PROJECT MANUAL

VOLUME 1 OF 1

HEATING AND CONTROL SYSTEM
BRANFORD ARMORY
BRANFORD, CONNECTICUT

PROJECT NO.: 16MIL21501
AGENCY TRACKING NO.: BN 14002

CONNECTICUT ARMY NATIONAL GUARD
FACILITIES MANAGEMENT OFFICE

360 Broad Street, Hartford, Connecticut

PREPARED BY:

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T&M Submission (May 10, 2018)

Table of Contents

01000 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Number 16MIL21501 is entitled Replacement Boiler/HWS and New BMS. It is to be located in Branford, Connecticut. It is to be completed and ready for use by the Owner and Agency within the Contract Time specified in Section 00020 Bid Proposal Form.

B. The Project Description:

1. Replacement of the existing boiler and hot water heater and BMS installation.
2. This Project does not Exceed the Threshold Limits as defined by the Connecticut General Statutes.

C. Project Location: The Connecticut Army National Guard Armory (Branford Armory), located at 87 Montowese Street in Branford, CT

01001 OWNER AND AGENCY

A. The Owner and Agency is the Connecticut State Military Department.

1. The Agency Design Coordinator is Ed Fulton. The Agency Design Coordinator is located at 360 Broad Street, Hartford, Connecticut 06105. Phone: (860) 548-3274; Fax: (860) 524-4937; E-mail: george.e.fulton.nfg@mail.mil.
    a. The Agency Design Coordinator is the authorized representative for the Military Department for all design related decisions at the facility and or site where the work is being performed but does not have the authority to change the contract documents or direct the contractor.
2. The Agency Construction Coordinator is James A. Cavanna. The Agency Construction Coordinator is located at 360 Broad Street, Hartford, Connecticut 06105. Phone: (860) 548-3279; Fax: (860) 548-3260; E-mail: james.a.cavanna2.nfg@mail.mil.
    a. The Agency Construction Coordinator is the authorized representative for the Military Department for all construction related decisions at the facility and or site where the work is being performed but does not have the authority to change the contract documents or direct the contractor.

01002 ARCHITECT AND ENGINEER:

A. The Architectural Firm is Fuss & O'Neill, Inc., and is located at 146 Hartford Road, Manchester, Connecticut 06040. The Engineer representing the firm for this project is Elizabeth Landry. Phone: (860) 646-2469 (x5364); E-mail: elandry@fando.com.

1. The Architect and Engineer or their accredited representative is referred to in the Contract Documents as "Architect" or "Architects" or "Engineer" or "Engineers" or by pronouns which imply them. As information for the Contractor, the Architect's or Engineer's status is defined as follows:
    a. The Architect and Engineer will not make interpretations or decisions directly to the Contractor. All interpretations or decisions will be conveyed through the Construction Administrator.

b. As the authorized representative of the Department of Public Works Commissioner, the Architect and Engineer is responsible for review of shop drawings, materials, and equipment intended for the work, in accordance with the "General Conditions", and the "Supplementary Conditions".

2. Wherever the Architect or Engineer is mentioned in the documents in connection with an administrative function, it shall include the Construction Administrator in that function except for shop drawings.

01003 CONSTRUCTION ADMINISTRATOR:

A. The Construction Administrator is James A. Cavanna, AIA, CBO, Construction Specialist, and is located at 360 Broad Street, Hartford, Connecticut 06105. Phone: (860) 548-3279; Fax: (860) 548-3260; E-mail: james.a.cavanna2.nfg@mail.mil.

1. The Construction Administrator is referred to in the Contract Documents as "Construction Administrator" or "Construction Manager" or by pronouns which imply it. All communications concerning the project will be directed through the Construction Administrator or a designated representative(s).

2. As information to the Contractor, the Construction Administrator's status is defined as follows:

a. The Construction Administrator is the Owner's Agent who will, among other thing's, monitor the General Contractor's performance, scheduling and construction, process shop drawings, material, and equipment submittals, review and process periodic billings, review and recommend cost changes.

b. The Construction Administrator will process all requests for information, interpretations and decisions regarding the meaning and intent of the Contract Documents, consulting with appropriate parties prior to rendering the interpretations or decisions to the Contractor. All such requests and replies shall be in writing.

01010 SUMMARY OF WORK

A. Summary of Work includes but is not limited to the following:

1. Electrical and Mechanical equipment upgrades;

2. Sitework, Site Utilities;

B. The Contractor will include in his bid, all items required in order to carry out the intent of the work as described, shown and implied in the Contract Documents.

C. It shall be the Contractor's responsibility upon discovery to immediately notify the Construction Administrator, in writing, of errors, omissions, discrepancies, and instances of noncompliance with applicable codes and regulations within the documents, and of any work which will not fit or properly function if installed as indicated on the Contract Documents. Any additional costs arising from the Contractor's failure to provide such notification shall be borne by the Contractor.

D. The Work will be constructed under a single lump.

E. Work Sequence - Phase:

1. The entire Project shall be constructed in 1 Phase. Work of this Phase shall be substantially complete, ready for occupancy within 120 Calendar Days of commencement of the Work.

01011 EXAMINATION OF SITE

A. It is not the intent of the Documents to show all existing conditions. All contractors are advised to visit and examine the site with the Construction Administrator prior to submitting bids.

B. Contractors should investigate and satisfy themselves as to the conditions affecting the work, including but no restricted to those bearing upon transportation, disposal, handling and storage of materials, availability of labor, water, electric power, uncertainties of weather, roads or similar physical conditions of the ground, the character of equipment, and facilities needed preliminary to and during the prosecution of the Work. The Contractor should further satisfy himself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, as well as from information presented by the Contract Documents. Any failure by the Contractor to acquaint himself with the available information shall not relieve him from the responsibility for estimating properly the difficulty and cost of successfully performing the Work.

C. Review Of Hazardous Material Reports are contained in a separate Volume of this Project Manual.

D. Pre-Bid Conference:

1. A Pre-Bid Conference and tour of the site will be conducted as scheduled in the Invitation to Bid. This scheduled conference is the only official opportunity for the bidders to tour the site with the Owner, Architect, Engineer, Construction Administrator, and Agency.

01012 PROJECT DOCUMENTS

A. The Specifications and Drawings are intended to describe and illustrate the materials and labor necessary for the work of this Project.

B. Throughout the Technical Specifications, the Connecticut Department of Transportation Standard Specifications for Roads, Bridges, and Incidental Construction Form 814A, current addition including any interim and supplemental specifications are referenced. Where so referenced the requirements set forth therein are applicable and made a part hereof Copies of Form 814A are available from the Connecticut Department of Transportation at a nominal charge.

01013 DOCUMENTS FURNISHED

A. The General Contractor will be given 3 sets of the Contract Documents on or about the time of execution of Contract, free of charge. If additional copies are wanted, they will be available at the direct additional cost of their reproduction, to the contractor.

