walls, ceilings and floors. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Pipes passing through all masonry walls and fire rated gypsum board walls shall pass through clean cut holes fitted with steel pipe sleeves. The annular space between the pipes and sleeves shall be fire-stopped in accordance with an applicable UL approved detail using UL listed fire-stopping materials. Where UL approved for the application, pipe insulation may run continuous through the penetration. Submit typical applicable UL details and associated fire-stopping materials for review and approval for each penetration type on the project. Where fire-stopping is not required to maintain the rating of the assembly, penetrations shall be air sealed with silicone base elastomeric caulking.

E) Provide wall or ceiling access panels for all concealed equipment and valves concealed within inaccessible general construction.

PART 3 - EXECUTION

3.01. INSTALLATION

A) The Contractor shall provide all labor and materials necessary for complete, operable systems.

Refer to section 3.02 for a detailed explanation of the intent of the drawing and specifications.

B) The Contractor shall furnish all labor, materials, including gases, equipment and instruments required to conduct tests of piping systems. Tests shall be as herein called for. The results of all tests shall be reported to Engineer. Material and/or joints found defective during testing shall be replaced and/or corrected and additional tests shall be conducted after correction of work and re-submitted to the Engineer.

3.02. PIPE SIZING, DRAWINGS AND SPECIFICATIONS

A) It is intended that work covered by these specifications and drawings include everything requisite and necessary to make the various systems complete and operative, irrespective of whether or not every item is specifically provided for. Any omission of direct reference herein to any essential item shall not excuse Contractor from complying with the above intent.

B) Figured dimensions supersede scaled ones. Contractor shall take no advantage of, and shall promptly call the Owner's Representative's attention to any error, omission or inconsistency in specifications and drawings.

C) Special attention is directed to requirements that equipment and materials stated in specifications and/or indicated on drawings shall be furnished, except if otherwise noted, completely installed, adjusted and left in safe and satisfactory operating condition. Accessories, appliances and connections necessary for operation of equipment shall be provided to satisfaction of the Owner's Representative.

D) Materials, apparatus or equipment specified or otherwise provided for on drawings, addenda, or change orders issued subsequent to award of contract shall be same brand, type, quality and character originally specified unless otherwise provided.

E) Layout of equipment, accessories, specialties and suspended, concealed or exposed piping systems are diagrammatic unless dimensioned. In preparing shop drawings, Contractor shall check project conditions before installing work. If there are any interferences or conflicts, they shall be called to attention of the Owner's Representative immediately for clarification.

F) The drawings indicate required size and points of termination of piping and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of this Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further obstruction or cost to the Owner.

G) Shop drawings shall be furnished by this Contractor, indicating all changes to meet space requirements, code requirements and as necessary to resolve all space conflicts.

H) It is intended that all apparatus be located symmetrical with architectural elements, and shall be installed at exact height and locations as shown on the architectural drawings. Refer to architectural details in completing and correlating work.

I) The Contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract, prior to submitting his bid. He shall exercise due and particular caution to determine

that all parts of his work are made quickly and easily accessible.

3.03. GENERAL DEMOLITION REQUIRMENTS

A. The Contractor shall remove piping and equipment as indicated on plans including all abandoned Plumbing system piping, equipment and appurtenances remaining within the contract area of the existing building. These include but are not limited to waste, vent and domestic water piping, fixtures, natural gas piping, etc. The facility Owner shall be given first option for salvage of any/all demolished equipment. Any equipment not salvaged by the Owner shall become the property of this contractor and shall be hauled away from the site and disposed of properly.

END OF SECTION

SECTION 15404

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01. REQUIREMENTS

A) Furnish all labor, materials, equipment, and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.

B) This Section includes the following mechanical identification materials and their installation:

1) Equipment nameplates.
2) Equipment markers.
3) Equipment signs.
4) Access panel and door markers.
5) Pipe markers.
7) Stencils.
8) Valve tags.
10) Warning tags.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 Specifications. Submit the following:

1) Samples: For color, letter style, and graphic representation required for each identification material and device.
2) Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.
3) Details of fabrication and attachment of all items.

1.03. 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.

1.04. 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.

1.05. DELIVERY, STORAGE AND HANDLING

A) Deliver all materials in unopened, unbroken and undamaged original packaging bearing the manufacturer’s label and identification for installation.

B) Handle all materials with care to prevent defacement of any nature.

PART 2 – PRODUCTS

2.01. 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. Markers are in addition to nameplates.

1) Terminology: Match schedules as closely as possible.
2) Data: Name and plan number.
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.

2.02. 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) Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
3) 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.
4) 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) Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C) Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.03. 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 approved by the Owner's Representative. Provide 5/32-inch hole for fastener.

1) Material: 0.032-inch-thick brass.
2) Valve-Tag Fasteners: Brass wire-link or beaded chain.

2.04 VALVE SCHEDULES

A) Valve Schedules: For each piping system, reproduce 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. When connecting with existing piping networks, coordinate numbering system with existing numbering system.

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.

2.05. 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.
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

3.01. EQUIPMENT IDENTIFICATION

A) Install and permanently fasten equipment nameplates on each major item of mechanical equipment. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1) Water Heaters (storage tanks and heat exchangers)
2) Hot Water Re-Circ Pumps
3) RPZ backflow preventer & check valve assemblies

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) Pumps, compressors, and similar motor-driven units.

C) Install access panel markers with screws on equipment access panels.

3.02. 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: Pretensioned pipe markers. Use size to ensure a tight fit.
2) 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.

B) Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations, and where piping may be viewed above removable ceilings 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 non-accessible enclosures.
4) At access doors, manholes, and similar access points that permit view of concealed piping.
5) Near major equipment items and other points of origination and termination.
6) Spaced at maximum intervals of 30 feet along each run, with at least one marker in every space where piping may be viewed.

3.03. VALVE-TAG INSTALLATION

A) Install tags on valves and control devices in piping systems.

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: 2 inches, round.
    b) Hot Water: 1-1/2 inches, round.

3.04. VALVE-SCHEDULE INSTALLATION

A) Mount valve schedule on wall in accessible location in each major equipment room.

3.05. WARNING-TAG INSTALLATION

A) Write required message on, and attach warning tags to, equipment and other items where required.

3.06. ADJUSTING

A) Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.07. CLEANING

A) Clean faces of mechanical identification devices.

END OF SECTION

SECTION 15408

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 -GENERAL

1.01. SUMMARY

A. This Section includes the following:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. See Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.02. PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping, ductwork and equipment per the requirements of Division 15 Section “Vibration and Seismic Controls for Plumbing Piping and Equipment”.

1.03. SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.04. QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01. MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02. STEEL PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Anvil International.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Globe Pipe Hanger Products, Inc.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.
9. PHS Industries, Inc.
10. Piping Technology & Products, Inc.
11. Tolco Inc.

B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03. TRAPEZE PIPE HANGERS

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

2.04. METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05. THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06. FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Masterset Fastening Systems, Inc.
d. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Powers Fasteners.

2.07. EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.08. MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 -EXECUTION

3.01. HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are identified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS .
5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.02. HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above and below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03. EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04. METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.05. ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.06. PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 15409

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 -GENERAL

1.01 SUMMARY

A. General: This dual-purpose section provides for vibration isolation and seismic control for the equipment as listed below.

B. Intent:
1) 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's center of gravity.
2) Each and every support attachment to the structure of equipment that meets the requirements of this specification must be positive, including equipment that may be excluded from auxiliary seismic bracing as noted in Part 3.

C. The work in this section includes the following:
1) Vibration isolation elements for equipment.
3) Piping flexible connectors.
4) Seismic restraints for isolated equipment.
5) Seismic restraints for piping.
6) Seismic restraints for non-isolated equipment.
7) Certification of seismic restraint designs and installation supervision.
8) Equipment support stands, bases or rails.

D. Definitions:
1) The term EQUIPMENT will be used throughout this specification and it includes ALL non-structural components within the facility and/or serving this facility, such as equipment located in outbuildings or outside of the main structure on grade. Equipment buried underground is excluded but entry of services through the foundation walls are included. Equipment referred to below is a partial list of equipment for reference. (Equipment not listed is still included in this specification)

Tanks (All types)
Pumps (All types)
Piping

2) Positive Attachment
a) Positive attachment is defined as a support location with a cast-in or wedge type expansion anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or through bolted connection to the structure.
3) Transverse Bracing
a) Restraint(s) applied to limit motion perpendicular or angular to the centerline of the pipe or duct.
5) Longitudinal Bracing
a) Restraint(s) applied to limit motion along the centerline of the pipe or duct.

1.02 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. Reference "TYPE" as per "PRODUCTS" section of this specification.
2) An itemized list of all isolated and non-isolated equipment including detailed schedules showing isolator and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.

B) Shop Drawings

1) Show base construction for equipment; include dimensions, structural member sizes and support point locations.
2) When walls and slabs are used as seismic restraint locations, details of acceptable methods for ducts and pipe must be included.
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 or contract drawings shall be marked-up with the specific locations and types of restraints shown for all pipe and duct. Rod bracing requirements and assigned load at each restraint location shall be clearly delineated. Any and all tributary loads shall be considered for proper restraint sizing.
6) For ceiling suspended equipment design restraints for a minimum installation angle of 300 from vertical. Indicate maximum installation angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.

C) Seismic Certification and Analysis

1) Seismic restraint 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.
2) Certification of calculations to support seismic restraint designs must be stamped by a professional engineer registered in the where the project is located.
    a) Analysis must indicate calculated dead loads, derived loads and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and weld length.
3) An in force, Errors and Omissions insurance certificate must accompany submittals. Manufacturer’s product liability insurance certificates are not acceptable.

1.04 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.

1.05 RELATED WORK

A) Housekeeping Pads (concrete bases)
1) Housekeeping pad attachment to structure design shall be by the project structural engineer. Material and labor required for attachment and construction shall be by the concrete section contractor.
2) Housekeeping pads shall be coordinated with the Seismic Restraint Supplier and sized to provide a minimum edge distance of 13 bolt diameters of clearance all around the outermost anchor bolt to allow for the use of full anchor ratings.

B) Supplementary Support Steel
1) Contractor shall supply supplementary support steel and connections for all equipment, piping, ductwork, etc. Including roof mounted equipment, as required or specified.
2) Where support for equipment requires stands, bases, rails, etc. these devices shall be designed and fabricated by Seismic Restraint Supplier to ensure the seismic capability of the entire installation.

C) Attachments
1) Contractor shall provide restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. as directed by the Seismic Restraint Supplier.

1.06 CODE REQUIREMENTS

A) Seismic restraints as described herein shall be provided in accordance with the International Building Code – 2009 as required by the State of New Hampshire.

PART 2-PRODUCTS

2.01 DESCRIPTIONS

A) Devices
1) Provide vibration isolation and seismic devices specified in this section as manufactured or supplied by Novia Associates, Inc. (NAI), or approved equal. Products of alternative manufacturers or suppliers will be considered provided their systems strictly comply with intent, structural design, performance and deflections of these specifications.

2.02 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 outdoor applications shall be as follows:
a) Springs shall be cadmium plated, zinc electroplated or powder coated.
b) Hardware shall be cadmium or zinc plated.
c) All other metal parts shall be hot spray or hot dipped galvanized or zinc electroplated.
3) All seismic restraint devices
a) Shall maintain the equipment in a captive position and not short circuit isolation device during normal operating conditions.
b) Shall have provisions for bolting and/or welding to the structure.
4) Welding of springs to isolator housing, base plates, etc. is strictly prohibited.

B) Seismic Restraint Types

1) TYPE I: Same as Type B isolator.

2) TYPE II: Where required, each corner or side of equipment base shall incorporate a seismic restraint snubber having an all directional resilient neoprene pad limit stops. Restraints shall be fabricated of plate, structural members or square metal tubing.
Model “SS” as manufactured by NAI.

3) TYPE III: Restraints for suspended systems.
   a) Vibration isolated systems shall be braced with multiple 7 x 19 galvanized steel cables with approved attachment devices (such as thimbles and wire rope clips) to equipment and structure.
   b) Non-isolated systems shall be braced with structural steel strut or cable with approved attachment devices to equipment and structure.
   c) Steel angles (by contractor) shall be provided to prevent rod bending of hung equipment where indicated by the Seismic Restraint Supplier’s submittals. Steel angles shall be attached to the rods with a minimum of three clamps model “SRC” at each restraint location. Welding of support rods to angles is not acceptable.

4) TYPE IV: Double deflection neoprene.
   a) Mountings shall be fabricated to resist the wind or seismic forces.
   Model “RNM” as manufactured by NAI.

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 anchor manufacturer’s published standards.

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 published load ratings to solid height) of 50% of the rated deflection.
   c) Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.
   Model “SM” as manufactured by NAI.

2) TYPE B: Spring Isolator – Restrained
   a) Shall be the same as TYPE A with the following additional features.
      i) Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.
      ii) Internal spring adjusting nut or bolt.
      iii) Built-in all-directional limit stops with minimum 1/8" clearance under normal operation.
   Model “RSM” as manufactured by NAI.

3) TYPE C: Spring Hanger Isolator
   a) Spring element (same as TYPE A) within a steel box with an Elastomer bushing to insulate lower support rod from the hanger box.
   b) Steel hanger box shall be capable 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.
   Model “SH” as manufactured by NAI.

4) TYPE D: Double deflection neoprene
   a) Mountings shall be fabricated to resist the wind or seismic forces.
   Model “RNM” as manufactured by NAI.

5) TYPE E: Elastomer Hanger Isolator
   a) Molded neoprene element with a bushing to insulate lower support rod from the hanger box.
   b) Steel hanger box shall withstand three times the rated load without failure.
   Model “NH” as manufactured by NAI.
6) TYPE F: Combination Spring/Elastomer Hanger Isolator
   a) Spring and neoprene elements in a steel hanger box with the features as described for TYPE C and E isolators.
   Model “SNH” as manufactured by NAI.

7) TYPE G: Pad type elastomer isolator
   a) Neoprene pad shall have 0.50" minimum thickness, deflection rating of 0.1 inch under rated load.
   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 compliance, neoprene and duck washers and bushings shall be provided to prevent short-circuiting of bolt.
   Model “NP” as manufactured by NAI.
8) TYPE H: Pad type elastomer isolator
   a) Laminated canvas duck & neoprene, maximum loading 1000 psi, minimum ½" 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 compliance, neoprene and duck washers and bushings shall be provided to prevent short-circuiting.
   Model “LNP” as manufactured by NAI.
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.
   Model “TR” as manufactured by NAI.
10) TYPE J: Telescoping Riser Guide
   a) Telescoping arrangement of two sizes of steel tubing separated by a minimum ½" thickness of TYPE H pad.
   Model “TRG” as manufactured by NAI.
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 ½" thickness of TYPE H pad.
   b) Vertical restraint 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.
   Model “RAG” as manufactured by NAI.
   Model “FRSM” as manufactured by NAI.
12) TYPE P: Elastomer Isolator
   a) Double deflection neoprene compression mountings.
   b) Non-skid top and bottom surfaces.
   c) Threaded bolting sleeves shall be embedded in the isolator.

d) Drilled tie-down bolt holes shall be provided in the base plate.
Model “FMD” by NAI.

2.03 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.

B) TYPE FC-1: Spherical Elastomer connector
1) Manufactured of EPDM.
2) Sizes 2" and larger shall have two spheres reinforced with an external ring between spheres. Bolted-on strap type reinforcing is not acceptable. Sizes 16" to 24" may be single sphere.
3) Threaded one piece bolted flange assemblies with female threaded ends for sizes 3/4" to 1-1/2".
4) Rated at 250 psi up to 1700 F, with a uniform drop in allowable pressure to 170 psi at 2500 F for sizes through 14". 16" through 24" single sphere minimum ratings are 180 psi at 1700 F and 130 psi at 2500 F.
5) Connectors shall be installed in piping gaps equal to the length of the connector under pressure.
6) Control rods are required in unanchored installations where the installation exceeds the pressure limitation without control rods.
a) Control rods shall have ½" thick Neoprene washer bushings large enough in diameter to take the thrust at 1,000 psi maximum on the washer area.
7) Connectors bolted to Victaulic type coupling or gate, butterfly or check valves to have a minimum 5/8" flange spacer (by others) installed between the connector and the coupling flange. Connectors must mate to a flat-faced flange in all instances.

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 flat faced steel flanges.
a) Lengths shall be: 9" for 2-1/2" to 4", 11" for 5" and 6", 12" for 8", 13" for 10", 14" for 12" to 16".

D) TYPE FC-4: 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.

PART 3 – EXECUTION

3.01 GENERAL

A) Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's submittal data.

B) Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

3.02 EQUIPMENT INSTALLATION

A) Equipment shall be isolated as indicated in TABLE A at the end of this section.

B) Additional Requirements:

1) The minimum operating clearance under all bases shall be 1".
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 isolation. The equipment shall be free in all directions.
6) Install equipment with flexibility in wiring.
7) Housekeeping pads for equipment in this section must be properly doweled or bolted, using wedge type expansion bolts to meet the acceleration criteria. Anchor equipment or isolators to housekeeping pads, see section 1.05: RELATED WORK.
8) Hanger isolators shall be installed with the hanger box hung as close as possible to the structure without touching. Hanger rods shall not short-circuit the hanger box.

3.03 PIPING 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.
2) Vertical riser supports for water or natural gas pipe 4" diameter and larger shall be isolated from the structure using TYPE K guides and anchors.
3) Install TYPE FC-1 flexible connectors at all connections of pipe to externally isolated equipment.
4) Install FC-2 or 4 type connectors only at locations which exceed temperature limitations of FC-1 or service requires stainless steel or bronze construction flex. (Such as; spaces without floor drains, or pipes carrying natural gas, fuel oil, steam or Freon)

3.04 SEISMIC RESTRAINTS

A) Installation

1) All floor mounted equipment whether isolated or not shall be snubbed, anchored, bolted or welded to the structure. 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.
2) All suspended equipment including, but not limited to; pumps, tanks, stacks, etc. shall be two or four point independently braced with TYPE III restraints. Install cable braces taught for non-isolated equipment and slack with ½" cable deflection for isolated equipment.
3) All horizontally suspended pipe shall use RESTRAINT TYPE III. Spacing of seismic bracing shall be as per TABLE B at the end of this section.
4) For all trapeze-supported piping, the individual pipes must be attached to the trapeze support at the designated restraint locations.

5) For overhead 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.
6) Pipe Risers
   a) Where pipe pass through cored holes, 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 all 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.
   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 that does not interfere with the thermal expansion/contraction of the pipe.
7) All non-isolated floor or wall mounted equipment and tanks shall use RESTRAINT TYPE III or V.
8) Where base anchoring of equipment is insufficient to resist seismic forces, restraint TYPE III shall be located above the unit's center of gravity to suitably resist "G" forces specified.
   a) Vertically mounted tanks or similar equipment may require this additional restraint.
9) A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and roof; solid concrete wall and a metal deck with lightweight concrete fill, pipes & duct that cross a building expansion joint.

B) Exclusions from seismic requirements on non life safety equipment:
1) Piping exemptions
   a) All piping less than 2-1/2" diameter except in mechanical rooms where piping less than 1-1/4" is exempted.
   b) All clevis or single level trapeze supported piping suspended by hangers with positive attachment to the structure that are less than 12 inches in length as measured from the top of the pipe to the point of attachment to the structure. If any hanger in the run exceeds the 12" limit, seismic bracing is required for the run.

3.05 INSPECTION

A. If in the opinion of the project engineer the seismic restraint installation does not meet with the project requirements, an outside consultant will be retained to inspect, verify and submit corrective measures to be taken. The consultant's fees and all work associated with such a review shall be borne by the contractor.

TABLE A VIBRATION ISOLATION & SEISMIC RESTRAINT REQUIREMENTS FOR HVAC EQUIPMENT				EQUIPMENT INSTALLATION ATTACHMENT POINT								
EQUIPMENT				ON GRADE			ABOVE GRADE			ROOF		
		SIZE (5) (8)	MOUNT-ING	ISOL	DEFL	BASE	ISOL	DEFL	BASE	ISOL	DEFL	BASE
PUMPS	BASE MOUNTED	TO 15 H.P.	FLOOR	D	0.3	B-2	B	0.75	B-2	- -	- -	- -
		15-30 H.P.		B	0.75					- -	- -	- -
		OVER 30 H.P.						1.5		- -	- -	- -
	INLINE	ALL	FLOOR	- -	- -	- -	D	0.3	- -	- -	- -	- -
			CEILING	- -	- -	- -	F	0.75	- -	- -	- -	- -
	CONDENSATE		FLOOR	D	0.3	- -	D	0.3	- -	- -	- -	- -
	BOILER FEED					- -			- -	- -	- -	- -

TABLE A NOTES:

GENERAL: ISOL = Isolator, DEFL. = Deflection, All deflections indicated are in inches.

(5) Equipment with less than 1/3 H.P. is excluded from vibration requirements. (Seismic requirements still apply)
(8) For equipment with multiple motors, H.P. Classification applies to largest single motor.

DEFLECTION GUIDE	
R.P.M.	DEFLECTION
LESS THAN 400	3.50"
401 TO 600	2.50"
601 TO 900	1.50"
OVER 900	0.75"

TABLE B SEISMIC BRACING TABLE		
EQUIPMENT	ON CENTER SPACING	
	TRANSVERSE	LONGITUDINAL
PIPE	40 Feet	80 Feet

END OF SECTION

SECTION 15411

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Bronze check valves.
3. Bronze gate valves.
4. Bronze globe valves.

B. See Division 15 piping Sections for specialty valves applicable to those Sections only.

1.02 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; furnished specialties; and accessories.

1.03 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.02 VALVES, GENERAL

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

B. Bronze Valves: NPS 2 and Smaller: Threaded ends, unless otherwise indicated.

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

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

E. Valve Actuators:

1. Handwheel: For valves other than quarter-turn types.
2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

F. Extended Valve Stems: On insulated valves.

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

H. Valve Ends:

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.

3. Grooved Ends: AWWA C606

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

2.03 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:
   a. Conbraco Industries, Inc.; Apollo Div.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
   d. Victaulic.
   e. Milwaukee Valve Company.
   f. Flow-Tek, Inc.
   g. Jamesbury, Inc.
   h. NIBCO INC.
   i. 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. Flow-Tek, Inc.
f. Victaulic.
g. Jamesbury, Inc.
h. Milwaukee Valve Company.
i. Nexus Valve Specialties.
j. Watts Industries, Inc.; Water Products Div.

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

a. Conbraco Industries, Inc.; Apollo Div.
b. Grinnell Corporation.
c. Hammond Valve.
d. Jamesbury, Inc.
e. Worcester Controls.

4. Safety-Exhaust, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. DynaQuip Controls.
c. Grinnell Corporation.
d. Hammond Valve.
e. Jamesbury, Inc.
f. Milwaukee Valve Company.
g. NIBCO INC.

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

2.04 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; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Walworth Co.

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

a. Cincinnati Valve Co.
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. Walworth Co.

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

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

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

a. Grinnell Corporation.
b. Kitz Corporation of America.
c. Milwaukee Valve Company.

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

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
g. Powell, Wm. Co.
h. Walworth Co.
i. 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; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Grinnell Corporation.
f. Milwaukee Valve Company.
g. Walworth Co.
h. Watts Industries, Inc.; Water Products Div.

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

2.05 BRONZE GLOBE VALVES

A. Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
h. Powell, Wm. Co.
i. Walworth Co.

2. Type 2, Bronze Globe Valves with Nonmetallic Disc:

    a. Cincinnati Valve Co.
    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. Milwaukee Valve Company.
    h. Powell, Wm. Co.
    i. Walworth Co.

3. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:

    a. Cincinnati Valve Co.
    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. Milwaukee Valve Company.
    h. Walworth Co.

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

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

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

1. Shutoff Service: Ball valves.
2. 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. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2-1/2 and Smaller: One piece 600-psig CWP rating, copper alloy, full port.
2. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 125, horizontal or vertical, bronze.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
4. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
5. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

D. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for steam and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.02 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 15 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. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.03 JOINT CONSTRUCTION

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

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.

3.04 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

SECTION 15412

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01. SUMMARY

A) Provide and install domestic cold and hot water piping, including hot water circulating piping in accordance with the materials and means specified herein.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 Specifications.

PART 2 - PRODUCTS

2.01. GENERAL

A) Provide valves and specialties as specified under additional Sections of this Specification and as identified in Section 15413 “Domestic Water Piping Specialties”.

2.02. REQUIRED PIPING MATERIALS

A) The following schedule covers materials unless otherwise specified under a particular System Section.

SCHEDULE OF PIPE MATERIALS			
PIPE	TYPE	JOINT	FITTINGS
Domestic hot, cold and recirculated hot water	Type L Copper	ASTM B 32 lead-free solder	Wrought Copper, ASTM B88

B) Copper tube, Type L, hard drawn, ASTM B88.

2.03. FITTINGS

A) Copper Tube: Wrought or cast brass solder joint.

2.04. PIPE JOINTS

A) Joints in copper piping shall be made with lead-free solder and non-acid flux. Contractor shall furnish manufacturers literature documenting that the lead content (trace quantities) are within the guidelines of the local codes having jurisdiction as well as the Safe Drinking Water Act Amendment (SDWAA).

B) Joints in threaded piping shall be made with teflon tape or non hardening pipe compound (seal-tite).

C) Joints in approved plastic piping systems shall be made per appropriate ASTM standards.

2.05. HANGERS AND SUPPORTS

A) Refer to Division 15, Section 15408, “Hangers and Supports for Plumbing Piping and Equipment” and Section 15409, “Vibration and Seismic Control for Plumbing Piping and Equipment” for detailed specifications.

PART 3 - EXECUTION

3.01. GENERAL

A) The design drawings are generally diagrammatic. They do not show every bend, offset, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.

B) Run all water lines parallel or perpendicular to building lines.

C) For piping requiring insulation, lay out and carefully install piping with sufficient clearances to permit proper application of the insulation. If the piping is such that a neat insulation job cannot be obtained with reasonable effort, the piping subcontractor shall relocate piping.

3.02. HANGERS AND SUPPORTS

A) Vertical Piping shall be supported at its base and no greater than every story height.

B) Horizontal Piping (Suspended) shall be supported in accordance with the pipe manufacturer’s published instructions, or at a maximum of six (6) foot intervals where instructions are not provided. Supports shall be adequate to maintain alignment and prevent sagging.

C) Supports shall be connected to the building structure not from other equipment, ducts or conduits.

3.03. JOINTING PIPE

A) All pipe lines shall be correctly aligned before joints are made.

B) Squarely cut pipe and properly ream to remove all constriction and burrs before making up the joints.

C) Threaded Pipe: Ream all pipe after cutting and before threading. Use non-hardening pipe compound or tape on male threads only at each joint and tighten joint to leave not more than 3 threads exposed.

D) Copper Tube: Ream all pipe after cutting squarely, clean outside of tube ends and inside of fittings and tin end to be soldered. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E) Provide nipples of same material and weight as pipe used. Provide extra strong nipples when length of unthreaded part of standard weight nipple is less than 1-1/2".

F) Run water supply main to point indicated on plans.

3.04. VALVES

A) Provide valves to isolate each riser, and branch line. See also Section 15411 for requirements.

3.05. REDUCERS

A) Screwed bushings are prohibited, except where available space prevents use of reducing couplings. Pipe reductions on horizontal, hot water piping shall be made with eccentric reducers arranged to allow complete drainage of the entire piping network. Top of hot water piping shall be flat for venting.

3.06. TESTS

A) Apply a water pressure test to all parts of the water supply system before the piping is concealed and before the fixtures and equipment are connected. Use a hydrostatic pressure of not less than 100 psig or 150% of system operating pressure, applied to the system for a period of four hours. There shall be no leaks at any point in the system at this pressure.

B) Leave concealed work uncovered until required tests have been completed, but if necessary, make tests on portions of the work and those portions of the work may be concealed after being inspected and approved. Make repairs of defects that are discovered as a result of inspection or tests with new materials. Caulking, welding or other such sealing methods of screwed joints, cracks or holes will not be accepted. Repeat tests after defects have been eliminated.

C) Complete all field testing prior to insulation, wrapping and/or backfill.

3.08. PIPE PROTECTIONS

A) Wrap pipe that touches metal or is exposed to masonry with a layer of 6 mil polylene film or 15 lb. felt.

B) Spirally wrap all pipe lines embedded in concrete with two layers of 30 lb. felt.

END OF SECTION

SECTION 15416

NATURAL GAS PIPING

PART 1 -GENERAL

1.01. SUMMARY

A) Pressure reducing valve and meter assemblies are provided by the local gas utility at the exterior of the building as shown on plans. The plumbing contract shall begin at points of reconnection to the existing natural gas service within the building as indicated on plans.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 Specifications.

1.03. REFERENCED STANDARDS

A) Installation and equipment shall conform to NFPA-54, "National Fuel Gas Code" and all requirements of local authorities having jurisdiction.