B. The Contractor shall receive one (1) set of AutoCAD compatible (latest version) Floor Plans on disks at no cost on or about the time of execution of the Contract from the Architect. Additional sets of AutoCAD compatible (latest version) Floor Plans on disks from the Architect at the cost of their reproduction, to the contractor.

01014 CONTRACTOR'S USE OF PREMISES

A. The Contractor shall confine his operations, including storage of apparatus, equipment and materials to the contract limit lines as directed by the Construction Administrator.

B. The areas and/or spaces, including their access, shall be maintained free and clear throughout the contract term.

C. Parking for Contractor's employees will be limited to an area (or areas) designated by the Construction Administrator. The Contractor may be required to provide identification stickers for employees' cars.

01015 OCCUPANCY REQUIREMENTS

A. Full Agency Occupancy During Construction: The Agency will occupy the site and existing building during the entire construction period. Cooperate with the Agency during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Agency's operations.

1. Provide adequate building and fire code egress from the buildings during the renovation process. The Contractor will be responsible to maintain and protect egress ways during the construction sequence per the design as supplied by the Architect. Contractor shall be responsible for preparing egress plans for Owner approval and for Office of State Building Official and Office of State Fire Marshal for approval if required.

01019 CONTRACT CONSIDERATIONS

A. Unit Prices - General:

1. Definition - Unit Price: Amount the General Contractor acknowledges in the Bid Proposal Form as a price per unit of measurement for materials or services as described in the Bidding Documents or in the Contract Documents.
2. Procedures:
   a. Unit Prices included in the Contract Documents are to be used for determining compensation to the Contractor or Owner for changes to the scope of the work indicated in the Contract Documents, and included in the Lump Sum Contract Price. Special Unit Prices are for items complete, in place, and shall be inclusive of furnishing and installing of all material, labor, trucking, overhead, profit, equipment, hoisting, engineering, scaffolding, power hookups, protection, shop drawings, taxes, permits, appliances, delivery, insurance, supervision, cost of bond, etc. and shall remain in effect until completion of the Contract.
   b. Unit Price: Is identified by the Owner as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if the estimated quantities of Work required by the Contract Documents are increased or decreased.
   c. Increases or Decreases: Should the amount of the Work required be increased or decreased because of changes in the work ordered in writing by the Project Manager, the Undersigned agrees that the following supplemental UNIT PRICES will be decreased 10% for a reduction of work. Each Unit Price shall include all equipment, tools, labor, permits, fees, etc., incidental to the completion of the work involved. All items marked with an asterisk (*****) in the unit price schedules shall include the completion of the excavation, formation and compaction of sub-grade and the disposal of surplus or unsuitable materials in accordance with the Plans and Specifications or as directed by the Construction Administrator.
2. The Owner reserves the right to reject the Contractor's measurement of work-in-place that involves use of established unit prices, and to have this work measured, at the Owner's expense, by an independent surveyor acceptable to the Contractor.

3. Defect Assessment: Replace the Work, or portions of the Work, not conforming to the specified requirements. If, in the opinion of the Architect/Engineer it is not practical to remove and replace the work the Architect/Engineer will direct an appropriate remedy or adjust the payment.
4. Unit Price Schedule: A "Unit Price Schedule" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials described under each unit price.

B. Unit Price Schedule – Alterations – NOT USED

1. Unit Price - Alterations:

2. Unit prices shall be negotiated if there is a change in scope of work.

01027 APPLICATION FOR PAYMENT

A. Schedule of Values: Submit the “Schedule of Values” to the Construction Administrator at the earliest possible date but no later than (21) twenty-one Calendar Days after the Contract Start Date. A separate "Schedule of Values" shall be provided for each Phase of the Project identified in Section 01010 Summary of Work, Work Sequence - Phase(s).

1. Format and Content: Use the Project Manual Table of contents as a guide to establish the format for the “Schedule of Values”. Provide at least one line item for each of the Specification Section on electronic media printout.
2. Identification: Project identification on the Schedule of Values shall include, but not be limited to, the following:
   a. Owner
   b. Project Number
   c. Project Name
   d. Project Location
   e. Contractor's name and address.
3. Arrange the “Schedule of Values” in tabular format as required by the Owner, containing separate columns including, but not limited to, the following Items:
   a. Item Number.
   b. Description of Work with Related Specification Section or Division Number.
   c. Scheduled Values broken down by description number, type material, units of each material.
   d. Name of subcontractor.

e. Name of manufacturer or fabricator.

f. Name of supplier.

g. Retainage.

h. Contract sum in sufficient detail.

4. Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

5. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.

6. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.

7. Unit-Cost Allowances: Show the line-item value of unit-cost allowances, as a product of the unit cost, multiplied by the measured quantity. Estimate quantities from the best indication in the Contract Documents.

8. General Conditions: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.

   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at the Contractor's option.

B. Applications for Payment - General: Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect and Construction Administrator and paid for by the Owner.

1. The initial “Application for Payment”, the “Application for Payment”, at time of “Substantial Completion”, and the final “Application for Payment”, involve additional requirements.

2. Payment-Application Terms: The Owner will process monthly progress payments. The Contractor may submit applications for payment on a monthly basis.

3. Payment-Application Forms: Use the “Application for Payment” form as required by the Owner. Present the required information on electronic media printout or approved Owner Form, multiple pages should be used if required.

4. For each item, provide a column including but not limited to the following items:

   a. Item Number.

   b. Description of Work and Related Specification Section or Division.

   c. Scheduled Value, break down by units of material and units of labor.

   d. Work completed from previous application.

   e. Work completed this period.

   f. Materials presently stored.

   g. Total completed and stored to date of application.

   h. Percentage of Completion.

   i. Balance to Finish.

   j. Retainage

5. Application Preparation: Complete every entry on the Application form. At the time of Final Payment only, include an executed Application form by a person authorized to sign legal documents on behalf of the Contractor. The Construction Administrator will return incomplete Applications without action.
    a. Entries shall match data on the "Schedule of Values".
    b. Include amounts of Change Orders issued prior to the last day of the construction period covered by the application.
6. Transmittal: Except for final payment, submit to the Construction Administrator by a method ensuring receipt within forty-eight (**48**) hours. One (**1**) complete, signed and notarized original of each Application for Payment, including lien waivers and similar attachments when required, along with six (**6**) copies. For Final Payment, nine (**9**) complete, signed and notarized copies shall be submitted.
    a. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Architect.
7. Applications for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment and all subsequent Application for Payments including, but not limited to, the following items:
    a. List of subcontractors and suppliers' name, FEIN/Social Security numbers, and Connecticut Tax Registration Numbers.
    b. List of principal suppliers and fabricators.
    c. Schedule of Values.
    d. Contractor's Construction Schedule (preliminary if not final).
    e. Schedule of principal products.
    f. Submittal Schedule (preliminary if not final).
    g. List of Contractor's staff assignments.
    h. List of Contractor's principal consultants.
    i. Copies of all applicable permits.
    j. Copies of authorizations and licenses from governing authorities for performance of the Work.
    k. Proof that as-built documents are updated as required by Section 01700 "Contract Closeout".
    l. Initial as-built survey and damage report, if required.

C. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion submit an Application for Payment form, use the form as required by the Owner. Present the required information on electronic media printout.

1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
2. Administrative actions and submittals that shall precede or coincide with this application include, but are not limited to, the following:
    a. Occupancy permits and similar approvals.
    b. Warranties (guarantees) and maintenance agreements.

c. Test/adjust/balance records.

d. Maintenance instructions.

e. Meter readings.

f. Startup performance reports.

g. Changeover information related to Owner's occupancy, use, operation, and maintenance.

h. Final cleaning.

i. Application for reduction of retainage and consent of surety.

j. Advice on shifting insurance coverage.

k. Final progress photographs.

l. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion.

m. DD Form 1354 Transfer and Acceptance of DoD Real Property.

n. NGB 593 Project Inspection Report.

D. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include, but are not limited, to the following:

1. Completion of Project Closeout requirements.
2. Completion of list of items remaining to be completed as indicated on the attachment to the Certificate of Substantial Completion.
3. Ensure that unsettled claims will be settled.
4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
5. Transmittal of required Project construction records to the Owner (including as-built documents Reference Section 01700 “Contract Closeout”.)
6. Certified property survey.
7. Proof that taxes, fees, and similar obligations were paid.
8. Removal of temporary facilities and services.
9. Removal of surplus materials, rubbish, and similar elements.
10. Change of door locks to Owner's access.
11. The requirements of the General Conditions and Supplementary Conditions for Final Acceptance, Final Completion, Final Inspection, and Final Payment.
12. Asbestos, Lead or other hazardous material manifests.
13. Completion of “Building Contractor Reporting Form” as supplied by Department of Construction Services, for all Contractors, Subcontractors, Vendors, Suppliers, etc. who work on the Contract. The form includes the following information:

    a. Contractor/Subcontractor name.

    b. FEIN/Social Security Numbers

    c. Connecticut Tax Registration Numbers

    d. Type of work

    e. Name of business and address

    f. Remittance address.

01030 SUPPLEMENTAL BIDS

A. Definition: A Supplemental Bid is an amount proposed by bidders and stated on the Bid Proposal Form for certain work defined in the Bidding Documents that may be added to the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. The cost for each supplemental bid is the net addition to the Contract Sum to incorporate the Supplemental Bid into the Work. Supplemental Bids are only accepted in the numerical order that they are listed on the Bid Proposal Form and never accepted out of numerical sequence. No other adjustments are made to the Contract Sum.

B. Procedures:

1. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate that Work into the Project.
    a. Include as part of each Supplemental Bid, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Supplemental Bid.
2. Execute accepted Supplemental Bids under the same conditions as other Work of this Contract.
3. Schedule: A "Schedule of Supplemental Bids" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each Supplemental Bid.

C. Schedule of Supplemental Bids:

1. Split heat pump systems (SBI#1)
2. Repaving of rear parking area (SBI#2)

01035 MODIFICATION PROCEDURES

A. Summary: This Section specifies administrative and procedural requirements for handling and processing contract modifications.

B. Requests for Information:

1. In the event that the contractor or subcontractor, at any tier, determines that some portion of the drawings, specifications, or other contract documents requires clarification or interpretation by the Architect, the contractor shall submit a “Request for Information” in writing to the Architect via Construction Administrator. “Requests for Information” may only be submitted by the contractor and shall only be submitted on the “Request for Information” forms as required by the owner. In the “Request for Information”, the contractor shall clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed from the Architect.
    a. In the “Request for Information”, the contractor shall set forth an interpretation or understanding of the requirement along with reasons why such an understanding was reached.
    b. The owner acknowledges that this is a complex project. Based upon the owner’s past experience with projects of similar complexity, the owner anticipates that there will probably be some “Requests for Information” on this project.

c. The Architect will review all "Requests for Information" to determine whether they are "Requests for Information" within the meaning of this term. If it is determined that the document is not a "Request for Information", it will be returned to the contractor, unreviewed as to content, for resubmittal on the proper form and in the proper manner.

d. "Requests for Information Response" shall be issued within seven (7) Working Calendar Days of receipt of the request from the contractor unless the owner determines that a longer time is necessary to provide an adequate response. If a longer time is determined necessary by the owner, the owner will, within seven (7) Working Calendar Days of receipt of the request, notify the contractor of the anticipated response time. If the contractor submits a "Request for Information" on an activity with seven (7) Working Calendar Days or less of float on the current project schedule, the contractor shall not be entitled to any time extension due to the time it takes the Architect to respond to the request provided that the Architect responds within the seven (7) Working Calendar Days set forth above.

e. "Requests for Information Response" from Architect will not change any requirement of the contract documents. In the event the contractor believes that the "Requests for Information Response" will cause a change to the requirements of the contract document, the contractor shall immediately give written notice to the Construction Administrator stating that the contractor believes the "Requests for Information Response" will result in "Change Order" and the Contractor intends to submit a "Change Order Proposal" request. Failure to give such written notice immediately shall waive the contractor's right to seek additional time or cost under the requirement these Requirements.

C. Minor Changes in the Work

1. The Architect, through the Construction Administrator, will issue supplemental instruction authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract time, on the "Supplemental Instructions" form as required by the Owner.

D. Proposal Request:

1. Architect/Owner-Initiated Requests For Proposals: The Architect or Owner will issue a detailed description of proposed changes in the Work via the Construction Administrator that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications. Such requests shall be on a "Proposal Request" form as required by the owner.
2. "Proposal Request" is issued for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
3. Within Fourteen (14) Working Calendar Days of receipt of a "Proposal Request", submit an "Change Order Proposal" with the required information necessary to execute the change to the Construction Administrator for the Architect's/Owner's review.
4. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
   a. Indicate applicable delivery charges, equipment rental, and amounts of trade discounts.
   b. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
   c. The Agency is tax exempt. All Contractor and Subcontractor services provided under your contract with the State of Connecticut may not be exempt from taxes. The Department of Revenue Services can guide you as to which services are exempt and which are not. Please

contact the State of Connecticut, Department of Revenue Services at 1-800-382-9463 or 860 541-3280.

d. Dollar values shown on the Schedule of Values shall not be the governing (or deciding) final amounts for change orders involving either additional charges or deletions.

E. Change Order Proposal:

1. When either a "Request for Information" from the Contractor or a "Proposal Request" from the Architect or Owner results in conditions that may require modifications to the Contract, the Contractor may propose changes by submitting a request for a "Change Order Proposal" to the Architect via the Construction Administrator on forms as required by the Owner. These forms shall also include "Change Order Proposal Worksheets" as required by the Owner.
   a. Include statements outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and Contract Time.
   b. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities as directed by Article 13 "Compensation for Changes in the Work" of the General Conditions of the Contract for Construction.
   c. Indicate applicable delivery charges, equipment rental, and amounts of trade discounts.
   d. Comply with requirements in Section 01631 "Equals and Substitutions" if the proposed change requires an equal or substitution of one product or system for a product or system specified.
2. The State of Connecticut construction contract has the following tax exemptions:
   a. Purchasing of materials which will be physically incorporated and become a permanent part of the project.
   b. Tools, supplies and equipment used in fulfilling the construction contract are not exempt.
   c. Services that are resold by the contractor are exempt, i.e. if a General Contractor hires a plumber, carpenter or electrician, a resale certificate may be issued to the subcontractor because these services are considered to be integral and inseparable component parts of the building contract
3. "Change Order Request" Forms: Use "Change Order Proposal" and "Change Order Proposal Worksheets" forms as required by Owner.
4. "Change Order Proposal" cannot be submitted without the Contractor either prior submission of a "Request for Information" from the Contractor or as a response to a "Proposal Request" submitted by the Architect or Owner.
5. Any "Change Order Request " submitted without a prior submittal of a "Request for Information" or as a response to a "Proposal Request" will be immediately rejected and returned to the Contractor.

F. Construction Change Directive:

1. "Construction Change Directive": When the Owner and the Contractor disagree on the terms of a "Change Order Proposal" resulting from either a "Request for Information" or "Proposal Request", then the Architect through the Construction Administrator may issue a "Construction Change Directive" on a "Construction Change Directive" as authorized by the Owner on the form

required by the Owner. The "Construction Change Directive" instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a "Change Order".

a. The "Construction Change Directive" contains a complete description of the change in the Work. It also designates the method to be followed to determine change in the Contract Sum or Contract Time.

2. Documentation: The Contractor shall maintain detailed records on a time and material basis of work required by the "Construction Change Directive".

a. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

b. The final value shall be negotiated based on the supporting data to determine the value of the work.

G. Change Order Procedures:

1. Upon the Owner's approval of a Contractor's "Change Order Proposal", the Construction Administrator will issue a "Change Order" for signatures of the Architect, Owner and the Contractor on "Change Order" form as required by the Owner.

01040 COORDINATION

A. Construction Administrator:

1. The Construction Administrator is identified in Division 1 Section 01003 "Construction Administrator".

2. Construction Mobilization:

a. Cooperate with the Construction Administrator in the allocation of mobilization areas of the site, for field offices and sheds, for agency facility access, traffic, and parking facilities.

b. During Construction, coordinate use of site and facilities through the Construction Administrator.

c. Comply with Construction Administrators procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.

d. Comply with instructions of the Construction Administrator for use of temporary utilities and construction facilities.

e. Coordinate field engineering layout as specified in Section 01050 "Field Engineering" for work under the instructions of the Construction Administrator.

B. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.

3. Make provisions to accommodate items scheduled for later installation.

C. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the Construction Administrator, Owner and separate contractors where coordination of their work is required.

D. **Administrative Procedures:** Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of schedules.
2. Installation and removal of temporary facilities.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Project closeout activities.

E. **General Coordination Provisions:**

1. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed and coordinate such inspections with the Construction Administrator and authorities having jurisdictions. If unsatisfactory conditions exist notify the Construction Administrator immediately. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
2. The Contractor shall coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.
3. The Construction Administrator will meet with the Contractor on all major items of coordination.
4. See also General Conditions Article 7 “Cooperation of Trades”.

01045 CUTTING AND PATCHING

A. Openings and chases may not be shown on the Drawings. It is the responsibility of the Contractor to examine the Architectural, Electrical, Heating, Cooling, Ventilating and Plumbing Drawings and to provide chases, channels or openings where needed.

B. The Contractor shall install sleeves, inserts and hangers furnished by the trades needing same.

C. After installing work into openings, channels and/or chases, the Contractor shall close same. If finishes are to be restored, the new work shall match the original and shall be done by the trade customarily responsible for the particular kind of work.

D. Permission shall be obtained from the Construction Administrator before cutting beams, arches, lintels or other structural members.

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

1. Obtain approval from the Architect/Engineers of the cutting and patching proposal before cutting and patching the following structural elements:
   a. Foundation construction.
   b. Bearing and retaining walls.

c. Structural concrete.

d. Structural steel.

e. Lintels.

f. Structural decking.

g. Miscellaneous structural metals.

h. Exterior curtain-wall construction.

i. Equipment supports.

j. Piping, ductwork, vessels, and equipment.

k. Structural systems of special construction in Division 13 Sections.

F. Do cutting and patching to integrate all elements of the work. Provide penetrations of existing surfaces. Provide samples for testing. Seal penetrations through floors, walls, ceilings and roofs, as applicable; restore or preserve fire-rated and smoke-barrier construction. Construction and finishes shall match original work.

G. The Contractor shall verify dimensions for built-in work and/or work adjoining that of other trades before ordering any material or doing any work. Discrepancies shall be submitted to the Construction Administrator before proceeding with the work.

H. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

I. See also General Conditions Article 23 “Cutting, Fitting, Patching and Digging”.

01050 FIELD ENGINEERING

A. Provide field engineering services to establish and record grades, lines and elevations.

B. The Contractor shall retain a Professional Engineer or Land Surveyor registered by the State of Connecticut to lay out the building, underground utility lines and other site work from the horizontal and vertical control information furnished by the Owner and to establish and record the necessary elevations, at no additional cost to the State.

C. The Contractor shall forward a letter from his Land Surveyor or Professional Engineer stating that the control information furnished by the Owner, is accurate or shall identify inaccuracies, if they exist. The Contractor shall not take advantage of errors, which may be included in the control information. Stakes and markings shall be preserved.

01095 REFERENCE STANDARDS & DEFINITIONS

A. For products specified by association or trade standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. References to standard specifications and codes refer to the editions current at the bid due date. An exception is, buildings exceeding the threshold limit must be in substantial compliance with the requirements of the effective code at the time of receipt of completed application to the Office of State Building Inspector (OSBI). References include their addenda and errata, if any, and shall be considered a part of these specifications as if they were printed herein in full.

C. The manufacturers' standard warranties or guarantees shall apply when their products are used on this project.

D. Flame Spread Ratings - all materials that are required of obligated to meet specified standards shall be submitted to the owner for their records as part of the shop drawing submittal process for their construction records.

01120 RENOVATION/DEMOLITION PROJECT PROCEDURES

A. Products For Patching And Extending Work:

1. New materials: As specified in product sections; match existing Products and Work .for patching and extending Work.
2. Type and Quality of Existing Products: Determine by inspecting and testing Products where necessary, referring to existing Work as a standard.

B. Inspection- General:

1. Verify that demolition is complete and areas are ready for installation of new Work.
2. Beginning of restoration Work means acceptance of existing conditions.