PART 2 -PRODUCTS

2.01. PIPING MATERIALS

A) Carbon Steel Piping and Fittings for Low Pressure (1 psig or less) Service and Vent Piping

1) General

a) Shall conform to ASTM A53, Type S, Schedule 40, Grade B for nominal pipe sizes larger than two (2) inches.

b) Shall conform to ASTM A106, Schedule 80, for nominal pipe sizes less than or equal to two (2) inches.

c) Shall be galvanized for exterior and vent piping.

B) Joints

1) Shall be threaded for nominal pipe size up to 2" and welded for nominal pipe sizes larger than 2".

2) The pipe ends shall be prepared for the jointing system specified for the pipe. Welding shall conform to the specifications contained herein.

3) Joints in pipe of nominal sizes three (3) inches and larger shall be butt welded. Joints in pipe of nominal sizes below (3) inches shall be socket welded.

C) Fittings

1) Threaded joints (nominal pipe sizes two (2) inches or smaller) shall be provided with Class 150 lb banded malleable iron threaded fittings made in conformance with ANSI B16.3.

2) Welded joints shall conform to the dimensional requirements of ANSI B16.5 Standard for Pipe Flanges and Flanged Fittings or ANSI B16.9 Factory-Made Wrought Steel Butt Welding Fittings. Fittings fabricated in conformance with ANSI B16.9 shall be of the same wall thickness as specified for the pipe and shall have tangents for slip on type flanges.

3) Bell type reducers shall not be acceptable; only cone type reducers shall be used.

D) Finish

1) All interior natural gas piping shall be painted with two (2) coats of rust inhibitive paint - yellow.

2) Vent pipe and fittings shall be galvanized.

2.02. Valves

A) 175 lb Class B, Lubricated Wedge plug valves, or 600 w.o.g. full port ball valves, listed for NATURAL gas service.

B) Manufacturer Walworth, Stockham, Watts or equal.

C) End connections threaded.

PART 3 -EXECUTION

3.01. General

A) The design drawings are generally diagrammatic. They do not show every bend, offset, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.

B) Joints and connections shall be made permanent and gas-tight.

3.02. Jointing

A) All threads shall be clean, machine cut and all pipe shall be reamed before erection.

B) Taps and dies shall be cleaned, sharpened and in good condition.

C) All threaded joints shall be made tight with joint compound approved for use with NATURAL gas.

D) After having been set up, a joint shall not be backed off unless the joint is broken, the threads cleaned, and new compound is applied.

E) Provide nipples of same material and weight as pipe used. Provide extra strong nipples when length of unthreaded part of standard weight nipple is less than 1-1/2".

F) Provide reducing fittings (reducing bushings shall not be used) where changes in pipe sizes occur.

G) Welded Joints

1) Shall be shop welded in accordance with the standards and specifications contained herein.

2) Field welding shall be permitted for black carbon steel pipe in non-hazardous (non-explosive) areas only and if it can be demonstrated that the interior of the pipe can be satisfactorily lined and inspected. Welding in the field shall be performed only when requested on the shop drawings and approved by the Engineer in writing as specified herein. Piping for hazardous areas shall be shop welded, brought to the site in segments and installed using flanges.

3) All welding shall be performed in accordance with ANSI B31.1 and AWWA C206 except as modified or supplemented herein. All welders shall be AWS certified in accordance with AWWA C206, and ANSI B31 requirements. Welders shall have their current certificate available for the Engineer's inspection.

a) Each welder shall be required to identify his weld with his specific code marking signifying his name and number assigned.
b) For piping systems with service temperatures in excess of 120 degrees F, each welder shall be examined at the job site by the Contractor in the presence of the Engineer to determine the ability of the welder to meet the qualifications required. Welders shall be tested for all positions including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified. It shall be the Contractor's responsibility to assign only the site tested welders to this piping.
c) When a welder fails to meet the prescribed welding qualifications and/or fails an on-site examination, or is responsible for a defective weld, that welder shall be retested on the job site. If he fails a second on-site examination he shall be disqualified for work on the project.

4) Pipe and fittings with wall thicknesses of 3/16-inch and larger shall have ends beveled for welding. Bevels shall be 30 degrees with a maximum of 37-1/2 degrees.

5) The abutting pipe ends shall be separated before welding to permit complete fusion to the inside wall of the pipe without overlapping.

6) Welding shall be continuous around the joint and shall be completed without interruption.

7) Welds shall be of the single vee butt type, of sound weld metal thoroughly fused into the ends of the pipe and into the bottom of the vee.

8) Welds shall be free from cold spots, pin-holes, oxide inclusions, burrs, snags, rough projections or other defects.

9) Filler metal for welding shall be of the same composition as the base metal.

10) All welding of steel pipe flanges shall be in accordance with requirements of AWWA C207 and ANSI B31.1.

11) The location of proposed field welded joints shall be shown on the shop drawings and approval obtained from the Owner at the time of submission.

12) Under no conditions shall field welding of stainless steel pipe be permitted.

13) Split welding rings shall be used for field joints on pipes with nominal pipe sizes over three inches to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.

14) Field welds shall be "fixed position" type.

15) All field welds shall be dye tested and visually inspected.

16) All welds shall be hydrostatically tested.

17) Defective welds shall be replaced and reinspected. Repairing defective welds by adding welding material over the defect or by peening will not be permitted. Welder responsible for defective welds must be requalified.

18) For piping with all welded joint indicated, flanges shall be located at all valves and equipment and where needed for piping installation. All flanged joints locations shall be clearly indicated on the shop drawings.

3.03. Pipe Support Systems

A) General

All supports and parts required for the installation of the piping systems shall conform to the requirements of Chapter 11, Part 5 of the ANSI Code for Pressure Piping (B-31.1) except as modified and supplemented by the requirements set forth herein. All piping shall be supported in such a manner to fulfill the intent of this Specification.

All piping shall be rigidly supported from the building structure by approved hangers, inserts or supports. No piping shall be supported from the piping of other trades or other piping. Provide seismic restraints in accordance with specifications of the Seismic Engineer (refer to Section 15409).

3.04. Testing

Testing shall be in accordance with NFPA-54, “National Fuel Gas Code” and local authority having jurisdiction.

END OF SECTION

SECTION 15418

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01. SUMMARY

A) Insulate all new above grade domestic cold water, hot water supply and re-circulation piping.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 Specifications.

PART 2 -PRODUCTS

2.01. GENERAL

A) Materials listed in subsequent paragraphs of this specification are those used as basis of design; alternate manufacturer's equivalent products as listed herein will be accepted. The insulation contractor shall verify materials comply with requirements of NFPA 90, with regard to a flame spread rating of 25 or less and a smoke developed/fuel contributed value of less than 50.

2.02. INSULATION MATERIALS

A) Glass-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1) Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
2) Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
3) Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
   a) Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
   b) Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
4) Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
5) Glass-Fiber Insulating Cements: Comply with ASTM C 195.
6) Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
7) Glass-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

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

1. Products:

   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.

c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180

B) Insulate piping in accordance with the Table below.

Pipe Insulation Table

Service Piping	Insulation Type	Insulation Thickness	Vapor Barrier Material	Jacket Material
Cold Water	Fiberglass Pipe Insulation	1"	Foil Film	PVC*

* Apply PVC jacket to domestic cold water piping located below 6'-0" AFF.

PART 3 -EXECUTION

3.01. GENERAL

A) Insulation is not to be installed until the piping systems have been checked and found free of all leaks. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.

B) Provide high density insulation pipe support inserts at each hanger and a shield that shall extend halfway up the pipe insulation cover and at least 6" on each side of the hanger. Securely fasten shield with pipe straps at each end. Insulate pipe anchors adequately to prevent moisture condensation problems.

3.02. Above ground domestic cold water, domestic hot water and domestic hot water recirculation piping:

A) Shall be insulated with ASJ fiberglass pipe insulation. Prior to installing the insulation the pressure release paper shall be removed from the jacket laps. The insulation shall be secured in place by applying pressure to the pressure sensitive closure system. All enclosed valves, fittings shall be insulated with molded fiberglass pipe insulation segments and finished with vapor barrier coating, and reinforced with a layer of white open weave glass fabric and pre-molded aluminum jacket. Jackets shall be secured by metal bands at an interval of no less than 2'-0" on center.

END OF SECTION

SECTION 15700

BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1) Piping materials and installation instructions
2) Dielectric fittings
3) Mechanical sleeve seals
4) Sleeves
5) Escutcheons
6) Grout
7) Equipment installation requirements common to equipment sections
8) Concrete bases
9) General Demolition Requirements

1.02 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.

1.03 SUBMITTALS

A. Provide submittals in accordance with Division 1 Specifications.

1.04 QUALITY ASSURANCE

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

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

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

C. Electrical Characteristics for 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, equipments hall comply with requirements

PART 2 - PRODUCTS

2.01 PIPE, TUBE AND FITTINGS

A. Refer to individual Division 15 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.

2.02 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:

1) ABS Piping: ASTM D 2235.
2) CPVC Piping: ASTM F 493.
3) PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4) PVC to ABS Piping Transition: ASTM D 3138.

2.03 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.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.04 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Glass reinforced Nylon Polymer. Include two for each sealing element.

D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1) Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.06 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.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1) Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
2) Design Mix: 5000-psi, 28-day compressive strength.
3) Packaging: Premixed and factory packaged.

2.08 CONCRETE BASES (HOUSEKEEPING PADS)

A. Provide concrete bases (housekeeping pads) for floor mounted equipment – refer to section 3.05 within this specification for detailed requirements.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS – COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Minor deviations in pipe routing to accommodate unanticipated field conditions are permitted. However, indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Significant deviations in pipe routing shall be brought to the attention of the engineer prior to installation for review.

C. Install piping in concealed locations, unless otherwise indicated or 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 recessed lighting and ceiling panel removal.

F. Install piping to permit valve servicing. Provide access doors to permit service access to valves or equipment concealed within inaccessible construction. Access doors in general construction

shall be installed by the Construction Manager, but this contractor shall be responsible for coordination of the installation and serviceability of all mechanical equipment.

G. Install horizontal piping with 1% pitch towards points of drainage.

H. Install drain valves at bottom of risers and all system low points.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install piping to allow application of insulation.

L. Provide flow arrows and pipe markers in accordance with specification section 15704, “Identification for HVAC Piping and Equipment”.

M. Select system components with pressure rating equal to or greater than system operating pressure.

N. Fire stop and air seal all pipe penetrations through walls, ceilings and floors.

O. Install escutcheons at exposed pipe and duct penetrations of walls, ceilings, and floors, including where penetrations are visible within cabinetry.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

Q. Above-ground, 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.

R. 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.

S. Fire-Stopping: Fire stop and air seal all pipe penetrations through walls, ceilings and floors. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Pipes

passing through all masonry walls and fire rated gypsum board walls shall pass through clean cut holes fitted with steel pipe sleeves. The annular space between the pipes and sleeves shall be fire-stopped in accordance with an applicable UL approved detail using UL listed fire-stopping materials. Where UL approved for the application, pipe insulation may run continuous through the penetration. Submit typical applicable UL details and associated fire-stopping materials for review and approval for each penetration type on the project. Where fire-stopping is not required to maintain the rating of the assembly, penetrations shall be air sealed with silicone base elastomeric caulking.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 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. No solder containing lead shall be present on site.

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 ASME B31 Series, "Code for Pressure Piping", 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.

3.03 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.

3.04 EQUIPMENT AND DUCTWORK INSTALLATION – COMMON REQUIREMENTS

A. Install equipment and ductwork to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment and ductwork level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install ductwork to facilitate service, maintenance, and repair or replacement of duct-mounted components and equipment. Provide access doors sized to facilitate inspection, repair and replacement of all equipment and components installed within ductwork.

E. Provide access doors in acoustically lined ductwork to allow inspection and cleaning of all duct lining.

F. Install equipment to allow right of way for piping installed at required slope.

G. Fire-stopping: Fire stop and air seal all duct penetrations through walls, ceilings and floors. Maintain indicated fire rating of walls, partitions, ceilings, and floors at duct penetrations. The annular space between the ducts and penetrated assembly shall be fire-stopped in accordance with an applicable UL approved detail using UL listed fire-stopping materials. Where UL approved for the application, duct insulation may run continuous through the penetration. Submit typical applicable UL details and associated fire-stopping materials for review and approval for each penetration type on the project. Where fire-stopping is not required to maintain the rating of the assembly, penetrations shall be air sealed with silicone base elastomeric caulking.

3.05 CONCRETE BASES (HOUSEKEEPING PADS)

A) Provide concrete bases (housekeeping pads) for all floor mounted equipment.

B) Concrete Bases: Anchor base mounted equipment to concrete housekeeping pads.

1) Construct concrete bases to extend a minimum of 4 inches beyond equipment base and a minimum of 4” in height.
2) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3) Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5) Install anchor bolts to elevations required for proper attachment to supported equipment.
6) Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7) Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in appropriate Division 3 Section "Cast-in-Place Concrete."

3.06 ROOFTOP EQUIPMENT SUPPORTS

A. Provide curb strips or equipment curbs for attachment of roof top equipment to structure.

B. Curb strips or equipment curbs shall be constructed, flashed and sealed in a manner as to be fully integrated with the roofing system as specified by the architect. Refer to Section 15709 for required vibration and seismic restraint elements.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Structural steel supports and miscellaneous steel required for supporting and/or hanging equipment and piping furnished under this Division shall be furnished and installed by this

contractor. No modifications to the building structure shall be made without prior approval of the Architect.

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.

3.08 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.09 GENERAL DEMOLITION REQUIREMENTS

A. The Contractor shall remove piping, ductwork and equipment as indicated on plans, including all abandoned heating system piping, equipment and appurtenances remaining within the existing building. These include but are not limited to boiler plant equipment, heating hot water piping, steam and condensate handling equipment and piping, boilers and breeching, pumps, etc. The facility Owner shall be given first option for salvage of any/all demolished equipment. Any equipment not salvaged by the Owner shall become the property of this contractor and shall be hauled away from the site and disposed of properly.

B. Removal of asbestos containing materials (ACM's) – a preliminary survey by an environmental consultant has identified that the gasket materials in the existing boiler breeching contain asbestos. Asbestos may be present in other areas, possibly within the Cleaver Brooks boilers which were not tested (these were manufactured in 1981, it is understood that asbestos phased out in the late 70's for Cleaver Brooks equipment). Any additional testing and remediation per all applicable regulations shall be included with the demolition scope of work.

END OF SECTION

SECTION 15704

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01. REQUIREMENTS

A. Furnish all labor, materials, equipment, and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.

B. This Section includes the following mechanical identification materials and their installation:

1) Equipment nameplates.
2) Equipment markers.
3) Equipment signs.
4) Access panel and door markers.
5) Pipe markers.
6) Duct markers.
7) Stencils.
8) Valve tags.
9) Valve schedules.
10) Warning tags.

1.02. SUBMITTALS

A. Provide submittals in accordance with Division 1 Specifications. Submit the following:

1) Samples: For color, letter style, and graphic representation required for each identification material and device.
2) Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.
3) Details of fabrication and attachment of all items.

1.03. 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.

1.04. 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.

1.05. DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in unopened, unbroken and undamaged original packaging bearing the manufacturer’s label and identification for installation.

B. Handle all materials with care to prevent defacement of any nature.

PART 2 – PRODUCTS

2.01. 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. Markers are in addition to nameplates.

1) Terminology: Match schedules as closely as possible.
2) Data: Name and plan number.
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.

2.02. 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) Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
3) 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.
4) 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. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.03. 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.

2.04. 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 approved by the Owner's Representative. Provide 5/32-inch hole for fastener.

1) Material: 0.032-inch-thick brass.
2) Valve-Tag Fasteners: Brass wire-link or beaded chain.

2.05. VALVE SCHEDULES

A. Valve Schedules: For each piping system, reproduce 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. When connecting with existing piping networks, coordinate numbering system with existing numbering system.

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.

2.06. 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.
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

3.01. EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment provided under this contract. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1) Air Handlers
2) Energy Recovery Ventilation Units
3) Exhaust Fans
4) Boilers

5) Pumps, compressors, and similar motor-driven units.
6) Fan Coil Units (including cabinet heaters and unit ventilators)

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) Air Handlers
   b) Energy Recovery Ventilation Units
   c) Exhaust Fans
   d) Boilers
   e) Pumps, compressors, and similar motor-driven units.
   f) Fan Coil Units (including cabinet heaters and unit ventilators)
   g) Heat exchangers, coils, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

3.02. 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: Pretensioned pipe markers. Use size to ensure a tight fit.
2) 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.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; exterior nonconcealed locations, and where piping may be viewed above removable ceilings 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, manholes, and similar access points that permit view of concealed piping.
5) Near major equipment items and other points of origination and termination.
6) Spaced at maximum intervals of 30 feet along each run, with at least one marker in each space where piping may be viewed (including above accessible ceilings).

3.03. 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 30 feet along each run, with at least one marker in each space where duct may be viewed (including above accessible ceilings).

3.04. VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1) Valve-Tag Size and Shape:
   a) Cold Water: 2 inches, round.
   b) Hot Water: 1-1/2 inches, round.
   c) Chilled Water: 1-1/2 inches, round.
   d) Heating water: 1-1/2 inches, round.

3.05. VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.06. WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.07. ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.08. CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION

SECTION 15705

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01. SUMMARY

A. This Section includes basic requirements for factory and field installed motors.

B. See individual Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.02. SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; operating weights; enclosure type and mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

1. Shop Drawings for Field-Installed Motors: Provide dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

D. Operation and Maintenance Data.

1.03. QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.04. COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with the following:

a. Magnetic controllers.
b. Multispeed controllers.
c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.01. MOTOR REQUIREMENTS

A. Motor requirements apply to factory and field installed motors except as follows:

1. Different ratings, performance, or characteristics for motor are specified in another Section.
2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.02. MOTOR CHARACTERISTICS

A. Motors 3/4 HP and Larger: Three phase, premium efficiency, unless otherwise noted on plans.

B. Motors for use with variable frequency drives: Three phase, premium efficiency.

C. Motors 1/2 HP and Smaller: Single phase, premium efficiency (ECM if available), unless otherwise noted on plans.

D. Frequency Rating: 60 Hz.

E. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

F. Service Factor: 1.15 for open drip-proof motors; 1.0 for totally enclosed motors.

G. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 100 feet above sea level.

H. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor. Comply with “soft-start” requirements of electric utility where applicable.

I. Enclosure: Open drip-proof or totally enclosed fan cooled.

2.03. POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium, as defined in NEMA MG 1.

C. Stator: Copper windings, unless otherwise indicated.

1. Multispeed motors shall have separate winding for each speed.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

2.04. POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Temperature Rise: Matched to rating for Class B insulation.
3. Insulation: Class H.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

D. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.05. SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

PART 3 -EXECUTION

3.01. MOTOR INSTALLATION

A. All motors shall be factory installed and tested as integral part of fan or pump assembly.

B. Comply with mounting and anchoring requirements specified in Division 15, Section 15709, "Vibration and Seismic Control for HVAC Piping and Equipment."

END OF SECTION

SECTION 15706

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flowmeters.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 THERMOMETERS

A. Liquid-in-Glass Thermometers:

1. Manufacturers:

a. Ernst Gage Co.
b. Eugene Ernst Products Co.
c. Marsh Bellofram.
d. Miljoco Corp.
e. Trerice, H. O. Co.
f. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
g. Winters Instruments.

2. Case: Plastic**,** 7 inches long.
3. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.

4. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
5. Window: Glass or plastic.
6. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
7. Stem: Metal, for thermowell installation and of length to suit installation.
8. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

B. Duct-Type, Liquid-in-Glass Thermometers:

1. Manufacturers:

    a. Miljoco Corp.
    b. Palmer - Wahl Instruments Inc.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.

2. Case: Metal or plastic, 7 inches long.
3. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.
4. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
5. Window: Glass or plastic.
6. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
7. Stem: Metal, for installation in mounting bracket and of length to suit installation.
8. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.
9. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

C. Bimetallic-Actuated Dial Thermometers:

1. Manufacturers:

    a. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
    b. Ernst Gage Co.
    c. Eugene Ernst Products Co.
    d. Marsh Bellofram.
    e. Miljoco Corp.
    f. NANMAC Corporation.
    g. Noshok, Inc.
    h. Palmer - Wahl Instruments Inc.
    i. REO TEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Weiss Instruments, Inc.
    m. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
    n. WIKA Instrument Corporation.
    o. Winters Instruments.

2. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
3. Case: Dry type, stainless steel with 3-inch diameter.
4. Element: Bimetal coil.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Connector: Adjustable angle type.
10. Stem: Metal, for thermowell installation and of length to suit installation.
11. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

D. Thermowells:

1. Manufacturers: Same as manufacturer of thermometer being used.
2. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.03 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, metal or plastic, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Metal or plastic.

9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: As required such that normal operating pressure is within the middle third of the range.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.04 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

2.05 FLOWMETERS

A. Wafer-Orifice Flowmeters:

1. Manufacturers:

a. ABB, Inc.; ABB Instrumentation.
b. Armstrong Pumps, Inc.
c. Badger Meter, Inc.; Industrial Div.
d. Bell & Gossett; ITT Industries.
e. Meriam Instruments Div.; Scott Fetzer Co.

2. Description: Differential-pressure-design orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.

3. Construction: Cast-iron body, brass valves, and calibrated nameplate.
4. Pressure Rating: 300 psig.
5. Temperature Rating: 250 deg F.
6. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.

    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.

7. Operating Instructions: Include complete instructions with each flowmeter.

B. Pitot-Tube Flowmeters:

1. Manufacturers:

    a. Dieterich Standard Inc.
    b. Meriam Instruments Div.; Scott Fetzer Co.
    c. Preso Meters Corporation.
    d. Taco, Inc.
    e. Veris, Inc.

2. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.
3. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.
4. Pressure Rating: 150 psig minimum.
5. Temperature Rating: 250 deg F minimum.
6. Display: Visual instantaneous rate of flow.
7. Integral Transformer: For low-voltage power connection.
8. Accuracy: Plus or minus 1 percent for liquids and gases.

C. Flow Indicators:

1. Manufacturers:

    a. Brooks Instrument Div.; Emerson Electric Co.
    b. Dwyer Instruments, Inc.
    c. Ernst Gage Co.
    d. Eugene Ernst Products Co.
    e. McCrometer, Inc.
    f. OPW Engineered Systems; Dover Corp.
    g. Penberthy, Inc.

2. Description: Instrument for installation in piping systems for visual verification of flow.
3. Construction: Bronze or stainless-steel body; with sight glass and plastic pelton-wheel indicator, and threaded or flanged ends.
4. Pressure Rating: 125 psig.
5. Temperature Rating: 200 deg F.
6. End Connections for NPS 2 and Smaller: Threaded.
7. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install thermometers in the following locations and additional locations as shown on the drawings:
   1. Inlet and outlet of each hydronic boiler and chiller.
   2. Chilled water main supply and return piping to building.
   3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
   4. Inlet and outlet of each hydronic heat exchanger.
   5. Inlet and outlet of each hydronic heat-recovery unit.
   6. Inlet and outlet of each thermal storage tank.
   7. Outside-air, return-air, and mixed-air ducts.

B. Provide the following temperature ranges for thermometers:

   1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
   2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
   3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
   4. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
   5. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
   6. Steam and Condensate: 30 to 300 deg F, with 5-degree scale divisions.
   7. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.02 GAGE APPLICATIONS

A. Install pressure gages for discharge of each pressure-reducing valve.

B. Install pressure gages at chilled water inlets and outlets from site chilled water connection points.

C. Install pressure gages at suction and discharge of each pump.

3.03 FLOWMETER APPLICATIONS

A. Install flowmeters at main chilled water and heating hot water supply or return piping at locations shown on the flow diagrams.

3.04 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

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

E. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

F. Install remote-mounting pressure gages on panel.

G. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

H. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

I. Install test plugs in tees in piping.

J. Install flow indicators, in accessible positions for easy viewing, in piping systems.

K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

L. Install flowmeter elements in accessible positions in piping systems.

M. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

N. Install wafer-orifice flowmeter elements between pipe flanges.

O. Install permanent indicators on walls or brackets in accessible and readable positions.

P. Install connection fittings for attachment to portable indicators in accessible locations.

Q. Mount meters on wall if accessible; if not, provide brackets to support meters.

R. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

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

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

END OF SECTION

SECTION 15707

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01. SUMMARY

A. This Section includes solid-state, pulse-width modulated (PWM), variable frequency drives (VFD's) for speed control of three-phase, squirrel-cage induction motors.

1.02. SUBMITTALS

A. Product Data: For each type of VFD.

B. Shop Drawings: For each VFD.

1. Include wiring diagrams.

C. Manufacturer Seismic Qualification Certification: Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Division 15, Section 15709, "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Field quality-control test reports.

E. Operation and maintenance data.

F. Load-current and overload-relay heater list.

G. Load-current and list of settings of adjustable overload relays.

1.03. QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

B. Comply with NFPA 70.

C. Comply with NEMA ICS 7.0, AC Adjustable Speed Drives and IEEE Standard 519-1992, IEEE Guide for Harmonic Content and Control.

D. Product Selection for Restricted Space: Where applicable, the drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.04. PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 14 to 104 deg F.
2. Humidity: Less than 95 percent (non-condensing).

3. Altitude: Not exceeding 3,300 feet.

1.05. COORDINATION

A. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 -PRODUCTS

2.01. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Baldor Electric Company (Graham).
3. Danfoss Inc.; Danfoss Electronic Drives Div.
4. Eaton Corporation; Cutler-Hammer Products.
5. General Electric Company; GE Industrial Systems.
6. Square D.
7. Toshiba International Corporation.
8. Yaskawa

2.02. VARIABLE FREQUENCY DRIVES

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

2. Provide unit specifically designed for HVAC applications.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.

5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
6. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and over-voltage trips; inverter over-temperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 20 performance.
4. Notch filter (programmable critical frequency lockout range) to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor over-temperature fault.

H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

L. Input Line Conditioning: The VFD manufacture shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be

sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors.

M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
    a) 0 to 10-V dc.
    b) 0-20 or 4-20 mA.
    c) Potentiometer using up/down digital inputs.
    d) Fixed frequencies using digital inputs.
    e) RS485.
    f) Keypad display for local hand operation.

3. Output Signal Interface:

    a) A minimum of two (2) analog output signal (0/4-20 mA), which can be programmed to any of the following:

        i. Output frequency (Hz).
        ii. Output current (load).
        iii. DC-link voltage (VDC).
        iv. Motor torque (percent).

v. Motor speed (rpm).
vi. Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a) Motor running.
b) Set-point speed reached.
c) Fault and warning indication (over-temperature or over-current).
d) PID high- or low-speed limits reached.

Q. Communications: Provide interface allowing VFD to be used with an external system within a multidrop LAN configuration (or appropriate interface for solid state control). Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.

R. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load). Do not provide manual bypass where specified in individual equipment sections.

S. Bypass Controller: NEMA ICS 2, full-voltage, non-reversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

T. Integral Disconnecting Means: NEMA KS 1, fusible switch with lockable handle.

U. Isolating Switch: Non-load-break switch arranged to isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

V. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.03. ENCLOSURE

A. The VFD package as specified herein shall be enclosed in a UL Listed Type 12 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. Enclosure shall be UL listed as a plenum rated VFD.

2.04. ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.05. FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to VFDs before shipping.

PART 3 - EXECUTION

3.01. APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.02. INSTALLATION

A. Install VFDs in weatherproof enclosures to serve rooftop exhaust fans where required. For air handling equipment, VFD’s shall be installed within the equipment cabinet. VFD’s for pumps shall be wall-mounted or mounted on unistrut channel frame, adjacent to the equipment served.

B. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

3.03. IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 15 Section “Identification for HVAC Piping and Equipment."

3.04. CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to appropriate Division 16 Sections.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05. FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Start, test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.06. ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION

SECTION 15708

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 -GENERAL

1.01. SUMMARY

A. This Section includes the following:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. See Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.

C. See Division 15 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.

1.02. PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping, ductwork and equipment per the requirements of Division 15 Section “Vibration and Seismic Controls for HVAC Piping and Equipment”.

1.03. SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.04. QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01. MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02. STEEL PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Anvil International.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Globe Pipe Hanger Products, Inc.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.
9. PHS Industries, Inc.
10. Piping Technology & Products, Inc.
11. Tolco Inc.

B. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03. TRAPEZE PIPE HANGERS

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

2.04. METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.05. THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.06. FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Masterset Fastening Systems, Inc.
d. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Powers Fasteners.

2.07. EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.08. MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 -EXECUTION

3.01. HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS .
5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.02. HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above and below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03. EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04. METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.05. ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.06. PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 15709

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. General:
1. This dual-purpose section provides for vibration isolation and seismic control for the "equipment" as listed below.

B. Intent:
1. 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's center of gravity.
2. Each and every support attachment to the structure of equipment that meets the requirements of this specification must be positive, including equipment that may be excluded from auxiliary seismic bracing as noted in Part 3.

C. 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. Equipment support stands, bases or rails.

D. Definitions:
1. The term EQUIPMENT will be used throughout this specification and it includes ALL non-structural components within the facility and/or serving this facility, such as equipment located in outbuildings or outside of the main structure on grade. Equipment buried underground are excluded but entry of services through the foundation walls are included. Equipment referred to below is a partial list of equipment for reference. (Equipment not listed is still included in this specification)

AC Units	Chillers	Pumps (All types)
Air Handling Units	Ductwork	Rooftop Units (ERV's)
Air Separators	Fans (All types)	Tanks (All types)
Boilers	Heat Exchangers	Unit Heaters
Cabinet Heaters	Piping	Var. Freq. Drives

2. Life safety systems defined
a. All systems involved with fire protection including fire dampers and smoke exhaust systems.
b. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all circuits to fire protection including smoke evacuation.

c. All medical and life support systems.
d. Fresh air relief systems on emergency control sequence including air handlers, duct, dampers, etc.

3. Positive Attachment
   a. Positive attachment is defined as a support location with a cast-in or wedge type expansion anchor, a double-sided beam clamp loaded perpendicular to a beam. A welded or through bolted connection to the structure.
4. Transverse Bracing
   a. Restraint(s) applied to limit motion perpendicular or angular to the centerline of the pipe or duct.
5. Longitudinal Bracing
   a. Restraint(s) applied to limit motion along the centerline of the pipe or duct.

1.2 OEM EQUIPMENT ISOLATION PACKAGES FOR INTERIOR EQUIPMENT

A. Internal and/or External Systems
1. Substitution of internally or externally isolated and restrained equipment 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 stamped and certified per the section on Seismic Restraints and Analysis stating that the seismic restraints are in full compliance with these specifications. Letters from field offices or representatives are unacceptable.
2. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment manufacturer in the event of non-compliance with the proceeding.
3. 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.

1.3 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. Reference "TYPE" as per "PRODUCTS" section of this specification.
2. An itemized list of all isolated and non-isolated equipment including detailed schedules showing isolator and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.

B. Shop Drawings
1. Show base construction for equipment; include dimensions, structural member sizes and support point locations.
2. When walls and slabs are used as seismic restraint locations, details of acceptable methods for ducts and pipe must be included.
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 or contract drawings shall be marked-up with the specific locations and types of restraints shown for all pipe and duct. Rod bracing requirements and assigned load at each

restraint location shall be clearly delineated. Any and all tributary loads shall be considered for proper restraint sizing.

6. For ceiling suspended equipment design restraints for a minimum installation angle of 30^0 from vertical. Indicate maximum installation angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.
7. Calculate thrust for fan heads, axial and centrifugal fans to determine whether thrust restraints are required. (See EQUIPMENT INSTALLATION)

C. Seismic Certification and Analysis

1. Seismic restraint 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.
2. For roof mounted equipment both the seismic acceleration and wind loads (30 psf) shall be calculated, the highest load shall be utilized for the design of the restraints and isolators.
3. Certification of calculations to support seismic restraint designs must be stamped by a professional engineer registered in the State where the project is located.
   a. Analysis must indicate calculated dead loads, derived loads and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and weld length.
4. An in force, Errors and Omissions insurance certificate must accompany submittals. Manufacturer’s product liability insurance certificates are not acceptable.

1.4 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.

1.5 RELATED WORK

A. Housekeeping Pads

1. Material and labor required for attachment and construction housekeeping pads shall be by the General Contractor.
2. Housekeeping pads shall be coordinated with the Seismic Restraint Supplier and sized to provide a minimum edge distance of 13 bolt diameters of clearance all around the outermost anchor bolt to allow for the use of full anchor ratings.

B. Supplementary Support Steel

1. Contractor shall supply supplementary support steel and connections for all equipment, piping, ductwork, etc. Including roof mounted equipment, as required or specified.
2. Where support for equipment requires stands, bases, rails, etc. these devices shall be designed and fabricated by Seismic Restraint Supplier to ensure the seismic capability of the entire installation.

C. Attachments

1. Contractor shall provide restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. as directed by the Seismic Restraint Supplier.

1.6 CODE REQUIREMENTS

A. Seismic restraints as described herein shall be provided in accordance with the International Building Code – 2009, as required by the State of New Hampshire.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Devices
1. Provide vibration isolation and seismic devices specified in this section as manufactured or supplied by Novia Associates, Inc. (NAI), or approved equal. Products of alternative manufacturers or suppliers will be considered provided their systems strictly comply with intent, structural design, performance and deflections of these specifications.

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 outdoor applications shall be as follows:
a. Springs shall be cadmium plated, zinc electroplated or powder coated.
b. Hardware shall be cadmium or zinc plated.
c. All other metal parts shall be hot spray or hot dipped galvanized or zinc electroplated.
3. All seismic restraint devices
a. Shall maintain the equipment in a captive position and not short circuit isolation device during normal operating conditions.
b. Shall have provisions for bolting and/or welding to the structure.
4. <u>Welding of springs to isolator housing, base plates, etc. is strictly prohibited.</u>

B. Seismic Restraint Types
1. TYPE I: Same as Type B isolator.
2. TYPE II: Where required, each corner or side of equipment base shall incorporate a seismic restraint snubber having an <u>all directional</u> resilient neoprene pad limit stops. Restraints shall be fabricated of plate, structural members or square metal tubing.
Model “SS” as manufactured by NAI.
3. TYPE III: Restraints for suspended systems.
a. Vibration isolated systems shall be braced with multiple 7 x 19 galvanized steel cables with approved attachment devices (such as thimbles and wire rope clips) to equipment and structure.
b. Non-isolated systems shall be braced with structural steel strut or cable with approved attachment devices to equipment and structure.
c. Steel angles (by contractor) shall be provided to prevent rod bending of hung equipment where indicated by the Seismic Restraint Supplier’s submittals. Steel angles shall be attached to the rods with a minimum of three clamps model “SRC” at each restraint location. <u>Welding of support rods to angles is not acceptable</u>.
4. TYPE IV: Double deflection neoprene.
a. Mountings shall be fabricated to resist the wind or seismic forces.

Model “RNM” as manufactured by NAI.

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 anchor manufacturer’s published standards.

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 published load ratings to solid height) of 50% of the rated deflection.
   c. Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.

   Model “SM” as manufactured by NAI.
2. TYPE B: Spring Isolator - Restrained
   a. Shall be the same as TYPE A with the following additional features.
      1) Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.
      2) Internal spring adjusting nut or bolt.
      3) Built-in all-directional limit stops with minimum 1/8" clearance under normal operation.

   Model “RSM” as manufactured by NAI.
3. TYPE C: Spring Hanger Isolator
   a. Spring element (same as TYPE A) within a steel box with an Elastomer bushing to insulate lower support rod from the hanger box.
   b. Steel hanger box shall be capable 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.

   Model “SH” as manufactured by NAI.
4. TYPE D: Double deflection neoprene
   a. Mountings shall be fabricated to resist the wind or seismic forces.

   Model “RNM” as manufactured by NAI.
5. TYPE E: Elastomer Hanger Isolator
   a. Molded neoprene element with a bushing to insulate lower support rod from the hanger box.
   b. Steel hanger box shall withstand three times the rated load without failure.

   Model “NH” as manufactured by NAI.
6. TYPE F: Combination Spring/Elastomer Hanger Isolator
   a. Spring and neoprene elements in a steel hanger box with the features as described for TYPE C and E isolators.

   Model “SNH” as manufactured by NAI.
7. TYPE G: Pad type elastomer isolator
   a. Neoprene pad shall have 0.50" minimum thickness, deflection rating of 0.1 inch under rated load.
   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 compliance, neoprene and duck washers and bushings shall be provided to prevent short-circuiting of bolt.

   Model “NP” as manufactured by NAI.

8. TYPE H: Pad type elastomer isolator
    a. Laminated canvas duck & neoprene, maximum loading 1000 psi, minimum ½" 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 compliance, neoprene and duck washers and bushings shall be provided to prevent short-circuiting.
    Model "LNP" as manufactured by NAI.
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.
    Model "TR" as manufactured by NAI.
10. TYPE J: Telescoping Riser Guide
    a. Telescoping arrangement of two sizes of steel tubing separated by a minimum ½" thickness of TYPE H pad.
    Model "TRG" as manufactured by NAI.
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 ½" thickness of TYPE H pad.
    b. Vertical restraint 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.
    Model "RAG" as manufactured by NAI.
12. TYPE M: Flashable restrained isolator
    a. Shall have all features of TYPE B isolator.
    b. Shall have galvanized steel spring pocket covers for adjustment and/or removal and replacement of springs.
    c. The combination floating top rail and top flashing shall be fabricated of two formed and nested layers of 12 ga. galvanized steel.
    d. Isolator shall be flashed directly into the waterproofing membrane.
    e. To be complete with wood nailers, plywood sides, counter flashing and resilient weather seal.
    Model "FRSM" as manufactured by NAI.
13. TYPE P: Elastomer Isolator
    a. Double deflection neoprene compression mountings.
    b. Non-skid top and bottom surfaces.
    c. Threaded bolting sleeves shall be embedded in the isolator.
    d. Drilled tie-down bolt holes shall be provided in the base plate.
    Model "FMD" by NAI.

2.3 EQUIPMENT BASES, CURBS & SUPPORTS

A. GENERAL

1. All curbs, roof rails and isolators are to be bolted or welded to the structure to attain the higher of the specified acceleration criteria or a minimum 30 PSF wind load applied to the largest face area.
2. All non galvanized materials shall be prime paint finished.

3. Review roof top mounted equipment sections of these specifications and contract drawings for supplementary conditions and/or requirements.
4. Operating height for roof mounted supports & curbs shall be as shown on the drawings.
5. Provide pre-drilled holes for all roof mounted curbs and rails for attachment to the building structure.

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. Perimeter members shall be a minimum of 1/10th the longest unsupported span. Centrifugal fan bases shall be complete with motor slide rails and drilled for driver and driven units.
   b. Height saving brackets shall be used to maintain 1" operating clearance under base.
   Model “SB” as manufactured by NAI.
2. TYPE B-2: Concrete Inertia Base
   a. Steel 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 inches or greater than 12 inches. Forms shall be manufactured from structural steel channel sections and include concrete reinforcement consisting of steel bars welded in place on 8 inch centers both ways in a layer 1-1/2 inches above the bottom.
   b. Height saving brackets shall be used to maintain 1" clearance below the base.
   c. Base shall be furnished with steel templates and anchor bolt sleeves to hold anchors while concrete is being poured.
   Model “CIB” as manufactured by NAI.
3. TYPE B-3: Spring Roof Curb
   a. Spring isolation curbs that bear directly on the roof 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. Curbs shall include the following features:
      1) Curbs shall be manufactured from 12 ga. galvanized sheet metal, reinforced and cross braced as required. All side & end seams between sheets shall be continuously welded, corner joints to be bolted.
      2) Springs pockets shall have all of the features of TYPE B isolator.
      3) The combination floating top rail and top flashing shall be fabricated of two formed and nested layers of 12 ga. galvanized steel.
      4) All spring locations shall have removable waterproof galvanized steel covers to allow for spring adjustment and/or replacement.
      5) Curbs shall be capable of accepting external insulation. All exterior insulation to be furnished and installed by the roofing contractor.
      6) Waterproofing and air tightness shall be achieved by use of a continuous flexible air and water seal attached to the bottom counter flashing. The seal shall be protected from exposure to the elements by the top flashing. Neoprene weather seals exposed to sunlight are not acceptable. Metal flashing that must be rigidly attached to the floating and non-floating portions of the curb which would short circuit the isolation effectiveness of the curb are not acceptable.
      7) Wood nailers around the full perimeter of the curb and around each spring pocket.
      8) Overhung condensing units shall be supported by TYPE B isolators. These isolators shall in turn be supported on cross braced structural steel pedestals that are attached to

the building structure and provide a consistent mounting height relative to the RTU. Field built pedestals for condensing units are not acceptable.

9) Galvanized steel duct supports shall be provided as required. Supports shall be capable of supporting the ductwork with a maximum deflection over the width of the curb of L/360.

10) All duct supports shall be provided with attached flexible connectors. Connectors shall be constructed of 3" wide coated woven nylon with double lock gripping finger attachment to metal.

11) Provide 22 ga. galvanized pans for roof top units that require pans under condensing sections.

12) Removable lifting lugs.

13) The curb 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.

14) Curbs shall be fully assembled at the factory and shipped as one piece.

15) Curbs shall be capped with 7 mil shrink wrap for weather protection.

16) Provide flexible connections for all piping connected to rooftop units (including ERV's). See paragraph 3.3 A. 6. & 7 for requirements.

17) Provide flexible duct connections for connections to supply and exhaust fan duct flanges.

Model "VibCurb" as manufactured by NAI.

4. TYPE B-4: Flashable Roof Rail System - Isolated

a. Spring isolation rails that bear directly on the roof structure and are flashed and waterproofed into the roof's membrane waterproofing system. Field fabricated rails with external isolators shall not be used.

b. Rails shall include the following features:

1) Springs pockets shall have all of the features of TYPE B isolator.

2) The combination floating top rail and top flashing shall be fabricated of two formed and nested layers of 12 ga. galvanized steel. 12 ga. galvanized end rails shall tie the side rails together providing full perimeter support.

3) All spring locations shall have removable waterproof galvanized steel covers to allow for spring adjustment and/or replacement.

4) Waterproofing and air tightness shall be achieved by use of a continuous flexible air and water seal attached to the bottom counter flashing. The seal shall be protected from exposure to the elements by the top flashing. NOTE WELL: Neoprene weather seals exposed to sunlight are not acceptable. Metal flashing that must be rigidly attached to the floating and non-floating portions of the rail which would short circuit the isolation effectiveness are not acceptable.

5) Plywood sides and ends.

6) Removable lifting lugs.

7) The rails 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.

8) Provide galvanized steel bridging members as required or as shown on the drawings to support equipment mounted between the rails. Bridging steel shall be designed for a maximum deflection at mid-span of L/360.

Model "FRR" as manufactured by NAI.

5. TYPE B-5: Non-isolated roof curb

a. Curbs shall be manufactured from 12 ga. galvanized sheet metal, reinforced and cross braced as required. All side & end seams between sheets shall be continuously welded, corner joints to be bolted.

b. Curbs shall have provision for up to 2” external insulation. All exterior insulation is to be furnished and installed by the roofing contractor.
c. Galvanized steel duct supports shall be provided as required. Supports shall be capable of supporting the ductwork with a maximum deflection over the width of the curb of L/360.
d. Provide 22 ga. galvanized pans for roof top units that require pans under condensing sections.
e. Curbs shall be fully assembled at the factory and shipped as one piece.
Model “SeisCurb” as manufactured by NAI.

6. TYPE B-6: Flashable non-isolated roof rails
a. Rails shall be manufactured from 12 ga. galvanized sheet metal, reinforced and cross braced on ends.
b. Provide galvanized steel bridging members as required or as shown on the drawings to support equipment mounted between the rails. Bridging steel shall be designed for a maximum deflection at mid-span of L/360.
Model “FRR-0” as manufactured by NAI

7. TYPE B-7: Steel Rails
a. Steel members of sufficient strength to prevent equipment flexure during operation.
b. Height saving brackets as required to reduce operating height.
Model “SR” as manufactured by NAI.

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.

B. TYPE FC-1: Spherical Elastomer connector
1. Manufactured of EPDM.
2. Sizes 2" and larger shall have two spheres reinforced with an external ring between spheres. Bolted-on strap type reinforcing is not acceptable. Sizes 16" to 24" may be single sphere.
3. Threaded one piece bolted flange assemblies with female threaded ends for sizes 3/4" to 1-1/2".
4. Rated at 250 psi up to 170^0 F, with a uniform drop in allowable pressure to 170 psi at 250^0 F for sizes through 14". 16" through 24" single sphere minimum ratings are 180 psi at 170^0 F and 130 psi at 250^0 F.
5. Connectors shall be installed in piping gaps equal to the length of the connector under pressure.
6. Control rods are required in unanchored installations where the installation exceeds the pressure limitation without control rods.
a. Control rods shall have ½" thick Neoprene washer bushings large enough in diameter to take the thrust at 1,000 psi maximum on the washer area.
7. Connectors bolted to Victaulic type coupling or gate, butterfly or check valves to have a minimum 5/8" flange spacer (by others) installed between the connector and the coupling flange. Connectors must mate to a flat-faced flange in all instances.

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 flat faced steel flanges.
a. Lengths shall be: 9" for 2-1/2" to 4", 11" for 5" and 6", 12" for 8", 13" for 10", 14" for 12" to 16".

D. TYPE FC-3: Unbraided Exhaust Hose
1. Low pressure Stainless steel annularly corrugated with flanged ends.
2. Maximum temperature of 1500 degrees F.

E. TYPE FC-4: 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.

PART 3 EXECUTION

3.1 GENERAL

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's submittal data.

B. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

3.2 EQUIPMENT INSTALLATION

A. Equipment shall be isolated as indicated in TABLE A at the end of this section.

B. Additional Requirements:
1. The minimum operating clearance under all bases shall be 1".
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 isolation. The equipment shall be free 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. Housekeeping pads for equipment in this section must be properly doweled or bolted, using wedge type expansion bolts to meet the acceleration criteria. Anchor equipment or isolators to housekeeping pads, see section 1.05: RELATED WORK.
9. Hanger isolators shall be installed with the hanger box hung as close as possible to the structure (without touching). Hanger rods shall not short-circuit the hanger box.

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.

2. All ductwork over four square feet face area located within 50' from air moving equipment shall be hung with TYPE C hangers with 0.75" deflection.
3. Vertical riser supports for water pipe 4" diameter and larger shall be isolated from the structure using TYPE K guides and anchors.
5. Install TYPE FC-1 flexible connectors at all connections of pipe to externally isolated equipment.
6. Install FC-2 or 4 type connectors only at locations which exceed temperature limitations of FC-1 or service requires stainless steel or bronze construction flex. (Such as; spaces without floor drains, or pipes carrying gas or refrigerant)
7. Install approved flexible duct connectors at ductwork connections to all fan-powered equipment, including but not limited to ERV's, exhaust fans, make-up air units, fan coils, etc.

3.4 SEISMIC RESTRAINTS

A. Installation
1. All floor mounted equipment whether isolated or not shall be snubbed, anchored, bolted or welded to the structure. 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.
2. All suspended equipment including, but not limited to; air handling units, pumps, fans, tanks, stacks, VAV boxes, unit heaters, fan powered boxes, cabinet unit heaters, etc. shall be two or four point independently braced with TYPE III restraints. Install cable braces taught for non-isolated equipment and slack with ½" cable deflection for isolated equipment. VAV Boxes (without fans) attached directly to ductwork on the main supply side shall be considered as ductwork for seismic design purposes. Rod bracing shall be installed as per approved submittals and shop drawings. Equipment connected to ductwork weighing less than 75 lbs. is excluded**.**
3. All horizontally suspended pipe and duct shall use RESTRAINT TYPE III. Spacing of seismic bracing shall be as per TABLE B at the end of this section.
4. For all trapeze-supported piping, the individual pipes must be attached to the trapeze support at the designated restraint locations.
5. For overhead 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.
6. Pipe Risers
   a. Where pipes pass through cored holes, 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 all 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.

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 that does not interfere with the thermal expansion/contraction of the pipe.

7. 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.
8. Diffusers shall be attached to lay-in ceilings with earthquake clips or other approved means of positive attachment to the T- bar ceiling structure.
9. All non-isolated floor or wall mounted equipment and tanks shall use RESTRAINT TYPE III or V.
10. Where base anchoring of equipment is insufficient to resist seismic forces, restraint TYPE III shall be located above the unit's 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.
11. A rigid piping or duct system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and roof; solid concrete wall and a metal deck with lightweight concrete fill, pipes & duct that cross a building expansion joint.

B. Exclusions from seismic requirements on non life safety equipment:
   1. 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.
   2. Duct exemptions
      a. Rectangular, Square and Oval ducts less than six square feet in cross sectional area.
      c. Individual ducts suspended by hangers positively attached to the structure that are less than 12 inches in length as measured to top of the duct to the point of attachment to the structure. Hangers must be attached within 2 inches of the top of the duct with a minimum of two #10 sheet metal screws. If any hanger in the run exceeds the 12" limit, seismic bracing is required for the run.
   3. Piping exemptions
      a. All piping less than 2-1/2" diameter except in mechanical rooms where piping less than 1-1/4" is exempted.
      b. All clevis or single level trapeze supported piping suspended by hangers with positive attachment to the structure that are less than 12 inches in length as measured from the top of the pipe to the point of attachment to the structure. If any hanger in the run exceeds the 12" limit, seismic bracing is required for the run.

C. Exclusions from seismic requirements on life safety equipment.
   1. Duct exemptions
      a. Smoke evacuation duct or fresh air make-up air that has a cross sectional area less than 3 square feet.

3.05 INSPECTION

A. If in the opinion of the project engineer the seismic restraint installation does not meet with the project requirements, an outside consultant will be retained to inspect, verify and submit corrective measures to be taken. The consultant's fees and all work associated with such a review shall be borne by the contractor.

TABLE A VIBRATION ISOLATION & SEISMIC RESTRAINT REQUIREMENTS FOR **HVAC** EQUIPMENT				**EQUIPMENT INSTALLATION ATTACHMENT POINT**								
EQUIPMENT				**ON GRADE**			**ABOVE GRADE**			**ROOF**		
		SIZE (5) (8)	**MOUNTING**	**Isol.**	**Defl.**	**Base**	**Isol.**	**Defl.**	**Base**	**Isol.**	**Defl.**	**Base**
BOILERS (B-1,2,3)		OIL OR GAS	FLOOR	- -	- -	- -	B	0.75 (1)	- -	- -	- -	- -
		-		- -	- -	- -	-	-	- -	- -	- -	- -
CENTRIFUGAL FANS (EF-1,2)		ALL	FLOOR/ ROOF	B	0.75	B-1	B	(2) (6)	B-1 (4)	B	(2) (6)	B-1 (4)
			-	- -	- -	- -	-		- -	- -		- -
			-	-	-	- -	-		- -	- -		-
			-	- -	- -	- -	-		- -	- -		- -
CHILLERS & CONDENSING UNITS	ABSORB. & CENTRIF.	ALL	FLOOR	G	0.1	- -	B	0.75	- -	- -	1.5	B-4
	RECIPR. & ROTARY OR SCROLL	To 5 TONS	FLOOR / ROOF	D	0.25	- -	D	.25	- -	- -	.75	B-4
		6-20 TONS		B	1.0	- -	B	1.5	- -	- -	1.5	B-4
		OVER 20 TONS						2.5	- -	- -	2.5	
		OVER 200				- -		2.5	- -		2.5	
CURB MOUNTED ROOF EXHAUSTERS		ALL (7)	ROOF	- -	- -	- -	- -	- -	- -	- -	- -	B-5
FAN COIL UNITS CABINET UNIT HEATERS		ALL	CEILING	- -	- -	- -	F	0.75	- -	- -	- -	- -
PUMPS	BASE MOUNTED	TO 15 H.P.	FLOOR	D	0.3	B-2	B	0.75	B-2	- -	- -	- -
		15-30 H.P.		B	0.75					- -	- -	- -
		OVER 30 H.P.						1.5		- -	- -	- -
	INLINE	ALL	FLOOR	- -	- -	- -	D	0.3	- -	- -	- -	- -
			CEILING	- -	- -	- -	F	0.75	- -	- -	- -	- -
ROOF TOP UNITS (10)		TO 3,000 CFM	CURB MOUNTED	- -	- -	- -	- -	- -	- -	- -	0.75	B-3
		3,001 TO 10,000 CFM		- -	- -	- -	- -	- -	- -	- -	1.50	B-3
		OVER 10,000 CFM		- -	- -	- -	- -	- -	- -	- -	2.50	B-3
		TO 6000 CFM	POINT SUPPORTED	- -	- -	- -	- -	- -	- -	B	0.75	(1)
		OVER 6000 CFM		- -	- -	- -	- -	- -	- -		2.5	(1)

TABLE A NOTES:

GENERAL: **Isol.** = Isolator, **Defl.** = Deflection, All deflections indicated are in inches.

(1) Units may not be capable of point support. Refer to separate equipment 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 determined 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 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 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 1/3 H.P. is excluded from vibration requirements. (Seismic requirements still apply)
(6) Utility sets with wheel diameters less than 15" 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, H.P. Classification applies to largest single motor.
(9) Exclude B-2 base for skid mounted pump sets.
(10) Based on Supply Air CFM.

DEFLECTION GUIDE	
R.P.M.	**DEFLECTION**
LESS THAN 400	3.50"
401 TO 600	2.50"
601 TO 900	1.50"
OVER 900	0.75"

TABLE B
SEISMIC BRACING TABLE

EQUIPMENT	**ON CENTER SPACING**	
	TRANSVERSE	**LONGITUDINAL**
DUCT	30 Feet	60 Feet
PIPE	40 Feet	80 Feet
BOILER BREECHING	30 Feet	60 Feet
CHIMNEYS & STACKS	30 Feet	60 Feet

END OF SECTION

SECTION 15710

HVAC HYDRONIC PIPING

PART 1 -GENERAL

1.01. SUMMARY

A) The Contractor shall furnish and install all HVAC piping and accessories as shown on the Drawings and in accordance with the Specifications.

B) This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating, and makeup water for these systems, blow-down drain lines; and condensate drain piping.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 specifications.

B) Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves

C) Welding Certificates: Copies of certificates for welding procedures and personnel.

D) Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03. QUALITY ASSURANCE

A) Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

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

1.04. COORDINATION

A) Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B) Coordinate pipe sleeve installations for foundation wall penetrations.

C) Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D) Coordinate pipe fitting pressure classes with products specified in related Sections.

E) Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

F) Coordinate installation of pipe sleeves for penetrations through wall and floor assemblies. Coordinate with requirements for firestopping.

PART 2 -PRODUCTS

2.01. MANUFACTURERS

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

1) Calibrated Manual Balancing Valves:
   a) Macon Balancing
   b) Nexus
   c) Bell & Gossett
   d) Tour & Andersson

2) Safety Valves:
   a) Amtrol, Inc.
   b) Armstrong Pumps, Inc.
   c) ITT McDonnell & Miller Div.
   d) Kunkle Valve Division
   e) Spence Engineering Company, Inc.

3) Automatic Balancing Valves:
   a) Flow Design, Inc.
   b) Nexus
   c) Macon Balancing
   d) Bell & Gossett

2.02. PIPING MATERIALS

A) General: Refer to Section 3.01 of this Specification for applications of pipe and fitting materials.

2.03. COPPER TUBE AND FITTINGS

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

B) Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C) DWV Copper Tubing: ASTM B 306, Type DWV.

D) Wrought-Copper Fittings: ASME B16.22.

E) Wrought-Copper Unions: ASME B16.22.

F) Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

G) Brazing Filler Metals: AWS A5.8, Classification Bag-1 (silver).

2.04. STEEL PIPE AND FITTINGS

A) Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade A, Schedule 40, black steel, plain ends.

B) Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.

C) Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

D) Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

E) Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

F) Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

G) Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.05. VALVES

A) Gate, globe, check, ball, and butterfly valves are specified in Section 15712.

B) Calibrated Manual Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and shall be equipped with a memory stop to retain set position.

C) Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

D) Automatic Balancing Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:

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

2.06. HYDRONIC SPECIALTIES

A) Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B) Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.

C) Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.

D) Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, 20 mesh perforated stainless-steel basket, and bottom drain connection with blow-down valve, cap and chain..

E) Basket Strainers: 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, 20 mesh perforated stainless-steel basket, and bottom drain connection.

F) Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

PART 3 – EXECUTION

3.01. PIPING APPLICATIONS

A) Hot Water NPS 2 and Smaller: ASTM B 88, Type L drawn-tempered copper tubing with ASTM B 32 Lead-Free alloy soldered joints or Schedule 40 steel pipe with malleable iron fittings with threaded joints.

B) Hot Water NPS 2-1/2” and Larger: Schedule 40 ASME A53 ERW, Grade B Carbon Steel with flanged or welded fittings.

C) Condensate Drain Lines: Schedule 40 PVC with solvent/cement tube and socket joints or polyethylene tubing as recommended and/or furnished by the boiler manufacturer.

3.02. VALVE APPLICATIONS

A) General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1) Shutoff Duty: NPS 2” and smaller – Ball Valves; NPS 2-1/2” and larger – Butterfly Valves.
2) Throttling Duty: Ball Valves – NPS 2” and smaller, and Butterfly Valves – NPS 2-1/2” and larger.

B) Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves in return mains and elsewhere as indicated.