C. Project Procedures for Work Involving Lead Containing Material (LBP):

1. Exposure levels for lead in the construction industry are regulated by 29 CFR 1926.62. Construction activities disturbing surfaces containing lead-based paint (LBP) which are likely to be employed, such as sanding, grinding, welding, cutting and burning, have been known to expose workers to levels of lead in excess of the Permissible Exposure Limit (PEL). Conduct demolition and removal Work specified in the technical sections of this specification in conformance with these regulations. In addition, construction debris/waste may be classified as hazardous waste. Disposal of hazardous waste material shall be in accordance with 40 CFR Parts 260 through 271 and Connecticut Hazardous Waste Management Regulations Section 22a-209-1; 22a-209-8(c); 22a-449(c)-11; and 22a-449(c)-100 through 110.
2. The Contractor's Work shall be based on a child under the age of six (6) in residence; the Work shall also be in accordance with Connecticut Regulations Section 19a-111-1 through 11.
3. This facility was constructed prior to 1978 and is likely to have painted surfaces containing lead-based paint.
4. Testing for lead-based paint has been conducted at the facility scheduled for renovation, demolition, reconstruction, alteration, remodeling, or repair. Results of the LBP testing are for information purposes only. The testing results are in a separate Volume of this Project Manual. Under no circumstance shall this information be the sole means used by the Contractor for determining the extent of LBP. The Contractor shall be responsible for verification of all field conditions affecting performance of the Work.

D. Project Procedures for Work Involving Asbestos Containing Material (ACM):

1. The Contractor is responsible for abating all ACM that is within the boilers, and is identified in Asbestos Inspection Reports. This is to be accomplished as part of the project. In demolition portion, every attempt shall be made by the Contractor to remove all ACM.
2. If the Contractor should encounter any material suspect or known to contain ACM, he should immediately notify the Construction Administrator of same. It is the Contractor’s responsibility to have the material tested and abated (if necessary).
3. Testing for asbestos has been conducted at the facility scheduled for renovation, demolition, reconstruction, alteration, remodeling, or repair. The asbestos testing results are for information purposes only. The testing results are in a separate Volume of this Project Manual.

Under no circumstance shall this information be the sole means used by the Contractor for determining the extent of asbestos. The Contractor shall be responsible for verification of all field conditions affecting performance of the Work.

4. See also General Conditions Article 23 "Cutting, Fitting, Patching and Digging".

E. Project Procedures for Work Involving Products Containing Persistent Bioaccumulative Toxic Chemicals" (PBT's) such as Polychlorinated Biphenols (PCB's), Di-2-ethylhexyl Phthalate (DEHP), and Mercury:

1. The Contractor is responsible for abating all PCB's, DEHP, and mercury prior to the start any work involving construction, renovation or demolition (if necessary).
2. Exposure Levels for Products Containing Persistent Bioaccumulative Toxic Chemicals (PBT's) such as PCB's. DEHP, and mercury in the construction industry is regulated by 29CFR1910.1200 and 29CFR1926.28 et. al. Construction, renovation or demolition activities disturbing Products Containing Persistent Bioaccumulative Toxic Chemicals" (PBT's) such as PCB's and DEHP which are likely to be employed. These materials include but are not limited to fluorescent light fixture & exit sign, ballast's, high density discharge (HID) lamps , and certain types of construction products containing vinyl, and mercury containing electrical switches and thermostats. These activities may expose workers in excess of the respective Permissible Exposure Limit (PEL). Conduct demolition and removal Work specified in the technical sections of these specifications in conformance with these regulations. In addition construction debris/waste may be classified as hazardous waste. Disposal of all hazardous materials shall be in accordance with but not limited to 40CRF Parts 761 Subpart K, 761, and 761.65 and the Connecticut General Hazardous Waste Statute Sec. 22a-454.
3. A Survey for Products Containing Persistent Bioaccumulative Toxic Chemicals (PBT's) such as PCB's, DEHP and Mercury has NOT been conducted at the facility. Examples include but are not limited to fluorescent light fixture & exit sign, ballast's, high density discharge(HID) lamps , and certain types of construction products containing vinyl, and mercury containing electrical switches and thermostats. It is the Contractors responsibility for verification of all material and field conditions prior to construction, renovation, and demolition that may affect the performance of their Work.

F. Preparation:

1. Cut, move, or remove items as are necessary for access to alterations and renovation Work. Replace and restore at completion.
2. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.
3. Remove debris and abandoned items from area and from concealed spaces.
4. Prepare surface and remove surface finishes to provide for proper installation of new Work and finishes.
5. Close openings in exterior surfaces to protect existing Work and salvage items from weather and extremes of temperature and humidity. Insulate ductwork and piping to prevent condensation in exposed areas.

G. Installation:

1. Coordinate Work of alterations and renovations to expedite completion and if required sequence Work to accommodate Owner occupancy.

2. Remove, cut and patch Work in a manner to minimize damage and to provide restoring Products and finishes to original and or specified condition in accordance with Section 01045 “Cutting and Patching”.
3. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes in accordance with Section 01045 “Cutting and Patching”.
4. In addition to specified replacement of equipment and fixtures, restore existing plumbing, heating, ventilation, air conditioning, electrical, systems to full operational condition.
5. Recover and refinish Work that exposes mechanical and electrical Work exposed accidentally during the Work.
6. Install Products as specified in individual sections.

H. Transitions:

1. Where new Work abuts or aligns with existing, perform a smooth and even transition. Patch work to match existing adjacent Work in texture and appearance.
2. When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect/Engineer.

I. Adjustments:

1. Where removal of partitions or walls result in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
2. Where a change of plane of ¼ inch in 12 inches or more occurs, request recommendation from Architect/Engineer for providing a smooth transition.
3. Trim existing doors as necessary to clear new floor finish. Refinish trim as required.
4. Fit Work at penetrations of surfaces as specified in Section 01045 “Cutting and Patching”.

J. Repair of Damaged Surfaces:

1. Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing imperfections.
2. Repair substrate prior to patching finish.

K. Finishes:

1. Finish surfaces as specified in individual Product sections.
2. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

L. Cleaning:

1. In addition cleaning specified in Section 01700 “Project Closeout”, clean Agency occupied areas of Work

01121 SALVAGEABLE MATERIALS

NOT USED

01200 PROJECT MEETINGS

A. Pre-construction Conference:

1. The Contractor will attend a Pre-construction Conference before starting construction, as scheduled by the Construction Administrator convenient to the Owner, the Construction Administrator, Architect, and Contractor. This meeting will take place within fourteen (14) Calendar Days after the written Notice to Proceed and before the Contract Start Date. Hold the conference at the Project Site or another convenient location as directed by the Construction Administrator. The Construction Administrator shall conduct the Pre-construction Conference to review the Contractor and Subcontractor responsibilities and personnel assignments.
2. Attendees: Authorized representatives of the Construction Administrator, Owner, Architect, and their consultants; the Contractor and its superintendent; major subcontractors; agency; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:
    a. Tentative construction schedule.
    b. Critical work sequencing.
    c. Progress meeting schedule.
    d. Designation of responsible personnel.
    e. Procedures for processing field decisions and Change Orders.
    f. Procedures for processing Applications for Payment.
    g. Distribution of Contract Documents.
    h. Submittal of Shop Drawings, Product Data, and Samples.
    i. Preparation of record documents.
    j. Use of the premises.
    k. Parking availability.
    l. Office, work, and storage areas.
    m. Equipment deliveries and priorities.
    n. Safety procedures.
    o. First aid.
    p. Security.
    q. Housekeeping.
    r. Working hours.
    s. Coordination with Audio-Visual and Telecommunications.