C) Install automatic balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

D) Install check valves at each pump discharge and elsewhere as required to control flow direction. Check valves at pump discharge shall be spring-loaded, non-slam type.

E) Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

3.03. PIPING INSTALLATIONS

A) Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

B) Install drains, consisting of a tee fitting, NPS 3/4 ball valve with NPS 3/4 threaded hose connection with cap and chain, at low points in piping system mains and elsewhere as required for system drainage.

C) Install piping at a uniform grade of 0.2 percent upward in direction of flow (pitched to drain).

D) Reduce pipe sizes using eccentric reducer fittings installed to prevent low pockets and allow drainage of the entire piping network back to low points with drain valves.

E) Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Match size of strainer blow-off connection for strainers smaller than NPS 2.

F) Anchor piping for proper direction of expansion and contraction.

G) Provide manual air vents at all high points and where piping changes from horizontal to downward, including but not limited to the tops of each piping riser.

3.04. HANGERS AND SUPPORTS

A) Hanger, support, and anchor devices are specified in Sections 15708 and 15709. Comply with requirements below for maximum spacing of supports.

B) Install the following pipe attachments:

1) Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2) Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3) Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4) Spring hangers to support vertical runs.

5) On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

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

1) NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2) NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3) NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4) NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

D) Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1) NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2) NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3) NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4) NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

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

3.05. HYDRONIC SPECIALTIES INSTALLATION

A) Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B) Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.06. TERMINAL EQUIPMENT CONNECTIONS

A) Size for supply and return piping connections shall be same as for equipment connections or larger where indicated on plans.

B) Install control valves in accessible locations close to connected equipment.

C) Install ports for pressure and temperature gages at coil inlet connections.

3.07. FIELD QUALITY CONTROL

A) Prepare hydronic piping according to ASME B31.9 and as follows:

1) Leave joints, including welds, uninsulated and exposed for examination during test.
2) Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3) Flush system with clean water. Clean strainers.
4) Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5) Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B) Perform the following tests on hydronic piping:

1) Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2) While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3) Check expansion tanks to determine that they are not air bound and that system is full of water.
4) Subject piping system to hydrostatic test pressure that is 1.5 times the design pressure but not less than 125 PSIG. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
5) After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6) Submit written report of testing.

3.08. ADJUSTING

A) Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B) Perform these adjustments before operating the system:

1) Open valves to fully open position. Close coil bypass valves.
2) Check pump for proper direction of rotation.
3) Set automatic fill valves for required system pressure.
4) Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5) Set temperature controls so all coils are calling for full flow.
6) Check operation of automatic bypass valves.
7) Check and set operating temperatures of boilers to design requirements.
8) Lubricate motors and bearings.

3.09. CLEANING AND FLUSHING

A) After completion of piping installation, clean and flush hydronic piping systems with clean water. Replace or clean all strainers, and blow off all piping low points at the end of the flush period. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers (“start-up strainers”) in pump suction diffusers.

B) Completely bleed system of all air.

3.10. CHEMICAL TREATMENT

A) Chemically treat all new piping with appropriate corrosion inhibitors in accordance with the current best practices of the trade.

B) Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling. Provide a report to the Owner with recommendations for water treatment, if necessary, to meet specifications of the equipment (boiler) manufacturer.

END OF SECTION

SECTION 15712

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following general-duty valves:

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

B. See Division 15 Section “Instrumentation and Control for HVAC” for control valves and actuators.

C. See Division 15 piping Sections for specialty valves applicable to those Sections only.

1.02 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; furnished specialties; and accessories.

1.03 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.02 VALVES, GENERAL

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

B. Bronze Valves: NPS 2 and Smaller: Threaded ends, unless otherwise indicated.

C. Ferrous Valves NPS 2-1/2 and Larger: 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. Handwheel: For valves other than quarter-turn types.
2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

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 Ends:

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.

3. Grooved Ends: AWWA C606

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

2.03 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:
   a. Conbraco Industries, Inc.; Apollo Div.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
   d. Victaulic.
   e. Milwaukee Valve Company.
   f. Flow-Tek, Inc.

g. Jamesbury, Inc.
h. NIBCO Inc.
i. 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. Flow-Tek, Inc.
f. Victaulic.
g. Jamesbury, Inc.
h. Milwaukee Valve Company.
i. Nexus Valve Specialties.
j. Watts Industries, Inc.; Water Products Div.

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

a. Conbraco Industries, Inc.; Apollo Div.
b. Grinnell Corporation.
c. Hammond Valve.
d. Jamesbury, Inc.
e. Worcester Controls.

4. Safety-Exhaust, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. DynaQuip Controls.
c. Grinnell Corporation.
d. Hammond Valve.
e. Jamesbury, Inc.
f. Milwaukee Valve Company.
g. NIBCO Inc.

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

2.04 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

1. Ferrous-Alloy Butterfly Valves (Lug or Wafer):

a. Bray International, Inc.
b. Crane Co.; Crane Valve Group; Center Line.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. General Signal; DeZurik Unit.
e. Grinnell Corporation.
f. Milwaukee Valve Company.
g. Jamesbury, Inc.
h. Tyco International, Ltd.; Tyco Valves & Controls.

i. Watts Industries, Inc.; Water Products Div.
j. Victaulic

B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for bubble-tight, bi-directional shutoff. Body: Cast Iron A126 Class B. Seat: EPDM – Food Grade. Stem: 304 or 416 SS. Disc: Aluminum Bronze ASTM B148-954.

C. Rating to match piping system. Use lug type valves unless otherwise noted.

2.05 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; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Walworth Co.

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

a. Cincinnati Valve Co.
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. Walworth Co.

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

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

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

a. Grinnell Corporation.
b. Kitz Corporation of America.
c. Milwaukee Valve Company.

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

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
g. Powell, Wm. Co.
h. Walworth Co.
i. 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; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. Grinnell Corporation.
    f. Milwaukee Valve Company.
    g. Walworth Co.
    h. Watts Industries, Inc.; Water Products Div.

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

2.06 GRAY-IRON SWING CHECK VALVES

A. Manufacturers:

1. Type I, Gray-Iron Swing Check Valves with Metal Seats:

    a. Cincinnati Valve Co.
    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. Flomatic Valves.
    f. Grinnell Corporation.
    g. Milwaukee Valve Company.
    h. Mueller Co.
    i. Walworth Co.
    j. Watts Industries, Inc.; Water Products Div.

2. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:

    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Stockham Div.
    c. Mueller Co.
    d. Watts Industries, Inc.; Water Products Div.

3. Grooved-End, Ductile-Iron Swing Check Valves:

    a. Grinnell Corporation.
    b. Mueller Co.
    c. Victaulic Co. of America.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

2.07 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Manufacturers:

1. Type I, Wafer Lift-Disc Check Valves:

a. Mueller Steam Specialty.

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

a. Durabla Fluid Technology, Inc.
b. Flomatic Valves.
c. Grinnell Corporation.
d. Hammond Valve.
e. Metraflex Co.
f. Milwaukee Valve Company.
g. Mueller Steam Specialty.
h. Val-Matic Valve & Mfg. Corp.

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

a. Durabla Fluid Technology, Inc.
b. Flomatic Valves.
c. Grinnell Corporation.
d. Hammond Valve.
e. Metraflex Co.
f. Milwaukee Valve Company.
g. Val-Matic Valve & Mfg. Corp.

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

a. Check-All Valve Mfg. Co.
b. Durabla Fluid Technology, Inc.
c. Grinnell Corporation.
d. Metraflex Co.
e. Milwaukee Valve Company.
f. Mueller Steam Specialty.
g. 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.

2.08 BRONZE GATE VALVES

A. Manufacturers:

1. Type 1, Bronze, Non-rising-Stem Gate Valves:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Milwaukee Valve Company.
i. Powell, Wm. Co.

j. Walworth Co.
k. Watts Industries, Inc.; Water Products Div.

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

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell, Wm. Co.
k. Walworth Co.

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.

2.09 CAST-IRON GATE VALVES

A. Manufacturers:

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

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
h. Powell, Wm. Co.
i. Walworth Co.
j. 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; 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. Milwaukee Valve Company.
h. Powell, Wm. Co.
i. Walworth Co.
j. Watts Industries, Inc.; Water Products Div.

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

2.010 BRONZE GLOBE VALVES

A. Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
h. Powell, Wm. Co.
i. Walworth Co.

2. Type 2, Bronze Globe Valves with Nonmetallic Disc:

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
h. Powell, Wm. Co.
i. Walworth Co.

3. Type 3, Bronze Globe Valves with Renewable Seat and Metal Disc:

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
h. Walworth Co.

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

2.011 CAST-IRON GLOBE VALVES

A. Manufacturers:

1. Type I, Cast-Iron Globe Valves with Metal Seats:

a. Cincinnati Valve Co.
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. Milwaukee Valve Company.
h. Powell, Wm. Co.
i. Walworth Co.

B. Cast-Iron Globe Valves, General: MSS SP-85.

PART 3 - EXECUTION

3.01 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 valves.
2. Throttling Service: Angle, 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: One piece 600-psig CWP rating, copper alloy, full port.
2. Butterfly Valves, NPS 2-1/2 and Larger: Lug type, 150-psig CWP rating, ferrous alloy.
3. Lift Check Valves, NPS 2 and Smaller: Type 2, Class 125, horizontal or vertical, bronze.
4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
6. Wafer Check Valves, NPS 2-1/2 and Larger: Single-plate, wafer, Class 125 or 150 ferrous alloy.
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 150.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type I or II, Class 125, cast iron.
9. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
10. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

D. Select valves, except wafer and flangeless types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for steam and steam condensate services.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends.

3.02 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 15 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. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.03 JOINT CONSTRUCTION

A. Refer to Division 15 Section “Basic HVAC Requirements” for basic piping joint construction.

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.

3.04 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

SECTION 15714

HVAC PIPING INSULATION

PART 1 -GENERAL

1.01 SUMMARY

A) The Contractor shall furnish and install all pipe insulation and accessories as shown on the Drawings and in accordance with the Specifications.

B) This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.02 SUBMITTALS

A. Provide submittals in accordance with Division 1 Specifications.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show details for the following:
1. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
2. Removable insulation at piping specialties, equipment connections, and access panels.
3. Application of field-applied jackets.
4. Application at linkages of control devices.
5. Field application for each equipment type.

D. Field quality-control inspection reports.

1.03 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.

1.04 COORDINATION

A) Coordinate size and location of supports, hangers, and insulation shields.

B) Coordinate clearance requirements with piping Installer for insulation application.

C) Coordinate installation and testing of steam or electric heat tracing.

1.05 SCHEDULING

A) Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1) Glass-Fiber Insulation:
   a) CertainTeed Manson.
   b) Knauf FiberGlass GmbH.
   c) Owens-Corning Fiberglas Corp.
   d) Schuller International, Inc.

2.02 INSULATION MATERIALS

A) Glass-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1) Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
2) Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
3) Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
   a) Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
   b) Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
4) Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
5) Glass-Fiber Insulating Cements: Comply with ASTM C 195.
6) Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
7) Glass-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

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

1) Products:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2.03 FIELD-APPLIED JACKETS

A) General: ASTM C 921, Type 1, unless otherwise indicated.
B) PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1) Jackets:
   a) Johns Manville; Zeston.
   b) P.I.C. Plastics, Inc.; FG Series.
   c) Proto PVC Corporation; LoSmoke.
   d) Speedline Corporation; SmokeSafe.

2) Adhesive: As recommended by jacket material manufacturer.
3) Color: White.

C) Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-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.

E. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products:

a. Childers Products, Division of ITW; Metal Jacketing Systems.
b. PABCO Metals Corporation; Surefit.
c. RPR Products, Inc.; Insul-Mate.

2. Factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:

a. Same material, finish, and thickness as jacket.
b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
c. Tee covers.
d. Flange and union covers.
e. End caps.
f. Beveled collars.
g. Valve covers.
h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.04 VAPOR RETARDERS

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

PART 3- EXECUTION

3.01. PREPARATION

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

3.02 GENERAL APPLICATION REQUIREMENTS

A) Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B) Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C) Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D) Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E) Apply multiple layers of insulation with longitudinal and end seams staggered.

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

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

H) Keep insulation materials dry during application and finishing.

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

J) Apply insulation with the least number of joints practical.

K) Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L) Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at supports, anchors, and other projections with vapor-retarder mastic.

1) Apply insulation continuously through hangers and around anchor attachments.
2) For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3) Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4) Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M) Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

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

O) Apply insulation with integral jackets as follows:

1) Pull jacket tight and smooth.
2) Circumferential Joints: Cover with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
3) Longitudinal Seams: Overlap jacket seams at least 1½ inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a) Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
4) Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5) At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P) Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1) Seal penetrations with vapor-retarder mastic.
2) Apply insulation for exterior applications tightly joined to interior insulation ends.
3) Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
4) Seal metal jacket to roof flashing with vapor-retarder mastic.

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

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

S) Fire-Rated Wall and Partition Penetrations: Where UL approved, apply insulation continuously through penetrations of fire-rated walls and partitions. Refer to Division 15, Specification Section 15700 for requirements for firestopping and air sealing of pipe penetrations.

T) 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.

3.03 GLASS-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 glass-fiber blanket insulation.
4) Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C) Apply insulation to fittings and elbows as follows:

1) Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2) When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3) Cover fittings with standard PVC fitting covers.
4) Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D) Apply insulation to valves and specialties as follows:

1) Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2) When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3) Apply insulation to flanges as specified for flange insulation application.
4) Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5) Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6) For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.04 FIELD-APPLIED JACKET APPLICATION

A) Apply PVC jacket directly over bare insulation or insulation with factory-applied jackets.

1) Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2) Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products:

   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

2. Factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:

   a. Same material, finish, and thickness as jacket.
   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange and union covers.
   e. End caps.
   f. Beveled collars.
   g. Valve covers.
   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3.05 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) Drainage piping located in crawl spaces, unless otherwise indicated.
5) Below-grade piping, unless otherwise indicated.
6) Chrome-plated pipes and fittings, unless potential for personnel injury.
7) Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.06 INTERIOR INSULATION APPLICATION SCHEDULE

A) Service: Heating hot-water supply and return (new and existing piping):

1) Operating Temperature: 100°F to 200°F.
2) Insulation Material: Glass fiber
3) Insulation Thickness: Apply the following insulation thicknesses:
   a) Pipe size less or equal to 1-1/2 inch ID: 1.5-inch
   b) Pipe size greater than 1-1/2 inch ID: 2-inch
4) Applied Jacket: PVC on exposed piping below 6’-0” AFF.

5) Vapor Retarder Required: No

B) Service: Domestic cold water make-up for boilers and supply to condensate neutralization tank(s). Provide insulation on all domestic cold water piping installed under this contract, and, in addition, replace any damaged insulation on existing cold water piping with new.:

1) Operating Temperature: 40°F to 60°F.
2) Insulation Material: Glass fiber
3) Insulation Thickness: 1”
4) Applied Jacket: PVC on exposed piping below 6’-0” AFF.
5) Vapor Retarder Required: Yes

END OF SECTION

SECTION 15715

HVAC PUMPS

PART 1 - GENERAL

1.01. SUMMARY

A. The Contractor shall supply and install all pumps as shown on the Contract drawings, as specified below and as listed in the schedule.

1.02. CONDITIONS OF SERVICE AND DESIGN DATA

A. All pumps shall be selected from performance curves and not from rating tables.

B. A copy of the curve, indicating the operating point, shall be submitted for each proposed pump.

C. Motors shall not be selected for operation in the service factor. The maximum brake horsepower required at any point on the performance curve shall not exceed the rated horsepower of the motor.

D. Motors 1/2 HP and less shall be suitable for use with 120V-1Ph-60Hz electric service. Motors 3/4 HP and larger shall be for use with 208V-3Ph-60Hz electric service. Motors for use with VFD's shall be premium efficiency, 208V-3Ph-60Hz electric service. (Electronically commutated motors rated for 230V-3Ph-60Hz electric service can run on 208V-3Ph-60Hz electric service.)

1.03. SUBMITTALS

A. Provide submittals in accordance with Division 1 requirements.

PART 2 - PRODUCTS

2.01. MANUFACTURERS

A. Subject to compliance with the specifications and equipment schedule on plans, provide products manufactured by one of the following:

1) Bell and Gossett
2) Armstrong
3) Taco
4) Grundfos
5) Wilo

2.02. MATERIALS

A. In-line Pumps

1) Furnish and install pumps, close-coupled, single stage design for installation in vertical or horizontal position.

2) Pump volute shall be of class 30 cast iron, and impeller shall be bronze, enclosed type, dynamically balanced, keyed and secured to the shaft by locking capscrew or not.
3) The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat, carbon steel ring, suitable for continuous operation at 225°F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.
4) Pump bearing bracket shall have oil lubricated bronze journal and thrust-bearings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibrations shall be employed.
5) Motor shall meet NEMA specifications and shall be the size, voltage and enclosure call for on the plans.
6) Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least two coats of high grade machinery enamel prior to shipment.

B. End Suction Pumps

1) Furnish and install pumps with close coupled, single stage, vertical split-case design.
2) Pump volute shall be Class 30 cast-iron, and impeller shall be cast bronze enclose type, dynamically balanced, keyed to the shaft and secured by a locking capscrew.
3) The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat of at least 98 percent alumina oxide content, and carbon seal ring, suitable for continuous operation at 225°F. A replaceable shaft sleeve of bronze alloy shall completely cover the wetted area under the seal.
4) Pumps shall be rated for minimum of 175 psi working pressure. Casing shall have gauge ports, and vent and drain ports at top and bottom of casing.
5) Pump bearing housing assembly shall have heavy duty regreasable ball bearings, replaceable without disturbing piping connections and have foot support at coupling end.
6) Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and at ends, with securely welded cress members and fully open grouting area. A flexible-type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor, and it shall be factory aligned, and shall be realigned by Contractor after installation. Contractor shall level and grout each unit according to manufacturer's instructions.
7) The motor shall meet NEMA specifications and shall be of the size, voltage, and enclosure called for on the plans. Motor and pump shall be factory aligned, and shall be realigned by contractor after installation.
8) Each pump shall be factory tested and shall then be thoroughly cleaned and painted with two coats of high-grade machinery enamel prior to shipment.

PART 3 – EXECUTION

3.01. INSTALLATION

A. Refer to Section 15700 “Basic HVAC Requirements” and install per manufacturer’s recommendations.

END OF SECTION

SECTION 15722

CONDENSING BOILERS AND VENTING SYSTEMS

PART 1 - GENERAL

1.01. SUMMARY

A) This Section includes packaged, factory fabricated and assembled, gas-fired condensing boilers, trim, and accessories for generating hot water.

1.02. SUBMITTALS

A) Provide submittals in accordance with Division 1 specifications.

B) Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

C) Shop Drawings: For boilers, boiler trim, and accessories, include plans, elevations, sections, details, and attachments to other work.

1) Wiring Diagrams: Power, signal, and control wiring.
2) Venting shop drawings.

D) Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 15 Section 15709, “Vibration and Seismic Restraint."

E) Source quality-control test reports.

F) Field quality-control test reports.

G) Operation and maintenance data.

H) Warranty: Special warranty specified in this Section.

1.03. QUALITY ASSURANCE

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

B) ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C) ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements".

D) DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E) UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.04. CERTIFICATIONS

A) Manufacturer's Certification: The boiler manufacturer shall certify the following:

1) The products and systems furnished are in strict compliance with the specifications.
2) The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
3) ASME certification.
4) CSA (AGA/CGA) certification.
5) The specified factory tests have been satisfactorily performed.
6) The specified field tests have been satisfactorily performed.

B) Contractor's Certification: The contractor shall certify the following:

1) The products and systems installed are in strict compliance with the specifications.

C) Boiler Inspectors' Certification: All boiler inspections during hydrostatic testing shall be performed by an authorized boiler inspector who is certified by the National Board of Boiler and Pressure Vessel Inspectors and shall be submitted in writing prior to final acceptance by the engineer.

D) Test Reports: Factory and field test reports as described above and as specified hereinafter, shall be submitted prior to final acceptance by the engineer.

E) Operation and Maintenance Manuals: Manufacturer's printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.

1.05. WARRANTY

A) Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Verify available warranties for units and components and insert number below.

1) Warranty Period for Condensing Boilers:

a) Leakage and Materials: Eight (8) years from date of Substantial Completion.
b) Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for ten (10) years from date of Substantial Completion.

1.06. DELIVERY, STORAGE, AND HANDLING

A) The contractor shall be responsible for the timely delivery of the equipment to the jobsite. The contractor shall be responsible for unloading and rigging of the equipment.

B) Equipment shall be unloaded, handled, and stored in accordance with the manufacturer's handling and storage instructions.

C) The contractor shall be responsible for protecting the equipment from the weather, humidity and temperature conditions, dirt, dust, other contaminants, as well as jobsite conditions during construction.

PART 2 - PRODUCTS

2.01. MANUFACTURERS

A) furnish and install Cleaver Brooks Model CFC 700-1800-125HW natural gas fired hot water boiler(s) with output as scheduled on the drawings.

B) Alternate manufacturers complying with plans and specifications must be submitted and approved by the engineer within 10 days prior to bid date. Acceptance of alternate manufacturer does not imply technical requirements of specification (including but not limited to all performance criteria, efficiencies and warranties) are waived.

2.02. GENERAL DESCRIPTION

A) Each unit shall be down-fired Firetube type complete with boiler fittings and automatic controls. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG. The boiler shall be CSA (formerly AGA/CGA) approved as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.

2.03.PERFORMANCE: BOILER SIZE AND RATINGS

A) The capacity of each unit shall be indicated on the drawing schedule.

B) Exit flue gas temperature of the boiler shall not exceed 320°F gross at maximum rated input and a hot water supply temperature of 200 °F and return temperature of 180 °F. The boiler net input shall not exceed 1,800,000BTU/Hr and the output not less than 1,566,000 BTU/Hr with an overall fuel-to-water efficiency of 85.5 % at high fire and 87% at low fire at above operating temperatures.

C) Performance Criteria:

Manufacturer:	CLEAVER-BROOKS
Model:	CFC-700-1800-60
Horsepower:	53.7 HP
Output:	1,566,000 BTU/HR
Gas Input:	1,800,000 BTU/HR
Design Pressure:	125 PSIG
Operating Pressure:	75 PSIG
Heating Surface (minimum):	547 Sq. Ft. Fireside
Burner Turndown Ratio	5:1

Overall Efficiency (w/68°F return water)	99 % at Low fire (min.)
	97.2 % at High Fire (min.)
Overall Efficiency (w/140°F return water)	94.5 % at Low fire (min.)
	87.0 % at High Fire (min.)
NOx Emissions (maximum)	20 PPM (corrected to 3% O2)
CO Emissions (maximum)	10 PPM (corrected to 3% O2)
Electrical:	120V/60H/1P
Electrical load (maximum):	4.1 Amps (Fan)
	1 Amp (controls)
Noise level (maximum):	66 Dba
Available Gas Supply Pressure in Boiler Room:	2 PSIG
Weight Dry:	2061 Lbs.
Weight Flooded:	2935 Lbs.
Seismic Zone:	4
Altitude:	100’ ASL
Code Requirements:	ASME / NATIONAL BOARD
	CSD-1
	STATE OF ME
	FACTORY MUTUAL (FM)
	GE-GAP [Formerly Industrial Risk Insurers (IRI)]

2.04.BOILER DESIGN

A) Boiler shall be vertical Firetube type with stainless steel tubes and tube sheets. The boiler pressure vessel shall be completely insulated with a minimum of 2” of insulation and shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint. Casing and controls shall ship loose for field installation by manufacturer’s representative.

B) The tubes shall be 316Ti Stainless Steel and shall be fitted with Aluminum fins creating no less than Ten (10) square feet of fireside heating surface per boiler horsepower.

C) The Vessel shall be mounted on a structural steel stand and fitted with drilled feet to facilitate bolt-down to the floor. Exhaust gasses and flue gas condensation shall be collected in a polymer drain collection box complete with drain fitting for draining condensation from the products of combustion.

D) A condensate neutralizing assembly designed by the boiler manufacturer for this boiler shall be included and shipped loose for field installation by contractor. Condensate neutralization assembly shall be shipped complete with sacrificial limestone chips.

E) The top tubesheet shall be fully accessible by lifting the burner assembly which shall come complete with lifting hinges and pneumatic lifters. The boiler shall have a built in hinged platform allowing the operator to access the tubesheet, burner, ignition assembly and flame rod without the use of a ladder.

F) The vessel shall be fully insulated with a minimum of 2" of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.

G) The condensing capability shall allow the boiler to be operated without the use of a 3-way valve for the boiler supply water temperature reset. No minimum boiler return water temperature or minimum flow rate shall be required which would necessitate the use of a secondary circulation loop, pump or other system to protect the boiler from thermal shock or low return water temperature.

2.05. BURNER

A) The burner shall be of the Unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions.

B) Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven Fecralloy material creating a 360 degree low temperature radiant flame.

C) Emissions: The boiler(s) shall operate with CO emissions less than 10 PPM (corrected to 3% O_2) and shall operate with NOx emissions less than 20 PPM (corrected to 3% O_2) while operating at no more than 5% O_2 (25% excess air) over the entire turndown range.

2.06. BOILER TRIM

A) Safety valve shall be ASME Section IV approved side outlet type mounted on the boiler water outlet. Size shall be in accordance with code requirements and set to open at 60 psig.

B) Temperature and pressure gauge shall be mounted on top of the boiler.

C) Low water cut-off probe with manual reset.

D) Auxiliary low water cut-off, manual reset, shipped loose for field installation by contractor

E) Temperature controls including operating controller, modulating controller, and high limit controller.

F) Low pressure Gas pressure regulator shall be furnished factory installed. A single 60# body step-down gas regulator (2 psig to 11" w.c.) with pressure relief valve shall be provided by boiler supplier for installation by contractor in the 2 psig gas line prior to each boiler.

G) Condensate treatment kit.

H) Sealed combustion air kit.

I) Drain Valve: Minimum NPS 3/4 hose-end ball valve.

2.07. BOILER CONTROLS

A) The Boiler package shall include an integrated, unit-mounted, microprocessor-based controller to allow each boiler to operate stand-alone. Boiler controller shall be capable of the following functions:

1) Electronic ignition.
2) Burner sequencing and flame supervision with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.
3) Modulating combustion fan and burner modulation over a 5:1 turndown ratio.
4) Safety shutdown with display of error.
5) Low gas pressure, air proving, high limit, and frost protection.
6) The supply temperature and set point temperature shall be displayed at all times by an LED readout. Output shall be a continuous PID via 4-20 mA current. (The control shall have the ability to reset the boiler water temperature based on outside air temperature or an input signal from a building management system).

B) Controller shall have an option for communication device to computer interface for commissioning and advanced diagnostics.

C) All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements. Electrical power supply shall be 120 volts, 60 cycle, single phase, for the boiler fan; 110 volts, 60 cycle, single phase for the control circuit requirements.

D) A control circuit transformer shall be provided to allow single point power connection.

E) Boiler plant shall be furnished with a Boiler Plant Control Panel (BPCP) to control and coordinate all boiler plant operations including modulation, staging and rotation of individual boilers and associated boiler pumps and modulation and rotation of building distribution pumps. Refer to Division 15, Section 15900, "Instrumentation and Control for HVAC" for BPCP specifications and Section 15901, “Sequences of Operation for HVAC Controls” for required operating sequences.

F) Building Management System Interface: Furnish the BPCP with all necessary hardware and software for integration with the existing Honeywell building management including a “LON” interface card. Interface shall allow remote monitoring and control of the following parameters:

1) Set and adjust Occupied/Unoccupied schedules (for optimal start/stop)
2) Monitor and adjust HWS temperature reset schedule based on OA temperature
3) Monitor current OA temperature
4) Monitor individual boiler lead or lag designation
5) Monitor individual boiler operating status (on/off)
6) Monitor individual boiler firing rate
7) Monitor accumulated run-hours of individual boilers
8) Monitor current HWS and HWR temperatures at each boiler

9) Set and adjust boiler HWS/HWR temperature difference
10) Monitor individual boiler pump operating status (on/off)
11) Monitor individual boiler pump operating speed
12) Monitor building HWS and HWR temperatures
13) Set and adjust building HWS/HWR temperature difference
14) Monitor individual building pump lead or lag designation
15) Monitor individual building pump operating status (on/off)
16) Monitor individual building pump operating speed
17) Monitor accumulated run-hours of building pumps
18) Set and adjust Warm-Weather Shutdown temperature setpoint
19) Monitor all alarms

2.08. BOILER FLUE VENTING

A) The Boiler shall be CSA approved as an indirect or direct vent boiler. Venting shall be accomplished with a stainless steel, double-wall, sealed vent piping installed in accordance with the vent system and boiler manufacturer's published installation instructions and applicable national and local codes as required to maintain the listing of the appliance. Vent system shall be a category IV compliant for positive pressure, condensing applications. Vibration isolation components are not required.

B) Furnish and install a complete, UL approved gas venting system for each boiler, as indicated on the Drawings. Provide all components and accessories required for a complete and approved system, including appliance connector, elbows, straight sections, expansion sections, boot-tee drain, termination kit (note requirements for custom termination fitting on the drawings), and all required fittings and support hardware. Submit detailed shop drawings of entire installation, including plan and elevation views with material list calling out each component to be installed.

C) Gas vent system shall be equal to Cheminee, model HEPL2, double-wall vent system with 24 gauge AL29-4C stainless-steel inner wall and 24 gauge 304 stainless steel outer wall, insulated between the inner and outer walls with 2" thick mineral fiber. The complete venting system shall be UL approved and listed for venting of Category IV (positive pressure, condensing) gas-fired appliances.

2.09. COMBUSTION AIR SYSTEM

A) Furnish and install a complete combustion air intake system for each boiler as indicated on the Drawings. Provide all components and accessories required for a complete and approved system. Combustion air intake system materials and installation shall be in strict accordance with the manufacturer's published instructions as required to maintain the listing of the appliance. Terminate combustion air intake pipes/ducts with factory furnished fittings or turned-down 90° elbows as recommended by the boiler manufacturer.

2.10. MANUFACTURER'S FIELD SERVICES

A) General: The boiler supplier shall be responsible for performance of inspections, start up and testing of the packaged boiler and accessory equipment and materials furnished under this Section. A detailed written record of the start up performance, including burner setting data over the entire load range shall be furnished to the engineer before acceptance. All labor, equipment and test apparatus shall be furnished by the supplier. All equipment defects

discovered by the tests shall be rectified. The minimum time for two (2) boilers is two (2) days.

B) Equipment inspection: Boiler representative to provide 4 hours of jobsite assistance to inspect boilers and other equipment verifying completeness of equipment supplied. Casing, insulation and boiler mounted controls shall ship loose for field assembly by Manufacturer's Representative after boiler has been set and mounted on legs by installing contractor. Installing contractor shall provide laborer for assistance. Responsibility of making freight claims shall be with the contractor or owner personnel.

C) Pre start-up walk through: Boiler representative shall provide 2 hours at jobsite reviewing installation with mechanical contractor. This walk-through to be conducted approximately 1 week prior to startup.

D) Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the boiler supplier, and shall include the following:

1) Demonstrate that boiler, burner, controls and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
2) Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and shall include stack temperatures, O2, CO, NOx, and overall boiler efficiency.
3) Auxiliary Equipment and Accessories: Observe and check all valves, draft fans and electric motors, as well as other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, and non-compliance with referenced standards or overloading as applicable.
4) Commissioning Requirements:

a) Fireside inspection
b) Set up fuel train and combustion air system
c) Set up operating set points
d) Check all safeties, including: Flame safeguard, LWCO, ALWCO, Air flow, Fuel pressures, High limits.
e) Set up and verify efficiencies at 20%, 50%, 75%, and 100%
f) Set up and verify burner turndown.

E) Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single 4 hour continuous session to accommodate operator's availability on site.

2.11. OPERATING & MAINTENANCE MANUALS

A) Provide two (2) Operating and Maintenance manuals including cut-away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and trouble shooting procedures.

B) A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

PART 3 -EXECUTION

3.01. GENERAL

A) Installation shall be provided by the contractor in accordance with the manufacturer’s printed installation, operation and maintenance instructions as well as the requirements of the codes specified hereinbefore. All of the contractor's work shall be performed by experienced workman previously engaged in boiler plant construction and shall be under the supervision of a qualified installation supervisor.

3.02. BOILER INSTALLATION

A) Install boilers level on concrete base. Concrete base is specified in Division 15 Section "Basic HVAC Requirements," and concrete materials and installation requirements are specified in Division 3. Existing concrete boiler room floor will be acceptable where height restrictions prevent installation of housekeeping pad.

B) Install equipment in strict compliance with manufacturer's installation instructions.

C) Install equipment in strict compliance with state and local codes and applicable NFPA standards.

D) Maintain manufacturer's recommended clearances around sides and over top of equipment.

E) Install components that were removed from equipment for shipping purposes.

F) Install components that were furnished loose with equipment for field installation.

G) Provide all interconnecting electrical control and power wiring.

H) Provide all fuel gas vent and service piping. Connect gas piping to boiler gas-train inlet with isolation valve, union and dirt leg. Piping shall be at least full size of gas train connection. Provide a reducer if required.

I) Provide all piping for boiler pipe connections. Install piping adjacent to boiler to allow service and maintenance. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

J) Install piping from safety relief valves to 12” above finish floor.

K) Install flue exhaust vent and combustion-air intake.

L) All wiring shall conform to the requirements of Division 16.

3.03. FIELD QUALITY CONTROL

A) The manufacturer’s representative shall test all boiler and burner interlocks, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. Any malfunctioning component shall be replaced. Refer also to section 2.10 above for specific testing and documentation requirements.

B) All adjustments to boiler, burner, and boiler control system shall be performed by the manufacturer's representative.

3.04.START-UP, INSTRUCTION AND WARRANTY SERVICE

A) The manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture. Refer also to section 2.10.E above.

END OF SECTION

SECTION 15740 – HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes mechanical insulation for HVAC equipment (air separators, pump bodies, tanks, etc.).

B. The contractor shall furnish and install insulation on HVAC equipment as identified on the drawings and in accordance with this specification section.

C. This Section includes semi-rigid and flexible insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.2 SUBMITTALS

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

B. Shop Drawings: Show details for the following:
1. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
2. Removable insulation at piping specialties, equipment connections, and access panels.
3. Application of field-applied jackets.
4. Application at linkages of control devices.
5. Field application for each equipment type.

C. Field quality-control inspection reports.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

1. Products:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

F. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products:

a. Johns Manville; HTB 23 Spin-Glas.
b. Owens Corning; High Temperature Flexible Batt Insulations.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.3 INSULATING CEMENTS

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

1. Products:

a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F .

1. Products:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products:

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates: Comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F .
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products:

a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.

c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F .
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products:

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products:
a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto PVC Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

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

5. Factory-fabricated tank heads and tank side panels.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products:

    a. Childers Products, Division of ITW; Metal Jacketing Systems.
    b. PABCO Metals Corporation; Surefit.
    c. RPR Products, Inc.; Insul-Mate.

2. Factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation with tightly butted joints free of voids and gaps. Vapor barriers shall be continuous. Before installing jacket material, install vapor-barrier system.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

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

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply vapor-barrier mastic to open ends, joints, seams, breaks, and punctures in insulation. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

    1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
5. Install insulation to flanges as specified for flange insulation application.

E. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

F. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

G. Special Installation Requirements for Flexible Elastomeric and Polyolefin Insulation:

1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:

    a. Install pipe insulation to outer diameter of pipe flange.
    b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
    d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:

    a. Install mitered sections of pipe insulation.
    b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.5 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Valves and Pipe Specialties Insulation:
   1. Mineral-fiber board, 2 inches thick.
   2. Flexible elastomeric foam, 2-inches thick (“Armaflex” or equal)

D. Heating-Hot-Water Air-Separator Insulation:
   1. Mineral-fiber pipe and tank, 2 inches thick.
   2. Flexible elastomeric foam, 2 inch thick (“Armaflex” or equal)

END OF SECTION

SECTION 15900

INSTRUMENTATION AND CONTROLS FOR HVAC

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 Boiler Plant Control equipment for HVAC systems and components furnished under this contract. Work under this section includes furnishing and installation of a Direct Digital Control/data acquisition system meeting the requirements outlined herein. Provide complete "Turnkey" services including mounting of control panels, wiring to input/output (I/O) devices, system setup, testing and performance verification. Furnish a complete, functional DDC/data acquisition system with fully programmed firmware and monitoring software, including complete "As-Built" documentation in digital format (WORD document) and bound paper hardcopy.

B. Related Sections include the following:
1. Section 15700 – Basic HVAC Requirements
2. Section 15707 – Variable Frequency Drives
3. Section 15901 – Sequence of Operation for HVAC Controls
4. Section 15990 – Testing, Adjusting and Balancing for HVAC
5. Division 16000 – Electrical

1.3 DEFINITIONS

A. Standard
1. BPCC: Boiler Plant Control Contractor
2. BPCP: Boiler Plant Control Panel
3. DDC: Direct Digital Control
4. GUI: Graphical User Interface
5. HVAC: Heating, Ventilation, and Air Conditioning
6. IEEE: Institute Electrical Electronic Engineers
7. LAN: Local Area Network
8. MER: Mechanical Equipment Room
9. PCM: Programmable Control Module
10. PID: Proportional, Integral, Derivative

1.4 SYSTEM DESCRIPTION

A. All HVAC controls furnished under this section shall be stand-alone (no building automation system exists at site), with electric actuating devices utilizing direct digital control technology.

B. Under this contract, the existing steam boiler plant at the Portsmouth City Hall Complex in Portsmouth, NH will be replaced with a new hot water boiler plant comprised of four (4) high-efficiency condensing boilers with variable-speed boiler pumps and variable-speed building

distribution pumps. The intent is to provide the Owner with a stand-alone boiler plant control system that provides the ability to control systems in accordance with the Sequences of Operation specified in Section 15901, "Sequences of Operation for HVAC Controls", and to interface new controls with the existing Honeywell control system as required to provide the Owner with the specified remote monitoring and adjustment capability. The new boiler plant control system shall be furnished, installed, started-up and commissioned by the boiler supplier. The BPCC will be responsible for integrating with factory-furnished equipment controllers, integrating with the existing Honeywell control system, and for providing all sensors and stand-alone programmable control modules as required to accomplish the specified sequences of operation.

C. Honeywell shall be responsible for any modifications to the existing controls and control panels necessary to facilitate communication between the new boiler plant control system and the existing Honeywell control system. Work shall include, but not be limited to, the addition of an XL50 controller with a "C-Bus" and "LON-Bus" and revision of graphics at the City of Portsmouth's front-end computer workstation. Honeywell shall also be responsible for miscellaneous HVAC controls within the boiler building, including Unit Heater and Exhaust Fan/Damper control.

D. At a minimum the DDC system shall meet the following basic requirements:

1. Achieves the specified sequences of operation.
2. All components and devices are labeled, accessible and easily serviced.
3. As-Built documentation is complete and accurate.
4. Provides Owner with the specified monitoring and adjustment capability.
5. Complies with all applicable state and national codes (in particular the NEC) and any requirements of local authorities having jurisdiction (AHJ)..

E. Furnish all required hardware including BPCP, PCM's, sensors, thermostats, devices, etc., software, programming and labor as required to accomplish the sequence of operations specified in Section 15901, and provide the owner with the specified monitoring and adjustment capability. The system set-points and operation schedules shall be adjustable, password protected and accessible to the owner.

1.5 INSTALLATION OF PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION.

A. Section 15710 – Hydronic Piping:
1. Control Valves.
2. Flow Switches.
3. Temperature Sensor Wells and Sockets.

1.6 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION.

A. Section 15722 – Condensing Boilers and Venting Systems:
1. Temperature Sensors.

1.7 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION.

A. Section 15707 –Variable Frequency Drives.

B. Section 16000 –Equipment and Motor Power Wiring.

1.8 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. Each control device labeled with setting or adjustable range of control.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and method of field assembly, components, and location and size of each field connection.
   1. Schematic flow diagrams showing equipment including fans, pumps, coils, dampers, valves, and control devices.
   2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   3. Details of control panel faces, including controls, instruments, and labeling.
   4. Written description of sequence of operation.
   5. Schedule of dampers including size, leakage, and flow characteristics.
   6. Schedule of valves including close-off and flow characteristics.
   7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
   8. Listing of connected data points, including connected control unit and input device.
   9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

C. Software and Firmware Operational Documentation: Include the following:
   1. Engineering, Installation, Operation and Maintenance manuals.
   2. Program Software Backup: On a flash drive or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application.
   5. Licenses, guarantee, and warranty documents for all equipment and systems.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For systems to include in maintenance manuals specified in Division 1, include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

F. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings and Submittals to reflect actual installation and operating sequences.

1.9 QUALITY ASSURANCE.

A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the BPCC's and Honeywell's local field offices. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the BPCC's and Honeywell's local field offices and shall not be subcontracted.

B. The BPCC shall have a full service support facility within 50 miles of the project with 24 hours/day, 7 days/week emergency service, factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system.

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

D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.10 COORDINATION.

A. Coordinate location of thermostats, humidistats, and other control sensors with plans, equipment installations and room details before installation.

B. Coordinate equipment from other divisions including "Panel boards" and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control devices and PCM's.

D. Coordinate with the Owner's IT department on locations for Ethernet communication cabling and TCP/IP addresses.

1.11 WARRANTY AND MAINTENANCE.

A. All components, system software, and parts furnished and installed by the BPCC or Honeywell shall be guaranteed by the providing contractor against defects in materials and workmanship for 1 year from the date of Owner acceptance. Labor to repair, reprogram, or replace these components shall be furnished by the contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the controls contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The contractor shall respond to the Owner's request for warranty service within 24 standard working hours.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL.

A. 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 to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

PART 2 - PRODUCTS

2.1 DDC EQUIPMENT

A. Input/output (I/O) capacity for discrete inputs, analog inputs (12-bit resolution), relay outputs, and analog outputs.

B. CPU Firmware capable of 64 simultaneous control algorithms with maximum 300ms scan rate.

C. Stand-alone control capability including 7-Day Programmable Time-Clock, on/off cycle timers, differential temperature setpoints, PI and PID analog control algorithms, time-of-day setback, outdoor reset, programmable startup and shutdown routines.

D. On-board data logging of all I/O and system processes with non-volatile memory. Each logged data point shall indicate date and time to nearest second and I/O state. Data logging capacity shall be at least 5,000 points per analog channel, 30,000 points total for discrete state changes, and 10,000 points for process events.

E. Monitoring access to DDC via Ethernet or analog modem, allowing real-time I/O monitoring, adjustment of setpoints, process control modification.

F. Email and text message alarm reporting capability.

G. Minimum three-level password protection for A) "View-only" mode, B) Full remote control mode, and C) Program logic access.

2.2 INTERFACE SOFTWARE

A. Windows-based supervisory control and operating software, capable of direct access to the DDC system from locations within and outside the facility via analog modem or Ethernet.

B. Controller and System HVAC Applications
   1. Update to latest version of software at Project completion. Include and implement the following capabilities from the control units if documented by the specified sequence of operations:
   2. Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, occupied/unoccupied setback/setup, lead/lag rotation, DDC with PID, and trend logging.
   3. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy/economizer switchover.
   4. Boiler Control Programs: Boiler plant optimization with hot water supply reset, boiler and pump equipment selection and sequencing.

5. Programming Application Features: Include trend point, alarm reporting, alarm lockout, weekly scheduling, sequencing, anti-short cycling and calculated points.

2.3 CONTROL PANELS

A. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
   1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
   2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
   3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
   4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel

2.4 SENSORS

A. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
   1. Resistance Temperature Detectors: Platinum, thermistor, or Balco
      a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than 0.225°F maximum error of no more than 0.36°F
      b. Wire: Twisted, shielded-pair cable
      c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
      d. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
      e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
      f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
      g. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
   2. Humidity Sensors: Bulk polymer sensor element.
      a. Accuracy: 2 percent at 10-90% RH with linear output.
      b. Room Sensors: Range of 0 to 100 percent relative humidity
      c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
   3. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
      a. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
      b. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.

c. Building Static-Pressure Range: -0.1” to 0.1”, -0.25” to 0.25”, -.5” to .5”, -1.0” to 1.0” w.c., jumper selectable.
d. Duct Static-Pressure Range: 0” to 1”, 0” to 2.5”, 0” to 5”, 0” to 10” w.c., jumper adjustable.

4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

B. Equipment operation sensors as follows:
1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0” to 5” w.c.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

C. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

D. Water-Flow Switches: Pressure-flow switches of bellows actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless steel or bronze paddle. For chilled water applications, provide vapor proof type.

2.5 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.
1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on two-gang switch box.

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.
1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
2. Dead Band: Maximum 2°F.

D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

E. Fire-Protection Thermostats: UL listed with fixed or adjustable settings to operate at not less than 75°F above normal maximum operating temperature, with the following:
   1. Reset: Manual with control circuit arranged to directly shutdown appropriate equipment and provide remote annunciation at the GUI

F. Room Thermostat Cover Construction:
   1. Set-Point Adjustment: Concealed or exposed
   2. Set-Point Indication: Concealed or exposed
   3. Thermometer: Optional
   4. Color: Neutral
   5. Orientation: Vertical or horizontal

G. Room thermostat accessories include the following:
   1. Insulating Bases: For thermostats located on exterior walls.
   2. Thermostat Guards: As specified in tamper prone areas
   3. Adjusting Key: As required for calibration and cover screws.
   4. Set-Point Adjustment: 1/2-inch diameter, adjustment knob.
   5. Digital Display
   6. Unoccupied Override Button

H. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

I. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
   1. Bulb Length: Minimum 20 feet.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

J. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.6 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).
   1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   2. Non-spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   3. Spring-Return Motors for Valves Larger than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
   4. Non-spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

5. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Damper and Valve Actuators: Direct-coupled type non hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve
1. Coupling: V-bolt and V-shaped, toothed cradle.
2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4. Actuators shall have the ability to be tandem mounted.
5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: -22°F to 140ºF.
10. Run Time: 200 seconds open, 40 seconds closed.
11. All actuators shall have a 5 year warranty
12. Valves:
    a. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    b. Valve and Actuators shall come from the factory fully assembled.
    c. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.
13. Dampers:
    a. Size for running torque calculated as follows:
        1) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
        2) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
        3) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
        4) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
        5) Dampers with 2 to 3 Inches wg of Pressure Drop or Face Velocities of 1000 to 2500 FPM, Multiply the minimum full-stroke cycles above by 1.5.
        6) Dampers with 3 to 4 Inches wg of Pressure Drop or Face Velocities of 2500 to 3000 FPM, multiply the minimum full-stroke cycles above by 2.0.
    b. Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.

2.7 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Globe Valves NPS 2” and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Valves shall have allowable media temperature of 20°F to 281°F to assure that the valve

packing will have a long life (valves will narrower allowable media temperatures have no reserve packing capability for long term watertight seal).

C. Globe Valves NPS 2-1/2" and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

D. Hydronic system globe valves shall have the following characteristics:
   1. Rating: Class 125 for service at 125 psig and 250°F operating conditions.
   2. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
   3. Sizing: 3 psig maximum pressure drop at design flow rate.
   4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

E. Steam system globe valves shall have the following characteristics:
   1. Rating: Class 125 for service at 125 psig and 250°F operating conditions.
   2. Internal Construction: Replaceable plugs and seats of stainless steel.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
   3. Sizing:
      a. 10 psig inlet pressure and 5 psig pressure drop.
      b. Pressure drop across steam valve at a maximum flow of 80 percent of inlet pressure for low-pressure systems and 42 percent for high-pressure systems.
   4. Flow Characteristics: Modified linear characteristics.

F. Control Ball Valves 3 inches and smaller (2 inches for 3-way valves): Forged brass body (CuZn39Pb2), chrome plated brass ball and blowout proof stem and EPDM o-rings with minimum 600 psi rating. Valve shall contain glass filled ball insert capable of providing equal percentage flow. Valves shall have allowable media temperature of 20 Deg F to 250 Deg F.
   1. Rating: Minimum 100 psi close off on 2 way valves and 70 psi on 3 way valves.
   2. Medium: Valves shall be used with hot water or cold water with up to 50% glycol.
   3. Sizing:
      a. Minimum 100 psi close off on 2 way valves and 70 psi on three way valves
      b. Maximum differential shall be 35 psi to ensure quiet operation.
   4. Flow Characteristics: 2 way vales shall have equal percentage characteristics. 3 way valves shall have an equal percentage characteristic through the control port and a linear characteristic through the bypass port.

G. Butterfly Valves: 200 psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   1. Body Style: Wafer, Lug, or Groove
   2. Disc Type: Nickel-plated ductile iron, Aluminum bronze, elastomer-coated ductile iron, epoxy-coated ductile iron.
   3. Sizing: 1 psig maximum pressure drop at design flow rate.

H. Terminal Unit Control Valves: 360 psi forged yellow brass body, nickel plated brass ball, with optimizer insert for modulating applications, blow-out resistant stem, two or three-port as indicated, and threaded ends for chilled or hot water, up to 50% glycol solutions. Actuators shall be as noted above with 5 year warranty. Spring return is required for all Unit Ventilator heating valves and other terminal equipment that has an outside air source. All non-spring return valves must have manual override ability built in to the actuator.
   1. Rating: ANSI class IV, maximum static pressure of 250 psig., minimum fluid temperature of 20ºF and maximum of 250ºF operating conditions.
   2. Sizing: 4 psig maximum pressure drop at design flow rate, to close against pump shutoff head.
   3. Flow Characteristics: Two-way and three-valves shall have equal percentage characteristics.

2.8 DAMPERS

A. Dampers: AMCA-rated, parallel or opposed blade designs; 0.1084 inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635 inch galvanized steel with maximum blade width of .8 inches.
   1. Blades shall be secured 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: -40°F to 200°F
   3. For standard applications, include optional closed-cell neoprene edging.
   4. For low-leakage applications, use 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 inches wg when the damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.
   5. For modulating flow applications, use opposed blade design.

2.9 CONTROL CABLE

A. Electronic and Fiber-Optic Cable for Control Wiring: As specified in Division 16 Section "Control/Signal Transmission Media."

2.10 BOILER PLANT CONTROL SYSTEM

A. The boiler plant system control shall consist of the Boiler Plant Control Panel (BPCP), to be located within the boiler room, [3] thermistors for outside air, supply water temperature, return water temperature, and a water flow measuring device. The thermistors shall be field wired to the BPCP along with the flow device. Each boiler within the heating system shall be equipped with an I/O device [up to 10 boilers on a single BPCP]. Each I/O device shall be hard wired into the boiler control circuit and located at the highest point on the boiler. An I/O device shall be provided for the building distribution (system) pumps, and field wired to the BPCP by the installing contractor.

B. The BPCP shall include a high resolution [320 x 240 pixels] seven inch, graphical user resistive touch screen interface. The touch screen shall be LED back lit and shall be standard screen format [4x3].

C. The BPCP shall include the following:

1. Ethernet or micro SD card slot for updating/upgrading to new levels of functionality and interactivity.
2. Determination of all on/off states of equipment, all output rates of equipment and communicate that data to the individual I/O devices via CAN bus over RS 485 for the purpose of boiler room control and heating operations.
3. Through the use of the Graphical User Interface (GUI), the BPCP shall provide all functionality required for parameterization of the network for system control and shall transmit data to the I/O devices via CAN network for local storage.
4. The BPCP shall have two RJ45 ports capable of updating/upgrading to new levels of functionality and both capable of ModBus Master/Slave protocols.
5. Alarm Output for notification of a boiler/pump/damper failure.
6. Capability of individually controlling up to ten boiler secondary pumps, with timing off delays for post on cycle purge.
7. Capability to individually operate up to ten main system or zone pumps. [System pumps can be individually identified as on, off, or lead lag.]
8. Capability of individually operating up to ten combustion make-up air dampers, mechanical combustion air make-up enable circuits, or mechanical draft enable circuits, linked to the firing sequence of the boiler for which it operates.

D. Input/Output [I/O] Devices shall include:
1. Two single pole double throw output contacts rated for 8 amps @ 120 VAC.
2. Operation at 24 VDC or 120 VAC (120VAC via power supply).
3. Each I/O device shall individually communicate confirmation of on/off status, output rate status, and alarm status and heartbeat to the BPCP for the purpose of boiler room control and heating operations.

E. Functionality:
1. The boiler controller shall be capable to individually operate between one [1] and ten [10] boilers with full modulation burners, on/off burners, or two stage [high low] burners. When a fixed firing rate [on/off] boiler is enabled, the controller shall account for this occurrence by assigning the entire load in MBH required to meet the rated output of the boiler to that boiler. The balance of the load, if any, will then be assigned to either two stage or modulating boilers in the system.
2. The control shall have the capability of selectable parallel sequential modulation, and shall provide parallel modulation at any percentage of rated output.
3. The boiler controller shall be enabled on outdoor air and via contact closure, indicating a call for heat, enable one of three resets for supply temperature; two [2] for winter operation, one [1] for summer operation, allowing changes in building loop temperature based on outdoor air.
4. Boiler controller shall also be capable of remote enable and remote setpoint override via external Modbus write commands. Any communication failure shall cause the controller to remain operating and revert to its normally calculated reset schedule.
5. A warm weather shut down option shall be included.
6. The boiler controller shall have the capability of individually controlling up to ten [10] boiler output temperatures and the target output temperatures for each boiler can differ one from the other.
7. The boiler controller shall have the capability of choosing any boiler on the network for operation according to outdoor air temperature, Real Time Load, load predictions, alarm status, minimum output rating, maximum output rating, minimum return temperature, maximum outlet temperature, condensing, non-condensing, winter priority, standby status, hot water priority, efficiency in a given range, and hours of operation.

8. The boiler controller shall have the capability of calculating the required heating load utilizing supply water temperature, return water temperature, and water flow rate of the main supply header. Based on the load requirement, the control shall assign all or part of any load to a condensing or non-condensing boiler at any outdoor temperature, as required to meet the needs of the system, boiler, and the building. It shall have the capability of overcoming burner output rate tuning issues in order to meet the building load.
9. The boiler controller shall have the capability of determining individual minimum return temperatures for the operation of non-condensing boilers according to the manufacturers published guidelines. It shall be able to overcome minimum return temperature errors by increasing boiler output or increasing system supply water setpoint temperature or both. The control shall also have the capability of determining individual maximum output temperatures for each system boiler according to the manufacturers published guidelines.
10. The control shall be equipped to read both the inlet and outlet temperature of each boiler on the system.
11. The control shall have the capability to control both boiler inlet temperature and outlet temperature differential [Delta T] of each boiler by sending a modulating signal to a customer supplied pump and appropriately sized frequency drive for this purpose. The control shall adapt to temperature overshoot above the maximum outlet temperature by assigning part of the load to another boiler during boiler delta T operations. As the outlet temperature of a boiler approaches maximum temperature, the boiler controller shall be able to respond by increasing the output signal to the frequency drive attached to the boiler pump in order to reduce boiler delta T and maintain compliance with the manufacturer's published maximum boiler outlet temperature.
12. The boiler controller shall have the capability to individually operate up to ten (10) main system pumps. All system pumps can be individually identified as on, off, or lead lag. The BPCP shall also have the capability of enabling up to (4) system pumps via discrete contacts without the need for a remote I/O device.
13. The boiler controller shall have the capability of controlling system delta T (temperature) by modulating system pump(s). It shall also be capable of calculating a delta T reset slope.
14. The boiler controller shall have the capability controlling system delta P (pressure) by modulating system pump(s) speed control to respond to heating system load requirements. It shall also be capable of calculating a delta P reset slope
15. The boiler controller shall have the capability of an adjustable night and weekend optimum stop/setback of building supply loop temperature. The optimum stop shall allow a gradual setback beginning in advance of unoccupied times through the use of customer input data and collected data.
16. The control shall have the capability of pre-occupancy system temperature optimum start return and system boost. The optimum start shall allow a gradual return and boost from setback beginning in advance of occupied times through the use of customer input data and collected data. The control shall gradually ramp down loading of boilers from boost setpoint operations.
17. The boiler controller shall utilize patented "Load Acceleration Control Algorithm" for action required in meeting heating load through an analog signal to the boilers which in turn affect the outputs of the selected boilers.
18. The boiler controller shall have the capability of a user definable summer reheat mode, reset loop temperature based on outdoor air.
19. The boiler controller shall have a user definable low fire hold [1 - 60 minutes] time period based on a system differential temperature during low load demands. The controller shall determine if the building is warming up fast enough and if it is, delay

release of the boiler to modulation by maintaining low fire to increase efficiency of operation.

20. The boiler controller shall have freeze protection programming that will overcome heat being disabled in order to protect the building equipment and boilers from the effects of freezing.
21. The boiler controller shall have the capability for individual boiler alarm inputs that can and will affect whether or not a boiler is available for operational rotation and shall share that information through network traffic.
22. The boiler controller shall have the capability for individual boiler "prove enabled" inputs that can set an alarm condition and affect whether or not a boiler is available for operational rotation and shall share this information with the network traffic.
23. The boiler controller shall have an alarm output on the Administrator device for notification of a boiler failure. There will be two levels of boiler control system alarm: low building temperature alarm triggered by low supply temperature set point and a general alarm indicating boiler and/or pump alarms and/or unavailability of boilers and/or pumps.
24. The boiler controller shall have the capability of selectable parallel, sequential modulation (efficiency optimization – run as many condensing boilers as possible to meet any given heating load).
25. The boiler controller shall have the capability of parallel modulation at any percentage of rated output.
26. The boiler controller shall be able to operate Domestic Hot Water priority and have a physical input to activate this feature. This control function shall allow for temporary set point override to a domestic hot water set point until the demand is satisfied.