B. Progress Meetings:

1. The Construction Administrator will conduct progress meetings, bi-weekly, at the Project Site or at regular intervals as agreed upon at the Pre-construction Conference. The Construction Administrator will notify the Owner, the Architect, and the Contractor of the scheduled Progress

Meeting dates. Coordinate dates of Progress Meetings with preparation of Application for Payment requests.

2. Attendees: In addition to representatives of the Contractor, Construction Administrator, Owner and the Architect, subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities may be requested to attend these meetings on an as needed basis. All participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work. The Contractor shall include the site superintendent as a minimum.
3. Agenda: Progress Meetings shall review and correct or approve minutes of the previous Progress Meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.
    a. Construction Schedule: Review progress since the last Progress Meeting. Determine where each activity is in relation to the required Contractor's "Construction Schedule" and whether each activity is on time or ahead or behind Schedule. Determine how Work that is behind Schedule will be expedited; secure commitments from parties involved to do so. Discuss whether Schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time.
    b. Review the present and future needs of each entity present
4. Reporting: The Construction Administrator will distribute minutes of the meeting to each party present, promptly and before the next scheduled meeting, and to parties who should have been present.
5. A schedule of regular Project Meetings will be established at the Pre-construction Conference.

01300 SUBMITTALS

A. Summary

1. This Section includes administrative and procedural requirements for submittals required for performance of the Work, including but not limited to the following:
    a. Submittal Procedures.
    b. Submittal schedule.
    c. Daily Construction reports.
    d. Shop Drawings.
    e. Shop Drawings for Fire Protection Systems.
    f. Product Data.
    g. Samples.
    h. Quality assurance submittals.
    i. Architects Action.
    j. Submittals shall comply with all requirements in Division 1 Section 01631 "Equals and Substitutions".
    k. Submittals shall comply with all requirements in Division 1 Section 01740 "Warrantees and Bonds".

l. Submittals shall comply with all requirements in Division 1 Section 01040 “Coordination”.

m. Submittals shall comply with all requirements in Division 1 Section 01730 “Operation & Maintenance Manuals”.

B. Administrative Submittals: Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:

1. Permits.
2. Applications for Payment.
3. Performance and payment bonds.
4. Contractor’s construction schedule.
5. Daily construction reports.
6. Construction Photographs.
7. Insurance certificates.
8. List of subcontractors.
9. Subcontractors/Suppliers FEIN #’s and Connecticut tax registration #.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section 01027 "Application for Payment" specifies requirements for submittal of the Schedule of Values.
2. Division 1 Section 01040 "Coordination" specifies requirements governing preparation and submittal of required Coordination Drawings.
3. Division 1 Section 01200 "Project Meetings" specifies requirements for submittal and distribution of meeting and conference minutes.
4. Division 1 Section 01310 “Construction Schedules”.
5. Division 1 Section 01315 "CPM Schedule" specifies requirements for contractor's schedule submittal.
6. Division 1 Section 01380 "Construction Photographs" specifies requirements for submittal of periodic construction photographs.
7. Division 1 Section 01400 "Quality Control" specifies requirements for submittal of inspection and test reports.
8. Division 1 Section 01631 "Equals and Substitutions" specifies requirements for submittal of requests to use products other than those specified.
9. Division 1 Section 01700 "Contract Closeout" specifies requirements for submittal of Project Record Documents and warranties at project closeout.
10. Division 1 Section 01740 “Warranties and Bonds”.

D. Definitions

1. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended and as identified in the Specification Division 2 through 16.
2. Preparation of Coordination Drawings is specified in Division 1 Section "Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.

3. Field samples are full-size physical examples erected on-site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the Work will be judged.
4. Mockups are full-size assemblies for review of construction, coordination, testing, or operation; they are not Samples.

E. Submittal Procedures

1. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
    a. The Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
    b. The Architect reserves the right to reject incomplete submitted packages.
4. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.
    a. Allow (2) two weeks for initial review. Allow additional time if the Architect must delay processing to permit coordination with subsequent submittals.
    b. If an intermediate submittal is necessary, process the same as the initial submittal.
    c. Allow (2) two weeks for reprocessing each submittal.
    d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Architect sufficiently in advance of the Work to permit processing.

F. Submittal Preparation: Place a permanent label, title block or 8-1/2 inches x 11 inches cover page approved by the Architect, on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. The minimum number of copies required for each submittal shall be at a minimum 7 copies or as determine otherwise at the pre-construction conference or by the Construction Administrator.
2. Provide a space approximately 4 inches by 5 inches on the label, beside the title block or on the cover page on Shop Drawings to record the Contractor's review and approval markings and the action taken.
3. Include the following information on the label for processing and recording action taken.
    a. Project Name and State of Connecticut Project Number.
    b. Date.
    c. Name and address of the Architect, Construction Administrator, and Owner Representative.
    d. Name and address of the Contractor.
    e. Name and address of the subcontractor.
    f. Name and address of the supplier.
    g. Name of the manufacturer.

h. Number and title of appropriate Specification Section.

i. Drawing number and detail references, as appropriate.

j. Indicate either initial or resubmittal.

k. Indicate deviations from Contract Documents.

l. Indicate if "equal" or "substitution".

G. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the Architect using a transmittal form. Copy the Construction Administrator on the transmittal. The Architect will return all submittals to the Contractor after action is taken with a complete copy of the submittal package and one complete copy of the submittal package. The Architect will not accept submittals received from sources other than the Contractor.

1. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

H. Submittal Schedule

1. After development and review by the Owner and Architect acceptance of the Contractor's Construction or CPM schedule prepare a complete schedule of submittals. Submit the schedule to the Construction Administrator within 30 days of Contract Award.
2. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products as well as the contractor’s Construction or CPM Schedule.
3. Prepare the schedule in chronological order. Provide the following information:
   a. Schedule date for the initial submittal.
   b. Related section number.
   c. Submittal category (Shop Drawings, Product Data, or Samples).
   d. Name of Subcontractor.
   e. Description of the part of Work covered.
   f. Scheduled date for resubmittal.
   g. Scheduled date for the Architect’s final release of approval.