F. Building Management System Interface: Furnish the BPCP with all necessary hardware and software for integration with the existing Honeywell building management including a "LON" interface card. Interface shall allow remote monitoring and control of the following parameters:

1. Set and adjust Occupied/Unoccupied schedules (for optimal start/stop)
2. Monitor and adjust HWS temperature reset schedule based on OA temperature
3. Monitor current OA temperature
4. Monitor individual boiler lead or lag designation
5. Monitor individual boiler operating status (on/off)
6. Monitor individual boiler firing rate
7. Monitor accumulated run-hours of individual boilers
8. Monitor current HWS and HWR temperatures at each boiler
9. Set and adjust boiler HWS/HWR temperature difference
10. Monitor individual boiler pump operating status (on/off)
11. Monitor individual boiler pump operating speed
12. Monitor building HWS and HWR temperatures
13. Set and adjust building HWS/HWR temperature difference
14. Monitor individual building pump lead or lag designation
15. Monitor individual building pump operating status (on/off)
16. Monitor individual building pump operating speed
17. Monitor accumulated run-hours of building pumps
18. Set and adjust Warm-Weather Shutdown temperature setpoint
19. Monitor all alarms

G. Field Parameterization

1. The boiler manufacturer's authorized field service representation shall be responsible for ensuring that all I/O devices are field programmed for the specific heating load application. Each I/O device will be tested to ensure system network functionality and interface functionality of the BPCP and temperature sensors and flow devices that interface with the BPCP. The field service representative shall demonstrate the functionality to the authorized boiler operator and or owner, and demonstrate the method needed to obtain data information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control panels, devices and PCM's.

B. Verify that duct, pipe, and equipment mounted devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Install software in control panels and PCM's. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate at height above the floor to comply with the Americans with Disabilities Act (ADA), State of NH adopted edition and amendments.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards or tamper proof enclosures on thermostats in the following locations:
   1. Entrances.
   2. Public areas.
   3. Where indicated.

F. Install damper actuators on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 15, Section 15704, "Identification for HVAC Piping and Equipment."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways and Boxes."

B. Install building wire and cable according to Division 16 Section "Conductors and Cables."

C. Install signal and communication cable according to Division 16 Section "Control/Signal Transmission Media."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable so that it shall be properly secured to structure within walls or ceilings.
4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
1. Install piping adjacent to machine to allow service and maintenance.

B. Ground equipment.
1. 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. Manufacturer's Field Service: Provide services of factory-trained and experienced field personnel at system commissioning. Verify that system is fully operational and performing within specified tolerances. Simulate and verify response to all alarm conditions. Services shall include adjustments to control program (if necessary), troubleshooting of sensor circuits and optimizing process control gains. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
3. Calibrate and test electric/electronic thermostats by disconnecting input sensors and simulating operation with compatible signal generator.

B. Replace damaged or malfunctioning controls and equipment.
1. Start, test, and adjust control systems to verify performance.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.6 TRAINING

A. Following completion of the installation and system commissioning, provide a minimum of four (4) hours of on-site or classroom training for personnel designated by the Owner. Coordinate scheduling of training session with the building Owner. Train the designated staff and Owner to enable them to:
   1. Proficiently operate the system
   2. Understand control system architecture and configuration
   3. Understand DDC system components
   4. Understand system operation, including DDC system control and optimizing routines (algorithms)
   5. Operate the control panel(s) and peripherals
   6. Log on and off the system
   7. Access graphics, point reports, and logs
   8. Adjust and change system set points, time schedules, and holiday schedules
   9. Recognize malfunctions of the system
   10. Understand system drawings, and Operation and Maintenance manual
   11. Understand the job layout and location of control components
   12. Access data from control panel(s)

END OF SECTION

SECTION 15901

SEQUENCES OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the required sequences of operation for control of mechanical and domestic hot water systems. The points for remote monitoring and interface with packaged equipment controls are also identified herein. The control system requirements are identified in Section 15900 "Instrumentation and Controls for HVAC".

PART 2 - EXECUTION

2.01 SEQUENCES OF OPERATION

A. Boiler Plant Control:

1. The new gas-fired, hot water boiler plant, consisting of boilers, B-1 through B-4, their associated boiler pumps, BP-1 through BP-4, and building loop heating pumps, P-1 and P-2, shall be controlled by a custom programmable boiler plant control panel (BPCP). All functions of boiler plant control including start/stop of boilers, modulation of boiler firing rate, staging of boilers, rotation of boilers, start/stop of boiler pumps, modulation of boiler pump speed, HWS temperature setpoint reset based on outside air temperature (OAT), start/stop of building loop pumps, and modulation of building pump speed shall be accomplished by the BPCP. The BPCP shall be interfaced with individual boiler integral controllers for all alarms and safeties required for each boiler including, but not limited to, low-water cut-off, high-limit cut-out, low gas pressure, blocked flue, and flame failure. This Contractor shall provide all required field wiring of factory-furnished, field-installed sensors and devices, interconnecting wiring between integral boiler control panels, adjustment of internal setpoints and operational testing to verify operation in accordance with the sequence described herein.
2. Warm-Weather Shutdown: The BPCP shall enable the boiler plant for building and domestic hot water heating whenever the outside air temperature (OAT) drops below the Warm-Weather Shutdown (WWSD) temperature setpoint of 65°F (adj.).
3. Rotation: Boilers B-1 through B-4 shall be rotated from "lead" to "lag" periodically as required to equalize runtime. BPCP shall log accumulated runtime of each boiler.
5. HWS Temperature Reset: The hot water supply (HWS) temperature setpoint of the building heating loop shall be varied in an inverse-proportional manner with OAT in accordance with the following schedule.

    - Below 10°F OAT, HWS Temperature = 180°F (adj.).
    - As OAT rises from 10°F to 60°F, HWS Temperature shall reduce linearly from 180°F to 130°F (adj.).
    - Above 60°F OAT, HWS Temperature = 130°F (adj.).

6. Boiler Control and Staging: The BPCP shall enable boilers and modulate their individual firing rates using PID control logic as required to maintain the building heating loop temperature equal to the current HWS reset setpoint. To optimize the

operating efficiency of the plant, an "Efficiency-Optimization" routine shall be employed that operates as many boilers as possible at minimum firing rates to meet the current heating demand. Using measured values of the building heating loop supply and return temperature and flow rate, the BPCP shall calculate the actual heating demand. Using the calculated demand, the BPCP shall determine the maximum number of boilers that may be enabled to meet the load and fire them in parallel.

8. Boiler Pumps (BP-1 thru BP-4): Whenever a boiler is enabled to operate, the associated boiler pump shall run. Using PID control logic, the BPCP shall modulate the speed of the boiler pump to maintain a temperature differential of 35°F (adj.) across the inlet and outlet of the associated boiler. (That is, if the temperature difference is less than 35°F, decrease pump speed. If the temperature difference is greater than 35°F, increase pump speed.) If a lag boiler is not enabled to fire (such as when heating demand is small), the associated lag boiler pump shall be off. A purge delay shall be programmed to operate a boiler pump for a period of time after disabling of the associated boiler to purge the boiler of stored heat.
10. Graphics List:
    (Note: All setpoints and schedules shall be readable and adjustable. Refer to specification section 15900 for required communications interface between the BPCP and Honeywell control systems.)

    - Occupied / Unoccupied Schedule (for optimal start/stop)
    - Boiler lead or lag designation
    - Individual boiler accumulated run-hours
    - Individual boiler operating status – firing/off
    - Individual boiler firing rate - % of maximum
    - Outside air temperature
    - HWS Temperature Reset Schedule (based on OA temperature)
    - HWS temperature in Building Loop
    - HWR temperature in Building Loop
    - Individual boiler inlet and outlet temperatures
    - Boiler inlet and outlet temperature difference setpoint - °F
    - Boiler Pump operating status – on/off
    - Boiler Pump speed command - % of maximum
    - Warm-weather-shutdown temperature setpoint
    - Alarms (HWS temp out of range, boiler controller alarm outputs, etc.)

B. Building Loop Heating Pump Control (P-1 and P-2)

1. Whenever the OAT is below the WWSD temperature setpoint (refer to paragraph A.2. above), building heating pumps, P-1 and P-2, shall be enabled for operation by the BPCP. Whenever the OAT is greater than the WWSD temperature setpoint, P-1 and P-2 shall be off.
2. When enabled to operate, the lead pump shall start and operate continuously. Using PID control logic, the BPCP shall modulate the speed of the lead pump as required to maintain a temperature differential of 25°F (adj.) between the HWS and HWR mains in the boiler room. (That is, if the temperature difference is less than 25°F, decrease pump speed. If the temperature difference is greater than 25°F, increase pump speed.)
3. Provide a flow sensor (or differential pressure sensor) to prove water flow and detect pump failure. Should failure of the lead pump be detected, disable the failed pump, start the lag pump, alternate lead/lag designations, and send alarm to the BPCP.

4. Rotation: Lead and lag pump designation shall be automatically alternated by the BPCP as required to equalize accumulated runtime.
5. Graphics List:
   (Note, all setpoints and schedules shall be readable and adjustable. Refer to specification section 15900 for required communications interface between the BPCP and Honeywell control systems.)

   - Pump lead or lag designation
   - Pump operating status – on/off
   - Pump operating speed – % of maximum
   - Hot water flow status (Proof of Flow)
   - Accumulated run hours for each pump
   - Alternation schedule
   - Warm-weather-shutdown temperature setpoint
   - Outside air temperature
   - ` Alarms (pump or sensor failure)

C. Unit Heater (UH-1, UH-2, UH-3 & UH-4) Control:

1. Furnish UH with a two-way, two-position, normally-open, spring-return automatic control valve (ACV) and space thermostat to operate as follows.
2. Upon a call for heat from the space thermostat, ACV shall open and UH fan shall be energized. When thermostat setpoint has been satisfied, ACV shall close and UH fan shall deenergize.
3. Whenever OAT < 30°F (adj.), ACV shall remain open and UH fan only shall cycle in response to the thermostat call.
4. Graphics List:
   (Note, all setpoints and schedules shall be readable and adjustable.)

   - Space Temperature
   - UH fan operating status – on/off
   - ACV commanded position – open/closed
   - Outside air temperature
   - ` Alarm (space temperature out of range)

D. Exhaust Fan (EF-1) Control:

1. Furnish a reverse-acting space thermostat to energize EF-1 and open the associated intake assembly whenever the space temperature rises above 84°F (adj.).
2. Furnish and automatic control damper (ACD) and two-way, two-position, normally-closed, spring return damper actuator for the associated intake assembly.
3. When the space thermostat is satisfied, EF-1 shall deenergize and the ACD shall close.
4. Graphics List:
   (Note, all setpoints and schedules shall be readable and adjustable.)

   - Space Temperature
   - EF-1 operating status – on/off
   - ACD commanded position – open/closed
   - ` Alarm (space temperature out of range)

END OF SECTION

SECTION 15990

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A) This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1) Adjusting total HVAC systems to provide indicated quantities.
2) Measuring electrical performance of HVAC equipment.
3) Setting quantitative performance of HVAC equipment.
4) Verifying that automatic control devices are functioning properly.
5) Reporting results of the activities and procedures specified in this Section.

B) Work under this contract shall include balancing of hydronic equipment located in the boiler room only. No balancing work shall be required in the City Hall Complex itself, except as necessary to complete balancing of pumps P-1 and P-2. This work would be limited to verifying (and possibly manipulating) the position of valves in the main loop where the P-1/P-2 piping loop interconnects with the secondary pump system in the Main Building.

1.02 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) 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.

D) Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

E) System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

F) 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.

G) Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system (typically a grille, register or diffuser).

H) Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

I) AABC: Associated Air Balance Council.

J) AMCA: Air Movement and Control Association.

K) CTI: Cooling Tower Institute.

L) NEBB: National Environmental Balancing Bureau.

M) SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.03 SUBMITTALS

A) Provide submittals in accordance with Division 1 Specifications.

B) Quality-Assurance Submittals: Submit 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 1.04, below.

C) Certified Testing, Adjusting, and Balancing Reports: Submit copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

D) Sample Report Forms: Submit sample testing, adjusting, and balancing report forms.

E) Warranty: Submit special warranty specified in the "Warranty" Article, 1.06, below.

1.04 QUALITY ASSURANCE

A) 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 approved testing, adjusting, and balancing plan.

B) 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."

C) Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.05 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.

1.06 WARRANTY

A) General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B) 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 USED)

PART 3 - EXECUTION

3.01 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, manual volume dampers, and the like 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 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.

D) 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.

E) Examine system and equipment test reports.

F) 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, manual volume dampers, and the like are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

G) Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

H) 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.

I) 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.

J) Examine strainers for clean screens and proper perforations.

K) Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L) Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M) Examine equipment for installation and for properly operating safety interlocks and controls.

N) Examine automatic temperature system components to verify the following:

1) Dampers, valves, and other controlled devices operate by the intended controller.
2) Dampers and valves are in the position indicated by the controller.
3) Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4) Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5) Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6) Sensors are located to sense only the intended conditions.
7) Sequence of operation for control modes is according to the Contract Documents.
8) Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9) Interlocked systems are operating.
10) Changeover from heating to cooling mode occurs according to design values.

O) Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.02 PREPARATION

A) Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B) Complete system readiness checks. Verify the following:

1) Permanent electrical power wiring is complete.
2) Hydronic systems are filled, clean, and free of air.
3) Automatic temperature-control systems are operational.
4) Equipment and duct access doors are securely closed.
5) Balance, smoke, and fire dampers are open.
6) Isolating and balancing valves are open and control valves are operational.
7) Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8) Windows and doors can be closed so design conditions for system operations can be met.

3.03 GENERAL TESTING AND BALANCING PROCEDURES

A) 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.

B) Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C) Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 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.

3.05 CONSTANT VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A) The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems, including HV-1.

B) Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1) Measure fan static pressures to determine actual static pressure as follows:
   a) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b) Measure static pressure directly at the fan outlet or through the flexible connection.
   c) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
2) Measure static pressure across each air-handling unit component.
   a) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3) Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
4) Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5) Adjust fan speed higher or lower than design with the approval of the Architect. 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.

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.

3.06 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A) Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B) Prepare schematic diagrams of systems' "as-built" piping layouts.

C) Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1) Open all manual valves for maximum flow.
   2) Check expansion tank liquid level.
   3) Check makeup-water-station pressure gage for adequate pressure for highest vent.
   4) Check flow-control valves for specified sequence of operation and set at design flow.
   5) Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
   6) Set system controls so automatic valves are wide open to heat exchangers.
   7) Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8) Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.07 HYDRONIC SYSTEMS' BALANCING PROCEDURES

A) Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1) Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
   2) Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust hot water return main butterfly valve until design water flow is achieved. Use calibrated flow measuring device (B&G Circuit Sensor specified) to read flow.
   3) Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4) Report flow rates that are not within plus or minus 5 percent of design.

B) Set calibrated balancing valves, if installed, at calculated presettings.

C) Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1) System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D) Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E) Adjust balancing stations to within specified tolerances of design flow rate as follows:

1) Determine the balancing station with the highest percentage over design flow.
2) Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
3) Record settings and mark balancing devices.

F) Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

G) Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.08 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

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

3.09 HEAT EXCHANGERS

A) Measure water flow through all circuits.

B) Adjust water flow to within specified tolerances.

C) Measure inlet and outlet water temperatures.

D) Measure inlet steam pressure. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves.

E) Record safety valve settings.

F) Verify operation of steam traps.

3.10 MOTORS

A) Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1) Manufacturer, model, and serial numbers.
2) Motor horsepower rating.
3) Motor rpm.
4) Efficiency rating if high-efficiency motor.
5) Nameplate and measured voltage, each phase.
6) Nameplate and measured amperage, each phase.
7) Starter thermal-protection-element rating.

B) Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.11 HEAT-TRANSFER COILS

A) Water Coils: Measure the following data for each coil:
1) Entering- and leaving-water temperatures.
2) Water flow rate.

3) Water pressure drop.
4) Dry-bulb temperatures of entering and leaving air.
5) Wet-bulb temperatures of entering and leaving air for cooling coils designed for less than 7500 cfm (3540 L/s).
6) Airflow.
7) Air pressure drop.

3.12 TEMPERATURE TESTING

A) During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B) Measure outside-air, wet- and dry-bulb temperatures.

3.13 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) Note operation of electric actuators using spring return for proper fail-safe operations.

3.14 TOLERANCES

A) Set HVAC system airflow and water flow rates within the following tolerances:
1) Supply, Return, and Exhaust Fans: -5 to +10 percent of design flows.
2) Air Outlets and Inlets: -5 to +10 percent or design flows.
3) Heating-Water Flow Rate: -5 to +5 percent of design flows.

3.15 FINAL REPORT

A) General: Report shall be bound, typewritten, or computer printout in letter-quality font, on standard bond paper, 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) Pump curves.
2) Fan curves.
3) Manufacturers' test data.
4) Field test reports prepared by system and equipment installers.
5) Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D) General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
1) Title page.
2) Name and address of testing, adjusting, and balancing Agent.
3) Project name.
4) Project location.
5) Architect's name and address.
6) Engineer's name and address.
7) Contractor's name and address.
8) Report date.
9) Signature of testing, adjusting, and balancing Agent who certifies the report.
10) Summary of contents, including the following:
a) Design versus final performance.
b) Notable characteristics of systems.
c) Description of system operation sequence if it varies from the Contract Documents.
11) Nomenclature sheets for each item of equipment.
12) Data for terminal units, including manufacturer, type size, and fittings.
13) Notes to explain why certain final data in the body of reports vary from design values.
14) Test conditions for fans and pump performance forms, including the following:
a) Settings for outside-, return-, and exhaust-air dampers.
b) Conditions of filters.
c) Cooling coil, wet- and dry-bulb conditions.
d) Face and bypass damper settings at coils.
e) Fan drive settings, including settings and percentage of maximum pitch diameter.
f) Inlet vane settings for variable-air-volume systems.
g) Settings for supply-air, static-pressure controller.
h) Other system operating conditions that affect performance.

E) System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
1) Quantities of outside, supply, return, and exhaust airflows.
2) Water and steam flow rates.
3) Duct, outlet, and inlet sizes.
4) Pipe and valve sizes and locations.
5) Terminal units.
6) Balancing stations.

F) Air-Handling Unit Test Reports: For air-handling units with coils, 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 (mm), and bore.
i) Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
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 (mm), and bore.
f) Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

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 (L/s).
j) Return airflow in cfm (L/s).
k) Outside-air damper position.
l) Return-air damper position.
m) Vortex damper position.

G) 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 (mm), and bore.
h) Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

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 (mm), and bore.
f) Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
g) Number of belts, make, and size.

3) Test Data: Include design and actual values for the following:
a) Total airflow rate in cfm (L/s).

b) Total system static pressure in inches wg (Pa).
c) Fan rpm.
d) Discharge static pressure in inches wg (Pa).
e) Suction static pressure in inches wg (Pa).

H) 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 (deg C).
d) Duct static pressure in inches wg (Pa).
e) Duct size in inches (mm).
f) Duct area in sq. ft. ((sq. m)).
g) Design airflow rate in cfm (L/s).
h) Design velocity in fpm (m/s).
i) Actual airflow rate in cfm (L/s).
j) Actual average velocity in fpm (m/s).
k) Barometric pressure in psig (Pa).

I) 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).

J) System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1) Unit Data: Include the following:
a) System and air-handling unit identification.
b) Location and zone.
c) Room or riser served.
d) Coil make and size.
e) Flowmeter type.
2) Test Data: Include design and actual values for the following:
a) Airflow rate in cfm (L/s).
b) Entering-water temperature in deg F (deg C).

c) Leaving-water temperature in deg F (deg C).
d) Water pressure drop in feet of head or psig (kPa).
e) Entering-air temperature in deg F (deg C).
f) Leaving-air temperature in deg F (deg C).

K) Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:\
1) Unit Data: Include the following:
a) Unit identification.
b) Location.
c) Service.
d) Make and type.
e) Model and serial numbers.
f) Ratings.
2) Primary Water Test Data: Include design and actual values for the following:
a) Entering-water temperature in deg F (deg C).
b) Leaving-water temperature in deg F (deg C).
c) Entering-water pressure in feet of head or psig (kPa).
d) Water pressure differential in feet of head or psig (kPa).
e) Water flow rate in gpm (L/s).
3) Secondary Water Test Data: Include design and actual values for the following:
a) Entering-water temperature in deg F (deg C).
b) Leaving-water temperature in deg F (deg C).
c) Entering-water pressure in feet of head or psig (kPa).
d) Water pressure differential in feet of head or psig (kPa).
e) Water flow rate in gpm (L/s).

L) Pump Test Reports: For pumps, include the following data.
1) Calculated impeller size (by plotting the shutoff head on pump curves).
2) Unit Data: Include the following:
a) Unit identification.
b) Location.
c) Service.
d) Make and size.
e) Model and serial numbers.
f) Water flow rate in gpm (L/s).
g) Water pressure differential in feet of head or psig (kPa).
h) Required net positive suction head in feet of head or psig (kPa).
i) Pump rpm.
j) Impeller diameter in inches (mm).
k) Motor make and frame size.
l) Motor horsepower and rpm.
m) Voltage at each connection.
n) Amperage for each phase.
o) Full-load amperage and service factor.
p) Seal type.
3) Test Data: Include design and actual values for the following:
a) Static head in feet of head or psig (kPa).
b) Pump shutoff pressure in feet of head or psig (kPa).
c) Actual impeller size in inches (mm).
d) Full-open flow rate in gpm (L/s).

e) Full-open pressure in feet of head or psig (kPa).
f) Final discharge pressure in feet of head or psig (kPa).
g) Final suction pressure in feet of head or psig (kPa).
h) Final total pressure in feet of head or psig (kPa).
i) Final water flow rate in gpm (L/s).
j) Voltage at each connection.
k) 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.

END OF SECTION

SECTION 16000 - ELECTRICAL

PART 1 – GENERAL

1.1 REFERENCE TO GENERAL CONDITIONS

A. The General and Supplementary Conditions and related documents as well as the provisions of Division One, shall be considered as forming a part of the specifications and shall be carefully examined before proposals for any work are submitted. Unless the specifications contain statements which are not more definitive or more restrictive than those contained in the General or Supplementary Conditions, the specifications shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

B. The Electrical Contractor shall comply with the 2009 Edition of the International Building Code, "Seismic Restraints for Electrical Systems" and shall comply with all requirements of this section and any local or county requirements (where applicable).

C. The Electrical Contractor shall strictly adhere to the project phasing schedule. The Electrical Contractor shall refer to the general conditions for the project phasing requirements.

1.2 SCOPE OF WORK

A. The scope of work shall consist of all labor, materials, equipment, and services required to complete all work indicated on the drawings and in these specifications. The work shall include, but shall not be limited to, the following:

1. Modifications to the existing secondary distribution system for the building including: over current and switching devices, panelboards, motor starters and controllers, feeders, cables, wiring, raceways, and all other components required for a complete secondary distribution system for the building.

2. Modifications to the existing lighting system (indoor, normal, emergency and exit) including all fixtures, lamps, mounting accessories, switches, outlet, wiring, raceways and all other components and fittings required for a complete lighting system.

3. Lighting control systems including: Time switches, lighting contactors, occupancy sensors, auxiliary relays, wiring, raceways and all other devices required.

4. Grounding and bonding of the electrical systems and equipment.

5. Modifications to the conventional fire alarm systems complete with all devices and wiring.

6. Wiring devices (switches and receptacles) complete with associated wall plates.

7. Power wiring to all HVAC, Plumbing, Fire Protection, and miscellaneous equipment.

8. Testing of all electrical systems.

9. Equipment supports and fastenings.

10. Branch circuit wiring including all boxes, fittings and devices.

11. Temporary power and lighting for construction period.

12. Seismic restraints for electrical systems

13. All other systems hereinafter specified or indicated on the Contract Drawings, complete, leaving ready and electrical system in perfect operating condition.

14. The foregoing is intended merely as a general description of the electrical systems and requirements and does not outline the work required by these Specifications and Contract Drawings. Moreover, the Specifications and Contract Drawings require the furnishing ad installing of certain equipment and apparatus and the performance of certain work which forms no part of the aforementioned systems and requirements.

1.3 RELATED WORK IN OTHER SECTIONS

A. The following equipment items and work shall be the responsibility of others:

1. Motorized dampers shall be furnished and installed by other, but shall be wired by the Electrical Contractor.

2. Low voltage temperature control and interlock wiring for HVAC equipment shall be provided by the HVAC Contractor.

1.4 CODES, PERMITS AND INSPECTIONS

A. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over electrical construction work and the project.

B. All required permits, fees and inspection certificates shall be obtained, paid for, and made available at the completion of the work. The Electrical Contractor shall give all required notices, pay all governmental taxes, and obtain all approvals as necessary to complete the electrical portion of the work.

C. All electrical work shall be governed by the National Electric Code, 2011 Edition, and other applicable sections of the National Fire Code, as published by the National Fire Protection Association, 60 Batterymarch Park, Quincy, Massachusetts 02269.

D. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA) and the Americans with Disabilities Act (ADA).

E. The Electrical Contractor shall be licensed to perform work in the State of New Hampshire and the City of Portsmouth.

1.5 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from defects. Any defective materials or workmanship, as well as damage to the work of all trades resulting from same, shall be replaced or repaired as directed for the duration of the stipulated guarantee periods.

B. The duration of the guarantee period shall be one year following the date of acceptance of the work or the date of issuance of the occupancy permit.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Non-durable items, such as electric lamps, shall be replaced up to the date of acceptance by the Electrical Contractor.

E. If during that period of general guaranty, any part of the work fails, becomes unsatisfactory, or does not function properly due to any fault in material or workmanship, whether or not manufactured or job built, the Electrical Contractor shall upon notice from the Architect promptly proceed to repair or replace such faulty material or workmanship without expense to the Owner including repair or restoration of any damaged sections of the premises resulting from such faults.

F. In the event that a repetition of any one defect occurs indicating a probability of further failure and which can be traced to faulty design, material, or workmanship, then repair or

replacement shall not continue to be made but the fault shall be remedied by a complete replacement of the entire defective unit.

1.6 SHOP DRAWINGS AND OTHER INFORMATION REQUIRED

A. Prior to purchasing any equipment or materials, a list of their manufacturers and shop drawings of all electrical equipment shall be submitted the Architect for approval.

B. Prior to assembling or installing the work, (6) copies of shop drawings for each item or system listed under section 1.2 (Scope of Work) shall be submitted for approval.

C. Documents will not be accepted for approval unless:

1. They comply with the requirements of the General Conditions.

2. One original brochure and six (6) copies of each are submitted.

3. They include complete information pertaining to appurtenances and accessories.

4. They are submitted as a package where they pertain to related items.

5. They are properly marked with service or function identification as related to the project, where they consist of catalog sheets displaying other items which are not applicable.

6. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

7. They are submitted within 14 days of the signing of the electrical construction contract.

D. Shop drawings submittals processed by the Engineer are not Contract Documents and are not Change Orders; the purpose of the shop drawing review is to establish a reporting procedure and is intended for the Contractor’s convenience in organizing his work. If deviations, discrepancies or conflicts between shop drawing submittals and the Contract Documents are discovered either prior to or after the shop drawing submittals are processed by the Engineer, the Contractor agrees that the Contact Documents shall control and be followed. Submission of Shop Drawings or commencement of the construction work implies that trade coordination has taken place. Thereafter, any costs for modifications to equipment or systems due to interferences shall be borne by the contractors.

1.7 SAMPLES

A. In the case of substitutions of specified electrical equipment during the shop drawing phase, the Electrical Contractor, upon request, shall provide the Architect with a sample of the substituted equipment for their review.

1.8 SUBSTITUTION OF SPECIFIED EQUIPMENT

A. In general, substitution of specified electrical equipment will be discouraged. If the Electrical Contractor wishes to substitute specified equipment with units of equal or superior performance characteristics and aesthetic abilities then the Electrical Contractor must first provide the following:

1. Complete shop drawings of said equipment as described and required hereinafter in Section 1.06 “Shop Drawings and Other Information Required”.

2. Indicate a dollar amount that the Electrical Contractor intends to credit back to the owner for utilizing said substituted equipment.

3. Upon request, furnish samples of substituted equipment as hereinafter required by Section 1.07 “Samples”.

B. Any proposed substitution of equipment must be submitted to the Architect no later than fourteen (14) days from the signing of Electrical Section of the Construction Contract. If the Architect has not received the Electrical Contractor’s shop drawing submittals for substituted equipment in the steps outlined above within the fourteen day period, then the Electrical Contractor must provide all equipment as specified in the contract documents. The Architect and their Consultants retain the right to reject any and all substituted equipment.

1.9 RECORD DRAWINGS

A. As part of the required electric work, a complete set of reproducible “as built” or record electrical drawings shall be made up as the job progresses and delivered to the Architect at the conclusion of the work or within 30 days of occupancy permit issue.

B. The drawings shall show:

1. All electric work installed exactly in accordance with the original design.

2. All electric work installed as a modification or addition to the original design.

3. The dimensional information necessary to delineate the exact location of all circuitry and wiring runs (other than lighting an appliance branch circuitry and small control, signal, and communications circuitry runs) which are so buried or

concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

4. The numbering information necessary to correlate all electrical energy consuming items (or outlets for same) to the panel or switchboard circuits from which they are supplied.

C. The drawings shall be prepared on AutoCAD version 2008 and submitted on disk in a DWG format and on one set of reproducible vellums.

D. The design tracings will be made available for copying into reproducibles should it be determined that such reproducibles would serve as suitable backgrounds for the "as-built" drawings. The quantity of design tracings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as built" information.

1.10 INTERPRETATION OF THE DRAWINGS AND SPECIFICATIONS

A. As used in the drawings and specifications for electrical work, certain non-technical works shall be understood to have specific meanings as follows regardless of indications to the contrary in the general conditions or other documents governing the electrical work.

"Furnish"	Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the electrical work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims or encumbrances.
"Install"	Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the electrical work.
"Provide"	"Furnish" and "Install".
"New"	Manufactured within the past two years and never before used.

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any electrical item in the drawings or specifications for electrical work carries with it the instruction to furnish, install and connect the item as part of the electrical work, regardless of whether or not this instruction is explicitly stated.

C. It shall be understood that the specifications and drawings for electrical work are complimentary and are to be taken together for a complete interpretation of the electrical

work except that indications on the drawings, which refer to an individual element of work, take precedence over the specifications where they conflict with same.

D. To the extent that they govern the basic work the specifications also govern change order work.

E. No exclusion from, or limitation in, the symbolism used on the drawings for electrical work or the language used in the specifications for electrical work shall be interpreted as a reason for omitting the appurtenances or accessories necessary to complete any required system or item of equipment.

F. The use of works in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

G. Ratings of devices, materials and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.

H. The electrical work shall be coordinated with all drawings which are part of the General Contract, which form a part of these specifications and contract drawings.

1.11 EQUIPMENT AND MATERIALS

A. All equipment and materials for permanent installation shall be the products of recognized manufactures, be UL listed, and shall be new (manufactured within the last six months).

B. Equipment and materials shall:

1. Where normally subject to Underwriters Laboratory Inc. listing or labeling services, be so listed or labeled.

2. Be without blemish or defect.

3. Not be used for temporary light or power purposes.

4. Be in accordance with the lastest applicable NEMA standards.

5. Be products which will meet with the acceptance of all authorities having jurisdiction over the work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or other recognized testing laboratory, the product shall be so examined, tested and certified.

6. Be on the jobsite as required by the construction schedule, and at least four weeks prior to the building opening.

C. Except for conduit, conduit fittings, outlets boxes, wire and cable, all items of equipment or material of one generic type shall be the product of one manufacturer throughout.

D. Items which are to be installed but not purchased as part of the electric work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electrical work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The electric work includes all items for which no claims have been submitted as outlined above.

1.12 TECHNICAL DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words as used in the drawings or specifications for the electrical work, shall be understood to have the specific meanings ascribed to them in the following list:

"Circuitry"	Any electrical work which consists of wires, cables, raceways, and/or specialty wiring method assemblies taken all together complete with associated junction boxes, pull boxes, outlet boxes joints, couplings, splices and connections except where limited to a lesser meaning by specific description.
"Wiring"	Same as Circuitry
"Circuit"	Any specific run of ciruitry.
"Branch Circuitry"	Any light and power distribution system circuit which, at it's load end, is directly connected to none or more electrical energy consuming items with no overcurrent protection devices interposed, other than (where required) those protecting the energy consuming items from overloading or overheating.
"Feeder"	Any item of circuitry used in distribution system which is not branch circuitry.
"Distribution Panel"	Any panel, used in a distribution system, containing only multi-pole branches and with all (or the majority) of its branches used for feeders supplying other panels.
"Power Panel"	Same as distribution panel, except with all (or the majority) of its branches used for feeders which do not supply other panels.

"Building Confines"	The extent of a building, as defined by the outside surfaces of its peripheral walls, the top surface of its roof, and the underside surface of its grade slab.
"Distribution Switch"	Any switch used in a light and power system other than a tumbler, toggle, or specialty switch in the "Wiring device" category.
"Underground"	Subsurface and exterior to building foundations.
"Raceways"	Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) which is used to contain wires, and which is of such nature as to require that the wires be installed by a "pulling-in" procedure.
"Concealed"	(As applied to circuitry)—Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.
"Exposed"	(As applied to circuitry)—Not covered in any way by building materials.
"Primary"	Over 600 Volts.
"Secondary"	Under 600 Volts.
"Assembly"	A defined set of elements of electric work.

B. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".

1.13 MOUNTING HEIGHTS

A. Mounting heights of all items shall be as directed by the Architect, or as indicated on the Contract Drawings.

1.14 SERVICE CHARACTERISTICS

A. Secondary Level – 120/208 volts, 3 phase, 4 wire, 60 hertz.

B. All electrical work shall meet with the approval of the utility company and the local wiring inspector.

C. All equipment and wiring shall be suitable for the applied voltage.

1.15 INSPECTION OF SITE

A. Prospective electrical bidders will be permitted to inspect the site prior to the closing of the bidding period so that the bidders may ascertain the scope of work and prevailing conditions. Failure to inspect existing conditions or to fully understand the work which is required shall not excuse the Electrical Contractor from his/her obligation to provide the work in accordance with the specification and the drawings and under all site conditions as they exist.

1.16 TEMPORARY LIGHT AND POWER

A. Utilize the existing a 120/280 volt 3 phase, 4 wire electrical distribution system as a temporary service to the building and pay all expenses related thereto. Provide any equipment that may be required, including, secondary feeders and panelboards.

B. Temporary light shall be based on one 200 watt incandescent lamp with plastic guard lamp covering each 500 square feet of floor area in the building. Each room 100 square feet and over shall have minimum of one 100 watt lamp. No provisions are to be made for electric welders.

C. Provide outlets located at convenient points so the extension cord of not over 50’ will reach all work requiring artificial light power. Provide ground fault protection on all receptacle circuits.

D. Contractors of all other trade shall furnish their own cords and sockets, as may be required for their work and shall also pay for cost of all temporary wiring of construction offices and shanties used by them.

E. The General Contractor shall pay for the cost of energy consumed by all the trades. Any temporary wiring of a special nature for light and power required on building other than mentioned above shall be paid for by the contractor using same. The Electrical Contractor shall pay for the cost of lamp replacement and shall maintain lamps.

F. All temporary wiring shall be maintained in a workmanlike manner throughout the entire construction period and shall be removed when permanent power is operational.

1.17 CUTTING AND PATCHING

A. Sleeves, inserts, anchor bolts and similar items set into the masonry structure or the work of other trades shall be furnished and installed by the Electrical Contractor. The Electrical Contractor shall be responsible for all such items necessary to hang or support his equipment.

B. The Electrical Contractor shall do all drilling and cutting of small holes in walls and floors as required for sleeves and supports with the approval of the General Contractor. The General Contractor shall be responsible for all floor openings, shafts, etc. larger than 4" in diameter. If the Electrical Contractor fails to give proper notice to the General Contractor of his/her requirements for sleeves, openings or chases than all costs for cutting and patching for said work shall be borne by the Electrical Contractor.

1.18 ACCESSIBILITY

A. All work shall be installed so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the General Contractor.

1.19 UNIT PRICES

A. The Electrical Contractor shall include, as part of the contract bid, a schedule of unit prices for each wiring device, light fixture, circuit breaker, fire alarm device, etc. to be used on this project. Submit unit prices in accordance with Division One requirements.

1.20 DEMOLITION

A. Unless otherwise noted on the floor plans, the Electrical Contractor shall be responsible for the disconnection of all existing electrical equipment, devices and circuitry in the renovated areas of the building. The Demolition Contractor shall be responsible for removing all electrical equipment, devices and circuitry after the Electrical Contractor electrically disconnects the existing equipment. Carefully review with the Architect and the General Contractor all electrical devices, fixtures, equipment and wiring which is noted as to be reused or relocated before commencing demolition.

B. The Electrical Contractor shall turn over all existing fluorescent ballasts and lamps (from light fixtures removed during the renovation) that contain PCB's or hazardous materials to the General Contractor for proper disposal. The General Contractor shall provide the Architect with a copy of the manifest records to verify that ballasts and lamps were disposed in accordance with all hazardous waste regulations.

C. The Electrical Contractor shall perform "Make Safe" demolition as required by the construction schedule prepared by the General Contractor. The Electrical Contractor shall perform all temporary electrical work to keep lighting systems functioning as required by the General Contractor during the renovation process. The Electrical Contractor shall be present on site as needed to make sure that the Demolition Contractor does not destroy, remove or cannibalize any electrical equipment, feeders, raceways, etc that are scheduled or intended to remain.

PART 2 – PRODUCTS

2.1 WIRING MATERIALS

A. Utilize wiring methods selected in accordance with the following list.

Wiring Method	Application (subject to restrictions hereinafter)
Schedule 40 Rigid Non Metallic PVC Electrical Conduit With wires pulled in	Feeder and branch circuits buried under floor slabs (within the building confines), site lighting and exterior underground raceways.
3/4 inch minimum steel electric metallic tubing with wires pulled in.	Main and branch feeders, branch circuitry and low tension system(s) wiring.
Metal clad cable type MC with Insulated ground conductor and A metal sheath rated for a redundant ground path	Interior branch circuitry concealed within stud walls and above suspended acoustical tile or gypboard ceilings only.
Hospital grade armor clad cable With insulated ground conductor (HCF-90)	All insulated/isolated ground receptacle circuitry

B. Branch circuitry shall not be buried in building floor slabs (except where necessary to feed fixed equipment) – Branch circuitry shall run overhead. Panelboard feeders may be run under floor slabs in approved raceways.

C. Wires shall be copper with 600V insulation, THWN for branch circuitry and XHHW for feeders. Manufactured cable systems shall be rated for 90 ^{o}C insulation temperature.

D. Conductors shall be of soft drawn 98% minimum conductivity properly refined copper, solid construction where No. 10 AWG and smaller, stranded construction where No. 8 AWG and larger.

E. Exterior of wires shall bear repetitive markings along their entire length indicating conductor size, insulation type and voltage rating.

F. Exterior of wires shall be color coded, so as to indicate all clear differentiation between each phase and between each phase and neutral. In all cases, grounded neutral wires and cables shall be identified by the colors white or gray. In sizes and insulation types where factory applied colors are not available, wires and cables shall be color coded by the

application of colored plastic tapes in overlapping turns al tall terminal points, and in all boxes in which splices are made. Colored tape shall be applied for a distance of 6 inches along the wires and cables, or along their entire extensions beyond raceways ends, whichever is less.

G. Final connections to motors shall be made with 18" of neoprene sheathed flexible conduit with insulated grounding conductor.

H. All exposed area fixture cord or cable drops shall have an outer PVC insulated jacketed assembly factory painted white, with no visible markings.

I. Minimum conductor size shall be No. 12 AWG unless noted otherwise on plans.

J. Fire alarm system wiring shall be a shielded low energy cable run in conduit or metallic sheathed cable assembly (type MC) or other Nashua Fire Department approved method. Minimum conductor size shall be #16 AWG.

K. Other wires and cables required for the various systems described elsewhere in this section of the Specifications shall be a specified herein, or as recommended by the manufacturer of the specific equipment for which they are used.

L. Wiring materials shall be manufactured by Triangle, Republic, Anaconda or General Cable.

2.2 OUTLET, JUNCTION, PULL BOXES, AND WIRING TROUGHS FOR ALL SYSTEMS

A. The Electrical Contractor shall provide outlet, junction, and pull boxes at all locations where they are required to facilitate the pulling, supporting or connecting of wires and cables. All boxes shall be steel.

B. Outlet boxes for mounting light fixtures or equipment shall be rated for the weight of the equipment supported.

C. Outlet and outlet size boxes shall be steel or metal.

2.3 OVERCURRENT PROTECTION AND SWITCHING DEVICES FOR POWER DISTRIBUTION

A. Select overcurrent protection and switching devices as follows:

Category of Application Types	Acceptable Device (See Legend Below)
Feeder unit in main distribution panel	CB-SMC

Main and branch units in distribution and power panels (800A and over)	CB-SMC
Main and branch units in distribution and power panels (under 800A)	CB-SMC
Branch and main units in lighting and appliance panels	CB-SMC
Individually mounted devices	SW-QMQB/CLCF or CB-SMC
Individually mounted unit without overcurrent protection	SW-QMQB
Fusing from combination motor starter	CLCF

B. Legend

SW-BP	Distribution switch; bolted Pressure type.
SW-QMQB	Distribution switch; quick-make, quick-break type.
/	Fusible – fused with.
CLCF	Current limiting cartridge fuses.
CB-SMC	Circuit breaker; standard molded case type.
CB-FAF	Circuit breaker; fixed airframe type.

C. Devices shall have voltage and interrupting capacity ratings suitable for the supply characteristics to which they are applied.

2.4 DISTRIBUTION SWITCHES

A. Quick-make, quick-break, type distribution switches shall equal or exceed the performance required for NEMA type heavy duty (general duty where 60A or less) horsepower rated switches.

1. They shall have arc quenchers and circuit breaker type pressure contacts

2. Where of the fusible type, they shall be designed for use with “Class R” fuses up to 600 amps. They shall be equipped with fuse rejection clips to disallow installation of fuses not rated for switch interrupting capacity rating.

B. Distribution switches shall be as manufactured by Siemens, Square D or General Electric with no exceptions.

2.5 PANELBOARDS AND DISTRIBUTION PANELBOARDS

A. Panelboards shall consist of factory completed deadfront assemblies of back pans, main busses, overcurrent and switching units, sheet metal cabinets and trims. They shall be so designed that switching and overcurrent devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machining, drilling or tapping.

B. All panelboards shall have a circuit directory card mounted in a frame with plastic cover installed on the inside of the door. All directory cards shall be properly filled in, using a typewriter, and indicating areas and devices served by each circuit.

C. Bus bars for their mains shall be of copper having current capacities as indicated and sized for such capacities in accordance with Underwriter Laboratory standards. Unless otherwise noted, full size neutral bars shall be included. Bus bar taps for panels with single pole branches shall be for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Neutral bussing shall have suitable lues for each outgoing feeder requiring a neutral connection.

D. A ground bus shall be provided for each panel. Each ground bus shall be of the same material as the phase and neutral buses.

E. Their cabinets shall be fabricated from industry standard gauge galvanized sheet steel with corners lapped and riveted, or fastened by approved methods.

F. The inside and outside of their trims shall be factory painted with one rustproofing primer coat and one finish coat. The finish paint shall be of a type to which field applied paint will adhere.

G. Their cabinets and trims shall be suitable for the required mounting trims shall be screw fastened to cabinets and shall be of a type that is self-supporting on cabinets after screws have been removed. Trims for flush panels shall overlap cabinets by at least ½” all around.

H. Cabinets and trims for lighting and appliance panels shall accommodate and conform to the following limiting dimensions:

1. Minimum wiring gutter width on each side – 5-3/4”
2. Maximum overall width – 24”
3. Maximum overall depth – 6”

I. Where wires or cables are used within panelboards to make-up internal connections (factory installed or otherwise) such wire or cable shall have copper conductors only.

J. Any cabinet for power or distribution panel shall (regardless of the actual devices required to be in it) have a width and a depth adequate for a three pole branch device equal to 50% of the rating of the panel mains.

K. Where indicated or as required to assure ready accessibility of top switching and overcurrent device, they shall be arranged as multiple adjacent sections. A single overall cabinet shall be supplied for the multiple adjacent sections which constitute one panel. ¼” minimum thickness plastic barriers having adequate angle iron framing such as to include wiring gutter space for each section as if it were an individual panelboard. Common bussing shall be arranged for adjacent sections unless there is indication that the individual sections are to be separately supplied. Sub-feed lugs with full capacity cables taps to adjacent panel sections will be accepted as the bussing method.

L. Hinged doors covering all switching device handles shall be included in all panel trims.

M. Doors in panelboard trim shall conform to the following:

1. In making switching device handles accessible, doors shall not uncover any live parts.

2. Doors shall have flush type paracentric cylinder locks and catches, except that doors over 48” in height shall have a vault handle and a 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Two keys shall be supplied for each lock and each key shall open all panelboards. Locks and keys shall conform to a “standard keying policy” as directed.

N. Where “spaces only” for overcurrent protection and switching devices are called for in a panel, its main bus, and backpan, as well as its cabinet and trim, shall be extended to accommodate these spaces.

O. Panelboards shall comply with the following industry standards.

1. UL Standards

a. Panelboards – UL 67

b. Cabinet & Boxes – UL 50

P. Flush mounted panels shall be provided with 1-1" empty conduit terminating in a pull box above the ceiling. If ceiling is constructed of drywall; providing and access panel. Access panel locations shall be approved by the General Contractor.

Q. Panelboards shall be located on full height walls only.

R. Panelboards shall be as manufactured by General Electric, Siemens or Square D with no exceptions.

2.6 WIRING DEVICES

A. Provide wiring device type plates for all wall mounted devices. All wiring devices shall be white in color. Verify with Architect before ordering. All telephone and CATV outlet finishes shall match the outlet/switch colors in that area.

B. Wiring device switches shall be toggle type AC quiet design, specification grade, with trim rings, 20 amps on 120V or 277V circuits. Switches shall be mounted 48" to centerline A.F.F. unless noted otherwise switches shall be installed with "off" position down.

C. Standard duplex convenience receptacles shall be 125 volt, 20 amps, three wire (two circuit wire plus grounds), "U-bar" ground NEMA slot configuration 5-20R, specifications grade. Receptacle heights shall be 18" to centerline A.F.F. unless noted otherwise. 15A rated receptacles may be utilized for residential general purpose outlets

D. Receptacles designated as ground fault circuit interrupters shall be feed through type with LED indicators.

E. Where more than one wiring device is indicated in the same location, the devices shall be mounted in gangs under a common wallplate.

F. Wallplates to be white. Verify with Architect before ordering.

G. The height of all devices shall be verified with the Architect.

H. All telephone and CATV outlet finishes shall match the switch and/or receptacle finishes in that area.

I. All device boxes shall have appropriate support "Caddy Clips" to properly secure boxes to stud walls.

J. Wiring devices shall be as manufactured by Leviton, Bryant or Hubbell.

2.7 LIGHTING FIXTURES

A. Lighting fixtures shall be in accordance with identification on the drawings and as hereinafter specified.

B. Finishes shall be as selected by the Architect or as indicated in the light fixture schedule.

C. Any additional appurtenances required for installation and operation, where same are not covered by the identification used on the drawings, shall be included. Include the aiming and/or adjustment of all lighting fixtures, requiring same, in accordance with instruction issued by the field architect.

D. Any additional appurtenances required for installation and operation, where same are not covered by the identification used on the drawings, shall be included. Include the aiming and/or adjustment of all lighting fixtures, requiring same, in accordance with instruction issued by the field architect.

E. Recessed fixtures throughout shall have their components, wiring and external connections coordinated for use in ceilings utilized as air handling plenums.

F. Fixtures for use outdoors or in areas designated as damp locations, shall be suitably gasketed.

G. All ballasts or transformers for discharge type lamps shall be for 60 cycles operation.

H. All ballasts or transformers for discharge or fluorescent type lamps shall be high power factor, full light output, electronic type. Provide individual fusing for ballasts where required by local wiring inspector.

I. Ballasts for fluorescent lamps shall be industry standard protected type “P”.

J. All ballasts or transformers for discharge type lamps intended for use outdoors shall be of the low temperature type having the lowest temperature rating available in standard manufacture.

K. All ballasts or transformers shall be of the low energy full light output type where available. Each shall not exceed industry minimum rated input wattage by more than 8%.

L. All lamps shall be included as listed in the light fixture schedule.

M. All lamps shall be of the type and manufacturer specified in the light fixture schedule with NO substitutions.

N. The contractor shall obtain all information relative to the exact type of hung ceilings and suspension systems to be installed before ordering any recessed fixtures. This Contractor

shall furnish the proper type fixtures applicable to the ceiling framing system. If, other than the type of fixtures specified are required for installation due to the type of ceiling construction, the Contractor shall furnish and install the proper type fixtures and mounting appurtenances required at no extra charge to the owner or others.

O. The Contractor shall coordinate the exact locations of all lighting fixtures with the ceiling pattern during the Construction Period and before installation of the fixtures. Interferences between lighting fixtures, and other equipment, shall be brought to the attention of the Construction Manager.

2.8 MOTOR CONTROLS

A. For Equipment in Mechanical Systems: In conjunction with the equipment which occurs in mechanical systems, included in the electrical work will be:

1. The furnishing and installing of motor starters where required.

2. The furnishing and installing of motor power circuitry up to motor terminals with connection to same.

3. The furnishing and installing of required line disconnect means.

4. The line fusing of all fusible combination starters.

5. The furnishing and installing of HVAC and plumbing line voltage circuitry control.

B. Motor Starters

1. The starter for each motor shall be suitable for the motors, and shall be equipped with all features and appurtenances required for proper operation.
2. Each motor starter shall be equipped with a NEMA Class I enclosure installed indoors unless otherwise noted.

3. Each motor starter installed outdoors, or in areas within the building confines designated as damp or wet locations shall be equipped with a NEMA Class 3R weatherproof enclosure.

4. Each phase magnetic or manual starter shall be equipped with an operating pole in each phase.

5. Magnetic starters of the combination type shall be equipped with a disconnect pole in each phase.

6. Manual starters of the combination type shall be equipped with a disconnect pole in each phase.

7. Magnetic starters of the combination fusible switch type where indicated shall have fuse gaps sized for time delay type fusing (RK-5).

8. Each motor starter shall be equipped with manual reset running overcurrent relay for each pole rated not in excess of the nameplate current of the associated motor.

9. Each magnetic starter shall have the holding coil and any other required control relay coils suitable for line-to-line operation-where starter is NEMA size 1 or larger; it shall be equipped with line voltage to low voltage control transformers tapped off the power circuit line. Control voltage shall be 120V AC or 25V DC as required by Mechanical Contractor.

10. Each magnetic starter NEMA Size 2 and larger, shall be equipped with an auxiliary control circuit relay arranged to permit the actuation of the strter without introducing holding coil currents into the external control circuit.

11. Covers of combination starters shall be suitably hinged and interlocked with the handle of the disconnect means to prevent opening when the handle is in closed.

12. Each combination type motor shall be equipped with approved padlock and key and a means for padlocking its manual line disconnect in the open position.

13. Each motor starter shall be equipped with an engraved lamacoid nameplate permanently screw fastened on the outside of the starters cover – the nameplate shall show ¼" high white lettering on a black background identifying the motor controlled.

14. The electrical contractor shall provide for each magnetic starter all auxiliary contacts required for interlocking or control purposes.

15. Motor starters for motor rated 3 Hp and over system shall be provided on "ON" time relays arranged to energize the holding coils after an adjustable range of 0.05 to 180 seconds.

16. Motor starters for motors rated 25 Hp and over shall be reduced voltage type.

17. Motor starters which are not part of packaged equipment shall be by one manufacturer throughout the project.

18. Motor starters shall be as manufactured by Cutler-Hammer, Westinghouse, Square D, General Electric, or other approved.

C. Motor Control Actuating Devices

1. All manual motor control actuating devices indicated as being required in starter covers shall be delivered so mounted to the project.

2. All motor control actuating devices indicated as not being in the starter covers shall be delivered to the site housed in NEMA Class I General Purpose Enclosures, except that where intended for use in exterior locations, they shall be housed in NEMA 3R Enclosures-where two or more motor control actuating devices are to be installed separately from a motor starter, but at a single location, such devices shall be delivered to the site ganged together in a single enclosure.

3. All motor control actuating devices shall have contacts rated at least 10 amperes at 250 volts regardless of the actual duty they are required to perform.

4. Pushbuttons shall be of the normal duty spring return momentary type.

5. Selector switches shall be of the normal duty maintained contact type.

6. Pilot lights shall be neon tube type with candelabra base and clear glass.

7. Pushbuttons shall be equipped with nameplates indicating their functions as noted in the list of electric motors and motor controls.

8. Selector switches shall be equipped with nameplates indicating the function as noted in the list of their positions as noted in the list of electric motors and motor controls.

9. Pilot lights shall be equipped with nameplates indicating the operating condition they annunciate as noted in the list of electric motors and motor controls.

10. Devices such as pushbuttons, pilot lights and selector switches, where mounted in enclosures other than the cover of the starter, shall be equipped with nameplates indicating the motor with which they are associated.

11. “Hand-Off-Remote” type selector switches in starter covers shall be of the key operated cylinder lock type, arranged for locking in the “remote” position with the key removable in this position only- All switches shall be keyed alike.

D. Motor Control Circuitry

1. Except as noted below, select materials exactly as specified for feeders. Utilize No. 12 A.W.G. THWN conductors throughout,; except in conjunction with a manual starter utilize conductors equal in size to those in the power circuit.

2. Motor control circuit wires may be run in the same conduit as the wires of motor power circuits; however, exclude motor control wires from enclosures (other than motor starter enclosures) which contain power circuit overcurrent protection and switching devices; also from pull boxes and junction boxes containing the wires of main the submain feeders. Utilizes auxiliary pull boxes to separate motor control wires from motor power circuit wires before the power circuit wires enter the items from which motor control wires are excluded.

2.9 GROUNDING REQUIREMENTS

A. Ground all systems and equipment in accordance with best industry practice, ANSI/NFPA 70 and current industry standards.

B. Provide grounding bonds between all metallic conduits of the light and power system which enter and leave cable chambers or other non-metallic cable pulling and splicing boxes. Accomplish this by equipping the conduits with bushings of the grounding type individually cross connected.

C. Bond metallic conduits containing grounding electrode conductors and main bonding conductors to the ground bus service enclosure and/or grounding electrode at both ends of each run utilizing grounding bushings and jumpers.

D. Provide grounding bonds for all metallic conduits of the light and power system which terminate in pits below equipment for which a ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually to the ground bus.

E. Provide supplementary ground bondings where metallic conduits terminate at metal clad equipment (or at the metal pull box equipment) for which ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually by means of jumpers to the ground bus. Exclude the jumpers where directed. This exclusion will be required where an isolated ground for electronic equipment is to be maintained.

F. Each grounding type bushing shall have the maximum ground wire accommodation available in standard manufacture for the particular conduit size. Connection to bushing shall be with of this maximum size.

G. Bonding conductors on the load size of the service device and equipment grounding conductors shall be sized in relation to the fuses or trip size for the overcurrent device supplying the circuit.

H. Connections of ground wires shall be in accordance with the following:

LOCATION	GROUND WIRE

	CONNECTION
Junction box at which non-metallic Conduits terminate	Metal body of junction Box
Equipment grounding conductor In branch circuits and feeders	Panelboard, distribution panelboard or Switchboard bus from which branch circuit or feeder originates.

I. A properly sized equipment grounding conductor shall be run with all circuits installed in PVC, EMT or rigid steel raceways, and in all premanufactured wiring or cabling systems.

2.10 CARTRIDGE FUSES

A. Cartridge fuses shall be as follows:

1. Regardless of actual fault current, they shall, at full recovery voltage, be capable of safely interrupting fault currents of 200,000 amperes RMS symmetrical or 340,000 amperes RMS asymmetrical, deliverable at the line side of the fuses.

2. They shall be of the dual element, current limiting, time delay type, having average melting time characteristics to meet Underwriters Laboratories requirements for “Class RK-5” fuses where 600 amperes or less, Class “L” for 601 amperes and greater.

3. They shall be suitable for application to fuse gaps which reject other types of fusing.

4. Supply 10 percent spare fuses of each size and type 60 amps and less. Supply three spare fuses for each size and type over 60 amps.

B. Cartridge fuses shall be manufactured by Buss or Shawmut.

2.12 MOLDED CASE CIRCUIT BREAKERS

A. Molded case type circuit breakers shall consist of manually operated quick-make quick-break mechanically trip free operating mechanisms for simultaneous operation of all poles, with contacts, arc interrupters and trip elements for each pole, all enclosed in molded phenolic plastic cases.

1. Their tripping units shall be of the “thermal magnetic” type having bimetallic elements for time delay overload protections and magnetic elements for short circuit protection.

2. They shall be manually operable by means of toggle type operating handles having “tripped” position midway between the “on-off” position.

3. They shall each be contained in an individual case enclosing only the number of poles required for the particular breaker.

4. Their interrupting rating shall not be less than as indicated in the panelboard schedules on the drawings.

5. They shall be of the “bolted-in” type.

6. Where necessary, to accommodate other requirements, their frame sizes shall be increased to conform to such requirements.