I. Distribution: Following response to the initial submittal, print and distribute copies to the Construction Administrator, Architect, Owner, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

J. Schedule Updating: Revise the schedule after each meeting or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

K. Daily Construction Reports

1. Prepare a daily construction report recording the following information concerning events at the site, and submit duplicate copies to the Construction Administrator at weekly intervals:
   a. List of subcontractors at the site.
   b. Approximate count of personnel at the site.
   c. High and low temperatures, general weather conditions.
   d. Accidents and unusual events.
   e. Meetings and significant decisions.
   f. Stoppages, delays, shortages, and losses.
   g. Meter readings and similar recordings.
   h. List of equipment on site and identify if idle or in use.
   i. Orders and requests of governing authorities.
   j. Change Orders received, start and end dates.
   k. Services connected, disconnected.
   l. Equipment or system tests and startups.
   m. Partial Completion's, occupancies.
   n. Substantial Completion's authorized.
   o. Equals or Substitutions approved or rejected.

L. Shop Drawings

1. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
2. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:
   a. Dimensions.
   b. Identification of products and materials included by sheet and detail number.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 36 by 48 inches.
   g. Submit one (1) reproducible media and seven (7) prints as directed by the Construction Administrator. The Contractor's submittal shall identify the specification section and/or drawing number applicable to the submittal.
   h. Details shall be large scale and/or full size.
3. The Contractor shall review the Shop Drawings, stamp with this approval, and submit them with reasonable promptness and in orderly sequence so as to cause no delay in his Work or in the

Work of any subcontractor. Shop Drawings shall be properly identified as specified for item, material, workmanship, and project number. At the submission, the Contractor shall inform the Architect, in writing of any deviation in the shop drawings from the requirements of the Contract Documents.

4. The Architect will review and comment on shop drawings with reasonable promptness so as to cause no delay, but only for conformance with the design concept of the project and with the information given in the Contract Documents. Refer to Article 5 of General Conditions. Shop Drawings received by the Architect that indicate insufficient study of drawings and specifications, illegible portions or gross errors, will be rejected outright. Such rejections shall not constitute an acceptable reason for granting the Contractor additional time to perform the work.
5. The Contractor shall make any corrections required by the Architect and shall resubmit the required number of corrected copies of shop drawings until fully reviewed.
6. Upon final review submit four (4) additional prints, same as submitted, to the Construction Administrator for his use.
7. The Architect's review and comments on shop drawings shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents.
8. Only final reviewed shop drawings are to be used on the project site.
9. The Work installed shall be reviewed in accordance with the shop drawings and the drawings and specifications. Final Review of the shop drawings by the Architect shall constitute acceptance by the State and the Architect of a variation or departure that is clearly identified. Final reviewed shop drawings shall not replace or be used as a vehicle to issue or incorporate change orders.

M. Shop Drawing for the Fire Protection Systems

1. Shop drawings for fire protection systems shall comply with all of the requirements in the section above “Shop Drawings” In addition Sprinkler system shop drawings and hydraulic calculations must be stamped by a professional engineer licensed in the state of Connecticut and must include the DPW project number. Two (2) sets of information [as noted in Division 1 “Submittals” Section 01300] shall be submitted to the State's Insurance Carrier (SIC), and one (1) set shall be submitted to a) the State Fire Marshals (SFM) office for projects exceeding statutory threshold limit or b) to DPW Code Unit for those projects which do not exceed statutory threshold limit.

STATE INSURANCE CARRIER (SIC):
FM Global
Factory Mutual Insurance Company
P.O. Box 9102 500 River Ridge Drive
Norwood, MA 02062
Tel: (781) 440-8000 or FAX (781) 440-8742
Contact: Costa Terzides (781) 440-8204 or Jeannette Dantona (781) 440-8245

Exceeds Threshold		**Does not exceed threshold**
STATE FIRE MARSHALS (SFM):		DPW Codes Unit
Deputy State Fire Marshal		State Office Building - DPW

1111 Country Club Road, PO Box 2794		165 Capitol Avenue Room 280
Middletown, CT 06457		Hartford, CT 06106
Tel: (860) 685-8350		Ira Henowitz (860) 713 5708 or
		Lisa Humble (860) 713-5729

Before the shop drawings are submitted to SIC or Code (either SFM or DPW), the A/E and/or the A/E fire protection consultant must review the sprinkler design for compliance with the code and DPW requirements. SIC review comments will be addressed to the DPW Chief Engineer. The DPW Chief Engineer shall confirm to the A/E any changes required by SIC/SFM. The A/E is responsible for changes that result from the SIC and/or Code (SFM or DPW) required during construction.

The State Insurance Carrier (SIC) requires two- (2) weeks prior notice of a sprinkler system acceptance test.

N. Product Data

1. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, schedules, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring iagrams, and performance curves.
2. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
   a. Manufacturer's printed recommendations.
   b. Compliance with trade association standards.
   c. Compliance with recognized testing agency standards.
   d. Application of testing agency labels and seals.
   e. Notation of dimensions verified by field measurement.
   f. Notation of coordination requirements.
3. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
4. Preliminary Submittal: Submit a preliminary single copy of Product Data where selection of options is required.
5. Submittals: Submit 7 copies of each required submittal; submit 5 copies where required for maintenance manuals. The Architect will retain one and will return the other marked with action taken and corrections or modifications required.
   a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
6. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
   a. Do not proceed with installation until a copy of Product Data is in the Installer's possession.
   b. Do not permit use of unmarked copies of Product Data in connection with construction.

O. Samples

1. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
2. Store, mount or display Samples on site in the manner to facilitate review of qualities indicated. Prepare Samples to match the Architect's sample. Include the following:
   a. Specification Section number and reference.
   b. Generic description of the Sample.
   c. Sample source.
   d. Product name or name of the manufacturer.
   e. Compliance with recognized standards.

f. Availability and delivery time.

3. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
   a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least (3) three multiple units that show approximate limits of the variations.
   b. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
   c. Refer to other Sections for Samples to be returned to the Contractor for incorporation in the Work. Such Samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Sample submittals.
   d. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.
4. Preliminary Submittals: Submit a full set of choices where Samples are submitted for selection of color, pattern, texture, or similar characteristics from a range of standard choices, unless otherwise noted in specification section..
   a. The Architect will review and return preliminary submittals with the Architects notation, indicating selection and other action.
5. Submittals: Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation, and similar characteristics, submit (3) sets. The Architect will return one set marked with the action taken.
6. Maintain sets of Samples, as returned, at the Project Site, for quality comparisons throughout the course of construction.
   a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
   b. Sample sets may be used to obtain final acceptance of the construction associated with each set.
7. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.
   a. Field samples are full-size examples erected on-site to illustrate finishes, coatings, or finish materials and to establish the Project standard.
8. Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

P. Quality Assurance Submittals

1. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.
2. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.
    a. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.
3. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

Q. Architect's Action

1. Except for submittals for the record or information, where action and return is required, the Architect will review each submittal, mark to indicate action taken, and return promptly.
    a. Compliance with specified characteristics is the Contractor's responsibility.
2. Action Stamp: The Architect will stamp each submittal with a uniform, action stamp. The Architect will mark the stamp appropriately to indicate the action taken, as follows:
    a. Final Unrestricted Release: When the Architect marks a submittal "Approved for fabrication," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
    b. Final-But-Restricted Release: When the Architect marks a submittal "Incorporate Notations," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Submit corrected copies for record. Final payment depends on that compliance.
    c. Returned for Resubmittal: When the Architect marks a submittal "Rejected, or Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
        1) Do not use, or allow others to use, submittals marked "Rejected, or Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
        2) Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Architect will return the submittal marked "Action Not Required."
    d. Unsolicited Submittals: The Architect will discard unsolicited submittals without action.