7. They shall have non-interchangeable trips.

8. Where single pole in trip sizes 20 amps or less, they shall be rated for switching duty.

9. They shall be equipped with 5 milliamp sensitivity ground fault interrupting features where so indicated.

10. Where used as the service disconnecting means, they shall be 100% rated.

2.12 FIRE ALARM SYSTEM

A. Modify the existing fire alarm system as specified herein and indicated on the drawings.

B. All fire alarm system equipment shall be labeled with the manufacturer’s name and logotype to assure the integrity of the complete system. “Hybridized” systems (systems containing equipment from several different manufacturers) shall not be accepted. All components of each system, including signal and initiating devices, shall be of the addressable type.

C. All equipment shall be listed as power limited by Underwriters Laboratories Inc. approved by Factory Mutual Research or as accepted by the authority having jurisdiction. Each fire alarm system in its entirety shall be in compliance with all applicable state and local fire and electrical codes and comply with the requirements of the Portsmouth Fire Department fire protection regulations. The system shall also comply with Americans with Disabilities Act (ADA) Requirements. Accessory components as required shall be cataloged by manufacturer and UL listed to operate with the manufacturer’s control panel.

D. The system shall be wired as a class A (four wire) system throughout including signal initiating and audible circuits.

E. The fire alarm system shall comply with the applicable provisions of the following current National Fire Protection Association (NFPA) standards:

1. NFPA 71, Installation, Maintenance, and Use of Signaling Systems for Central Station Service.
2. NFPA 72, Installation, Maintenance, and Use of Protective Signaling systems.
3. NFPA 90A, Installation of Air Conditioning and Ventilating Systems
4. NFPA 101, Life Safety Code.

F. All wire and cable shall be UL listed and a minimum of 18 AWG as required by local codes and authority having jurisdiction. The minimum wire size for AC power supply connections shall be #12 AWG. Raceways containing conductors identified as "FIRE PROTECTIVE ALARM SYSTEMS" conductors shall not contain any other conductors and no AC current carrying conductors shall be allowed in the same raceway with the fire alarm detection and signaling conductors.

G. Manual fire boxes shall be non-coded and shall be semi-flush mounted. Stations shall be double-action push in, then pull down. When operated, fire boxes shall remain mechanically locked until manually reset. Construction shall be of Lexan with raised lettering and clear instructions provided on the cover. Stations shall have no protruding knobs or handles. Manual fire boxes shall be double-action type.

H. Analog photoelectric smoke detectors shall be low voltage and have an LED light source which "blinks" every time the unit is addressed, and illuminates steady on alarm. The detectors shall be controlled by a regulating photocell circuit matched to the smoke detection circuit. The detectors shall operate on the light refractory principle and shall have a rate compensation circuit to increase detection sensitivity upon raped buildup of smoke. The detectors shall also have thermal elements that will cause the detectors to alarm when the temperature exceeds 135 F. Each detector shall be provided with a steel mounting plate, detector base, screen and cover. The visible alarm signal shall be capable of remote LED annunciation.

I. All heat and smoke detectors shall be of the low profile type and shall be white in color.

J. Audiovisual alarm horns shall have intensity flashing xenon strobe light and alarm horn as an integral unit. Both audio and visual components shall operate from the 24V dc polarized indicating circuits. All horns shall mount on 4X4 inch electrical boxes. The horn assembly should be housed in a rugged, die-cast enclosure, and the electronic light source shall be sealed in silicone, be clear or white in color and be protected by a Lexan lens. The word FIRE shall appear on the lens. The light will have a maximum pulse duration of two-tenths of one second with a maximum duty cycle of 40%. The light intensity shall be a minimum of 75 candela. The minimum sound level shall be 95 db at

ten feet. Audiovisual alarm horns must be semiflush or flush mounted, except as noted on the plans. Units shall be mounted 80" A.F.F. or 6" below the suspended ceiling, whichever is lower.

K. Provide all wiring, conduit and outlet boxes required in accordance with manufacturer's recommendations for the erection of each complete system as described herein and as indicated on the drawings.

L. All low voltage wiring shall be a shielded low energy type cable run in conduit or type MC cable unless noted otherwise on the plans and shall meet the requirements of all national, state, and local electrical codes. All wires shall be tagged at all junction points and shall test free from grounds or crosses between the conductors.

M. All equipment shall be provided by one manufacturer with total responsibility for the entire system operation, warranty and maintenance.

N. In the presence of the manufacturer's representative, the Portsmouth Fire Department, the final system testing procedure shall be as follows:

1. Manually operate each manual station, heat detector, smoke detector, or water flow switch.
2. Open each initiating and indicating circuit in at least two locations to verify the continuity of the supervisory circuitry.
3. One half of the system testing shall be performed on normal power and one half the testing shall be performed on emergency power.
4. After system testing is complete, reset the system in its normal operating mode.
5. Perform any other test sequences requested by the Portsmouth Fire Department representative.

O. Upon completion of the installation and as directed by the Architect, the electric work shall include making all arrangements and providing any assistance necessary for inspection and testing as required for approval by the Portsmouth Fire Department. Modifications, adjustments, and/or corrective work necessary to obtain along with subsequent inspection and tests as required for approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" shall precede any consideration of formal acceptance by the Architect. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system shall also form a part of the required work.

P. The fire alarm riser diagram included in the contract drawings is for informational purpose only and is included to assist in the understanding of the system. The designated system supplier and electrical contractor shall provide all necessary equipment and interconnecting wiring to allow the system to perform as specified herein. Provide a complete system wiring diagram for review by the Engineer.

2.13 EMERGENCY LIGHTING SYSTEMS

A. Each system shall be included a self-contained emergency lighting unit with fixtures and lamps, internal battery, battery charger, pilot light monitors, primary protection fuses, and relay or switching device arranged to connect the lighting load to the battery upon failure of AC power. Remote head emergency fixtures, lamps and external wiring shall comprise the remainder of each system. Each system shall operate on 12 volts DC and shall be connected to an unswitched 120 volt AC power supply.

B. Each system shall be so designed that in the event of a power failure, the emergency units shall instantaneously turn on all DC emergency lighting system shall provide a minimum of 90 minutes of light. Simultaneous with resumption of normal electric service following a power failure, the emergency fixtures shall be extinguished and the batteries shall be recharging automatically at fast-charge rate. At the conclusion of the automatic fast-charge period, the batteries shall be fully and completely recharged, and a trickle charge shall be reestablished to maintain a constantly full battery charge.

C. The self-contained emergency lighting units shall contain all required control circuitry to give complete electrical supervision of the battery and automatic charger circuits. The charging transformers shall be of the high impedance type. A voltmeter and ammeter shall be part of each unit and shall have an accuracy of not less than 2%. The units shall be equipped with signal lights that indicate the following:

Primary AC supply on
Trickle charge to battery on
Fast charge to battery on
Trouble in operation circuits
Trouble in supervisory circuits

D. Batteries shall be sealed lead acid type nominally rated for 12 volts and shall have sufficient capacity to carry the connected load for not less than 90 minutes to not less than 87-1/2% of nominal system voltage.

E. Remote fixtures and lamps shall be the size, type and wattage as required. The Electrical Contractor shall provide all hardware necessary for proper installation.

F. Each emergency lighting unit shall be guaranteed against defects in material and workmanship for a period of five (5) years, pro rata.

2.14 ELECTRONIC BALLASTS

A. Flourescent lamp ballasts shall be electronic type of use with either straight or “U” lamps.

B. The ballast manufacturer shall have been producing electronic ballasts in the United States for at least five (5) years.

C. Electronic ballasts shall be interchangeable as to size, mounting and voltage characteristics of core and coil type ballasts.

D. Electronic ballasts shall be UL listed, comply with all State and Federal Energy Code standards and be utility "eligible" where required.

E. Ballasts shall comply with FCC and NEMA limits governing electromagnetic and radio frequency interface (RFI) and shall not interfere or disrupt other building electrical equipment.

F. Ballasts shall comply with all ANSI and IEEE Standards regarding surge protection and harmonic distortion. Total harmonic distortion level of ballasts shall be less than 20% THD, but greater than 10% THD.

G. Ballast lamp crest factors shall be less than 1.6 and power factor shall be a power factor greater than 90%.

H. Ballasts shall not be affected by lamp failure and shall not have a detrimental effect on lamp life. Parallel circuit ballasts shall allow remaining lamp(s) to maintain full output and one lamp has failed.

I. Ballast sound rating shall be "A" or better and shall contain no PCB's.

J. Ballasts shall operate at an input frequency of 60 hertz and an input voltage of 108 to 132 volts for 120V models and 249 to 305 volts for 277 volt models.

K. Ballasts shall be potted and enclosed in a steel case.

L. Ballast operating temperature shall not exceed 60° at any point on the case during normal operation.

M. Ballasts shall be solid state, high frequency type, instant start.

N. Ballasts shall have a 3 year warranty with a minimum of $10.00 labor replacement allowance.

O. Ballast shall be as manufactured by Magnetek, Universal, Osram or approved equal.

2.16 RACEWAYS

A. Rigid steel conduit shall be hot dipped galvanized steel by Republic Steel Corp., Pyle National, Allied or equal.

B. Intermediate metal conduit shall be hot-dipped galvanized steel conforming to UL Standard No. 1242. Conduit shall be as manufactured by Republic Steel Corp., Pyle National, Allied Tube and Conduit Corp., Wheatland Tube Company or equal.

C. Electric metallic tubing shall be hot-dipped galvanized steel conforming to UL Standard No. 747. Tubing shall be as manufactured by Pyle National, Allied Tube and Conduit Corp., Wheatland Tube Company or equal.

D. Plastic conduit shall be schedule 40 PVC 90^{o}C conforming to NEMA Standard TC2 or type EB conforming to NEMA Standard TC6. Plastic conduit shall be as manufactured by Carlon Electrical Products Co., Allied Tube and Conduit Company, Triangle Company or equal.

E. Flexible metal conduit shall be galvanized steel with separate copper grounding conductor. Liquid-tight flexible metal conduit shall be similar, but with extruded moisture and oil-proof outer jacket of polyvinyl chloride plastic.

F. Intermediate metal conduit fittings, couplings and connectors shall be threaded and galvanized or cadmium plated.

G. Couplings and connectors for electric metallic tubing shall be galvanized steel with setscrew.

H. Steel supports or racks shall be galvanized steel channel and fittings, Unistrut, Kindorf, Husky Products Company, or equal.

I. Steel support rods or support bolts for conduits shall be 1/8" diameter for each inch or fraction thereof of diameter of conduit size, but no rod or bolt shall be less than 1/4" in diameter.

PART 3 - EXECUTION

3.1 BASIC REQUIREMENTS

A. Adhere to best industry practice and the following.

B. All work shall be concealed except exposed where run horizontally at ceiling of unfinished spaces, or through mechanical and electrical equipment spaces.

C. Equip each raceway intended for the future installation of wire with nylon cord.

D. Provide all outlet boxes, junction boxes, conduit, and pull boxes for proper wire pulling and surface mounted device installation. Include those omitted from the drawings due to symbolic methods of notation.

E. Equip each raceway intended for the future installation of wire with a nylon cord.

F. Provide all outlet boxes, junction boxes, and pull boxes for proper wire pulling and device installation. Include those omitted form the drawings due to symbolic methods of notation.

G. Provide all sleeves through fireproof and waterproof slabs, walls, etc., required for electric work.

1. Provide waterproof sealing for the sleeves through waterproof slabs, walls, etc.

2. Provide fireproof sealing for the sleeves through fireproof walls, slabs, etc.

3.2 TESTS

A. Before an application for final acceptance of the work will be considered, all tests deemed necessary by the Architect to show proper execution of the work shall have been performed and completed in the presence of the Architect's representative. Scheduling of all testing procedures shall be arranged to suit the convenience of the Architect.

B. Any defects or deficiencies discovered in any of the electrical work shall be corrected and promptly retested. Defective materials shall be replaced at no cost to the Owner.

C. After the electrical work is completed and tested, deliver three copies of the manufacturer's operation manuals, shop drawings, wiring diagrams, and parts list for each device by other requirements specified elsewhere to the Owner.

D. On the day the facility is turned over the Owner, the electrical contractor shall insure that a licensed electrician is present at the building for at least eight hours to insure that all electrical systems are operating properly.

3.3 BRANCH CIRCUITRY

A. For all lighting and appliance branch circuitry, raceway sizes shall conform to industry standard maximum permissible occupancy requirements except where these are exceeded by other requirements specified elsewhere.

B. For circuitry indicated as being protected 20 amps or less, abide by the following:

1. Except as specified below, minimum conductor size shall be No. 12 AWG copper.

2. Conductors for 115 volts to neutral circuitry extending in excess of 100 feet, from the point of supply, to the last outlet or fixture tap shall be a minimum of No. 10 AWG copper throughout.

3. Conductors for 208V circuitry extending in excess of 200 feet, from the point of supply to the last outlet or fixture tap, shall be a minimum of No. 10 AWG copper throughout.

C. Lighting fixtures and receptacles shall not be connected to the same circuit, unless shown otherwise on plans.

D. Circuitry for emergency and exit sign lighting fixtures shall be maintained separate from all other circuitry.

E. Circuits shall be balanced on phases at their supply point as evenly as possible.

3.4 REQUIREMENTS GOVERNING ELECTRIC WORK IN DAMP OR WET LOCATIONS

A. Exclude flexible metallic conduit except for final connections not in excess of six feet.

B. Outlets and outlet size boxes shall be of galvanized cast ferrous metal.

C. The finish of threaded steel conduit shall be galvanized.

D. Wire for pulling into raceways for lighting and appliance branch circuitry shall be limited to THWN.

E. Wires for pulling into raceways for feeders shall be limited to THWN.

F. Wiring device plates shall be galvanized sheet steel.

G. Plates for toggle switches and receptacles shall have gasketed snap shut covers.

H. Final connections of flexible conduit shall be neoprene sheathed.

I. Enclosures, junction boxes, pull boxes, cabinets, cabinet trims, wiring troughs and the like, shall be fabricated of galvanized sheet metal and shall conform to the following:

1. They shall be constructed with continuously welded joints and seams.

2. Their edges and weld spots shall be factory treated with cold galvanizing compound.

3. Their connection to circuitry shall be by means of watertight hub connectors with sealing rings.

J. Enclosures for individually mounted switching and overcurrent devices shall be NEMA Class 3R weatherproof construction.

K. The covers, doors and plates and trims used in conjunction with all enclosures, pull boxes, outlet boxes, junction boxes, cabinets and the like shall be equipped with gaskets.

L. Panels shall be equipped with doors without exception.

M. The following shall be interpreted as damp or wet locations within the building confines:

1. Spaces where any designations indicating weatherproof (WP) or vaporproof appear of the drawings.

2. Below waterproofing in slabs apply directly on grade.

3. Other unheated areas.

3.5 ELECTRIC MOTOR DRIVE EQUIPMENT

A. For electric driven mechanical system equipment, include:

1. Power circuitry with connections to motor.

2. Individually mounted line disconnect means.

3. Installation of motor starters.

4. Line fusing of motor starters.

5. If necessary, the substitution of local multiple disconnect means with suitable overcurrent protection for the indicated single unfused device when necessary to

meet the actual power supply requirements of package motorized equipment which is shown supplied by a single feed but which is not adapted to same.

3.6 IDENTIFICATION AND TAGGING

A. Identify individually:

1. Each panelboard.

2. Each disconnect switch.

3. Variable frequency drive.

B. Each wire or cable in a feeder shall be identified at its terminal points of connection and in each pullbox, junction box and panel gutter through which it passes.

C. The nomenclature used to identify panelboards shall designate the numbers assigned to them.

D. The nomenclature used to identify switches or circuit breakers shall:

1. Where they disconnect mains or services designate this fact.

2. Where they control feeders, designate the feeder number and the name of the load supplied.

3. Where they control lighting and appliance branch circuitry, designate the name of the space and the load supplied.

E. The nomenclature used to identify feeder wires and cables shall designate the feeder number.

F. Identification for panelboards and transformers shall be by means of engraved lamacoid nameplates showing 1/4" high white lettering on a black background screen fastened to the outside face of the front.

G. Identification for switches or circuit breakers shall be by means of the following:

1. Where individually enclosed – engraved lamacoid nameplates showing 1/8" high white lettering on a black background fastened on the outside front face of the enclosure.

2. Where in panelboards without doors– same as for individually enclosed.

3. Where in panelboards with doors – typewritten directories mounted behind transparent plastic covers, in metal frames fastened on the inside face of the doors.

H. Identification for the wires and cables of feeders shall be by means of wrap around "brady" type labels.

I. Device plates for local toggle switches, toggle switch motor starters, pilot lights and the like, whose function is not readily apparent shall be engraved with 1/8" high letters suitably describing the equipment controlled or indicated.

J. Phase identification letters shall be stamped into the metal of the bus bars of each phase of the main buses of each switchboard and each panelboard. The letters shall be visible from at least one "normal posture" location without having to remount any current carrying or supporting elements.

K. Equip the front face of all switchboards pull boxes junction boxes and the like containing cables, busing or devices operating in excess of 600 volts with enameled sheet metal "red on white" signs reading "DANGER – HIGH VOLTAGE".

L. Equip all electric closets and the like with enameled sheet metal "red on white" signs reading "Electrical Equipment Room – No Storage Permitted". Signs shall be mounted at clearly visible locations within the rooms.

M. Identify each outlet box, junction box, and cabinet used in conjunction with empty raceway for wires of a future system by means of indelible markings on the inside denoting the system.

N. Prior to installing identifying tags and nameplates, submit their nomenclature for approval.

3.7 SUPPORTS AND FASTENINGS

A. Support work in accordance with best industry practice.

B. No work intended for exposed installation in damp locations shall be mounted directly on nay building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4@ air space between the building surfaces and the work.

C. Nothing (including outlet, pull and junction boxes and fittings)shall depend on electric conduits, mechanical piping of equipment, raceways or cables for support.

D. Nothing shall rest on, or depend for support on, suspended ceiling media. Vertical members which suspend the ceiling, however, may be used for support.

E. Fasten electric work to building structure in accordance with the best industry practice.

F. Floor mounted equipment shall not be held in place solely by its own dead weight. Include floor anchor fastenings in all cases.

G. Fasten electric work to building structure in accordance with the bet industry practice.

H. Floor mounted equipment shall not be held in place solely by its own dead weight. Include floor anchor fastenings in all cases.

I. For items which are shown as being ceiling mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channels or angle iron bridging tying to building structural elements.

J. Provide expansion fittings for all raceways wherever building expansion joints occur or wherever raceways run through isolated slabs.

3.8 REQUIREMENTS FOR THE INSTALLATION OF JUNCTION BOXES, OUTLET BOXES, AND PULL BOXES

A. Flush wall mounted outlet boxes shall not be set back to back but shall be offset at least 12” horizontally regardless of any indication on the drawings.

B. Locate all boxes so that their removable covers are accessible without necessitating the removal of parts of permanent building structure, including piping, ductwork, and other permanent mechanical elements.

C. Barriers in junction and pull boxes of outlet size shall be of the same metal as the box.

D. Apply junction and pull boxes in accordance with the following:

1. Include pull boxes in long straight runs of raceway to assure that cables are not damaged when they are pulled in.

2. Include junction and pull boxes to assure a neat and workmanlike installation of raceways.

3. Include junction and pull boxes to fulfill requirements pertaining to the limitations to the number of bends permitted in raceway between cable access points, the accessibility of cable joints and splices, and the application of cable supports.

4. Include all required junction and pull boxes regardless of indications of the drawings (which, due to symbolic methods of notation, may omit to show some of them).

3.9 LOCATING AND ROUTING OR CIRCUITRY

A. All circuitry shall be run concealed except that is shall be run exposed where the following conditions occur:

1. Horizontally at the ceiling of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.

2. Horizontally and vertically in mechanical equipment spaces.

3. Horizontally and vertically in electric equipment rooms.

B. Concealed circuitry shall be so located that building construction materials can be applied over its thickest elements without being subject to spalling or cracking.

C. Circuitry run exposed shall be routed parallel or perpendicular to building walls and column lines.

D. Exposed circuitry located overhead shall be run in a completely accessible manner on the under side of all piping and ductwork.

E. Circuitry run in suspended ceilings shall be routed parallel or perpendicular to building walls, column lines, etc.

F. All circuitry shall be run concealed except that it shall be run exposed where the following conditions occur:

1. Horizontally at the ceiling of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.

2. Horizontally and vertically in mechanical equipment spaces.

3. Horizontally and vertically in electric equipment rooms.

3.10 INSTALLING CIRCUITRY AND RACEWAYS

A. In runs of conduit or raceway including flexible limit the number of bends between cable access points to a total which does not exceed the maximum specified for the particular system. Where no such maximum specified, limit the number to four right angle bends or the equivalent thereof.

B. In each conduit or raceway assigned for the future pulling in of wires, include a nylon drag cord.

C. In each conduit or raceway assigned for the future pulling in or wires, include a nylon drag cord. In raceways 2" trade size and larger, the cord shall be pulled in utilizing a suitable brush, followed by an 85% diameter ball mandrel ahead of the cord in the pulling assembly. In the event that obstructions are encountered, which will not permit the drag cord to be installed, the blocked section of raceway shall be replaced and any cutting and patching of the structure involved in such replacement shall be included as part of the electric work.

D. Circuitry shall be arranged such that conductors of one feeder or circuitry carrying "going" current are not separated from conductors of the same feeder or circuitry carrying "return" current by any ferrous or other metal. Where not within raceways, all "going" and "return" current conductors of one feeder or circuit shall be laced together so as to minimize induction heating of adjacent metal components.

E. Sleeves use where circuitry is to penetrate waterproof slabs, decks and walls, shall be of a type selected to suite the water condition encountered in the field.

F. Provide suitable raceway fittings to accommodate expansion and deflection where conduit(s) cross seismic, control and/or expansion joints.

G. Ground and bond all conduit under provisions of Section 2.16.

H. Route conduits through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate with mechanical and roofing contractors.

3.11 PHASING AND COLOR CODING

A. The insulation or covering of each wire or cable shall be color coded so as to provide for circuit identification as specified below.

120/208V Circuits	Phase
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground

B. The same colored cable shall be connected to the same phase throughout the project.

C. In general, building load centers and panelboards shall be phase "A", "B", "C", either top to bottom or left to right. The neutral, although it may be in different locations for different equipment, shall be identified.

3.12 REQUIREMENTS GOVERNING ELECTRIC WORK IN RETURN AIR PLENUMS

A. In spaces within suspended ceilings utilized as return air plenums, abide by the requirements specified for normal electric work conditions except:

1. Lighting fixtures recessed into the ceiling shall be certified for being suitable for this purpose.

2. All wiring systems must either be run in metallic raceways or shall be UL approved fire rated plenum cable.

3.13 SPARE PARTS, SPECIAL TOOLS

A. The following spare parts shall be provided to the Owner at no additional cost to the base contract price:

1. Additional copy of each type panelboard circuit directory (see 2.06 PANELBOARDS).

2. Additional set of each set of keys utilized for electrical equipment on the project (fire alarm control panel, panelboards, etc.).

3. Three (3) spare fuses of each type of fuse utilized on the project.

B. Special Tools: If any part of equipment furnished under these specifications requires a special tool for assembly, adjustment, setting or maintenance thereof and such tool is not readily available on the commercial tool market, shall be furnished with equipment as a standard accessory.

3.14 MECHANICAL AND ELECTRICAL COORDINATION

A. The Mechanical and Electrical Subcontractors shall coordinate their respective portions of the work, as well as the electrical characteristics and voltage requirements of all electrically operated mechanical equipment.

B. The Electrical Contractor shall review all mechanical, architectural, structural, and civil drawings and specifications associated with this project, prior to submitting his/her bid, to ascertain the total scope of work for this project. Submission of an electrical bid on this project confirms that the Electrical Contractor has reviewed all related contract documents.

3.15 REQUIREMENTS GOVERNING ELECTRIC WORK IN AIR HANDLING SPACES

A. Within air handling duct work or plenums (other than spaces within suspended ceilings used for air handling purposes).

1. Abide by the requirements specified for electric work in damp locations within building confines.

2. Where circuitry passes through duct walls, include, in accordance with instructions issued in the field, air-tight sealing provisions which allow for a relative movement between the circuitry and the duct walls.

B. In spaces within suspended ceilings used for air handling purposes, abide by the requirements specified for normal electric work conditions except:

1. Lighting fixtures recessed into the ceilings shall be certified as being suitable for this purpose.

3.16 LIMITING NOISE PRODUCED BY ELECTRICAL INSTALLATION

A. Perform the following work, in accordance with field instructions issued by the developer to assure that minimal noise is produced by electrical installations due to equipment furnished as part of the electrical work.

B. Check and tighten the fastenings of sheet metal plates, covers, doors and trims used in the enclosures of electrical equipment.

C. Remove and replace any individual device containing one or more magnetic flux path metallic cores (e.g. discharge lamp ballast, transformer, reactor, dimmer, solenoid) which is found to have a noise output exceeding that of other identical devices installed at the project.

3.17 SPLICING AND TERMINATING WIRES AND CABLES

A. Maintain all splices and joints in removable cover boxes or cabinets where they may be easily inspected.

B. Locate each completed conductor splice or joint in the outlet box, junction box, or pull box containing it , so that it is accessible from the removal cover side of the box.

C. Join solid conductors No. 8 AWG and smaller by securely twisting together and soldering or by using insulated coiled steel spring “wire nut” connectors. Exclude “wire nuts” employing non-expandable springs. Terminate conductors No. 8 AWG and smaller by means of a neat and fast holding application of the conductors directly to the binding screws or terminals of the equipment or devices to be connected.

D. Join, tap terminate stranded conductors No. 6 AWG or larger by means of solder sleeves, taps; and lugs with applied solder or by means of bolted saddle type or pressure indent type connectors, taps, and lugs. Exclude connectors and lugs of the types which apply set

screws directly to conductors. Where equipment or devices are equipped with set screw type terminals which are impossible to change, replace the factory supplied set screws with a type having a ball bearing tip. Apply pressure indent type connectors, taps and lugs utilizing tools manufactured specially for the purpose and having features preventing their release until the full pressure has been exerted on the lug or connector.

E. Except where wire nuts are used, build up insulation over conductor joints to a value, equal both in thickness and dielectric strength, to that of the factory applied conductor layers of rubber tape, with an outer layer of friction tape; by means of half-lapped layers of approved plastic electric insulating tape; or by means of split insulating casings manufactured specifically to insulate the particular connector and conductor, and fastened with stainless steel or non-metallic snaps or clips.

F. Exclude splicing procedures for neutral conductors in lighting and appliance branch circuitry which utilize device terminals as the splicing points.

G. Exclude joints or terminations utilizing solder in any conductors used for grounding or bonding purposes.

H. Exclude all but solder or pressure indent type joints in conductors used for signaling or communications purposes.

3.18 PULLING WIRES INTO CONDUITS AND RACEWAYS

A. Delay pulling in until the project has progressed to a point when general construction procedures are not liable to injure wires and cables, and when moisture is excluded from raceways.

B. Utilize nylon stakes or metallic fish tapes with ball type heads to set up for pulling. In raceways 2" trade size and larger, utilize a pulling assembly ahead of wires consisting of a suitable brush followed by an 3-1/2" diameter ball mandrel.

C. Leave sufficient slack on all runs of wire and cable to permit the secure connection of devices and equipment.

D. Include circular wedge-type cable supports for wires and cables at the top of any vertical raceway longer than 20 feet. Also include additional supports spaced at internals which are no greater than 10'. Supports shall be located in accessible pull boxes. Supports shall be of a nondeteriorating insulation material manufactured specifically for the purpose.

E. Pulling lubricants shall be used. They shall be products manufactured specifically for the purpose.

F. Slack on wires and cables located in cabinets and pull boxes shall be formed and set in place in groupings corresponding to their occupancy of raceways. They shall also be

arranged, with insulators and supports provided where necessary, such that cable shims or other such temporary expeditions do not have to be left permanently in place to prevent the wires and cables from shifting when covers or trims are removed.

3.19 SEISMIC RESTRAINT SYSTEM

A. The Electrical Contractor shall obtain the services of a licensed Structural Engineer to prepare stamped drawings which indicate the seismic restraint systems to be utilized on this project to meet the requirements of the 2009 Edition of the International Building Code.

END OF SECTION
(210218 - 5/1/13)

SECTION 16000

ELECTRICAL

PORTSMOUTH CITY HALL – BOILER PLANT UPGRADES
PORTSMOUTH, NEW HAMPSHIRE

INDEX

SECTION 16000

ELECTRICAL

PORTSMOUTH CITY HALL – BOILER PLANT UPGRADES
PORTSMOUTH, NEW HAMPSHIRE

INDEX (continued)