01310 CONSTRUCTION SCHEDULE

A. Definitions:

1. Construction Schedule: A method of planning and scheduling a construction project utilizing a horizontal bar chart with a separate bar for each major portion of the Work or operation to make the schedule an effective tool for planning and monitoring the progress of the work.

B. Quality Assurance: The Contractor's Consultant: Retain a consultant to provide planning, evaluating, and reporting by CPM scheduling.

1. In-house Option: The Owner may waive the requirement to retain a consultant if the Contractor can demonstrate that:
   a. The Contractor has the computer equipment required to produce construction schedules.
   b. The Contractor employs skilled personnel with experience in construction scheduling and reporting techniques.
2. Program: Use “Microsoft Project”, latest version.
3. Standards: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

C. Construction Schedule Format:

1. Format: Utilize a horizontal bar chart (gantt) with a separate bar for each major portion of the Work or operation, identifying first work day of each week.
2. Program: Use Microsoft Project, latest version.
3. Sequence of Listings: Utilize the Table of Contents of this Project Manual and the chronological order of the start of each item of work.
4. Scale and Spacing: Provide space for notations and revisions.
5. Sheet Size: To be coordinated with Construction Administrator.

D. Content:

1. Show complete sequence of construction by activity, with dates beginning and completion of each element of construction.
2. Identify each item by specification section number.
3. Identify work of separate phases other and other logically grouped activities.
4. Show accumulated percentages of completion of each item, and total percentage of Work completed, as of the first day of each month.
5. Provide separate schedule of submittal dates for shop drawings, product data, and samples, Owner/Agency furnished products and any products identified as under Allowances, and dates reviewed submittals will be required from Architect/Engineer. Indicate decision dates for selection of finishes.
6. Indicate delivery dates for Owner/Agency furnished products and any products identified as under Allowances.
7. Coordinate content with Schedule of Values specified in Section 01027 “Application for Payment”.
8. Indicate critical path with original baseline indicated.

E. Submittals And Revisions To Schedules:

1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
3. Provide narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect.

4. An initial bar graph (gantt) schedule is to be prepared by the General Contractor and submitted to the Construction Administrator within seven (7) Working calendar days of award of contract. This schedule is to cover all items of work from the start of the project up to the completion of the project. After review, resubmit required revised data within five (5) Working calendar days. This schedule must be revised monthly and when the actual schedule of significant items varies more than seven (7) Calendar days from the proposed schedule. The critical path with baseline must be indicated.
5. Submit revised Construction Schedules each Application for Payment.
6. Submit four (4) copies of the Construction Schedule to the Construction Administrator.

F. Distribution:

1. Distribute copies of the Construction Schedules to Construction Administrator, Architect, Owner, Subcontractors, suppliers, and other concerned parties.
2. Instruct recipients to promptly report, in writing, problem anticipated by projections indicated in schedules.

01380 CONSTRUCTION PHOTOGRAPHS

A. On the date the work is begun and every thirty (30) days thereafter (typically at the end of the month- until the work is at least 95 percent complete), the Contractor shall have photographs of the construction taken by a professional photographer or an individual approved by the Owner.

B. Photographs: Provide a digital camera to take (24) or more photos each time. Deliver 1 sets of photo files on CD-ROM and one set of prints to the Construction Administrator for the department. Label each CD-ROM with project name and the date the photographs were taken. With each submittal provide an index sheet of digital photos and where the photos were taken.

C. As photographs are a record of the work progress, they shall be taken each month, whether or not they show work done during the preceding month. Deliver digital photos to the Construction Administrator within 10 days of their taking.

01400 QUALITY CONTROL

A. Contractor Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, the Owner, through the Construction Administrator, shall provide Fire Alarm Acceptance testing, inspections, tests, and other quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction. All tests required by the individual specification sections are required to be scheduled and notification given to the Construction Administrator twenty-four (24), forty-eight (48) hours in advance to the test/inspection as applicable. Costs for these services are not included in the Contract Sum.

1. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Contractor's responsibility, the Contractor shall employ and pay a qualified independent testing agency to perform quality-control services. Costs for these services are included in the Contract Sum.
2. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Owner's responsibility, the Owner will employ and pay a qualified independent testing agency to perform those services.

a. Such services include Special Inspections as required by the latest adoption of the "Connecticut State building Code".

b. Where the Owner has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the Owner. The Owner will engage the services of a qualified Special Inspector for this project. The Special Inspector, as a representative of the Owner, shall document and confirm compliance with the provisions of the Connecticut State Building Code for Special Inspections.

c. Materials and assemblers for this project will be tested and construction operations inspected as the work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the State for final acceptance.

d. The Owner use of testing and inspection services shall in no way relieve the contractor of the responsibility to furnish materials and finished construction in full compliance with the Contract Documents and the Connecticut State Building Codes.

B. Retesting: The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements, regardless of whether the original test was Contractor's responsibility.

1. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements.
2. The Owner will issue a credit change order to cover all costs incurred related to all re-tests/re-inspection due to non-compliance to the contract documents, including but not limited to the Owners costs and the Consultants costs.

C. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:

1. Provide access to the Work.
2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
4. Provide facilities for storage and curing of test samples.
5. Deliver samples to testing laboratories.
6. Provide an approved design mix proposed for use for material mixes that require control by the testing agency.
7. Provide security and protection of samples and test equipment at the Project Site.

D. Duties of the Testing Agency: The independent testing agency engaged to perform inspections, sampling, and testing of materials and construction specified in individual Sections shall cooperate with the Construction Administrator, Architect and the Contractor in performance of the testing agency's duties. The testing agency shall provide qualified personnel to perform required inspections and tests.

1. The testing agency shall notify the Construction Administrator and the Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. The testing agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
3. The testing agency shall not perform any duties of the Contractor.

E. Owner will pay for the services of an independent testing agency laboratory to perform inspections, tests and other services required by the Specifications except as noted below, listed for which the Owner will issue a deduct change order to cover the cost associated with these tests:

1. When the Contractor notifies the Construction Administrator and/or Testing Agency less than twenty-four (24) hours before the expected time of testing.
2. When the Contractor requires testing for his own convenience.
3. When the Contractor schedules a test and is not ready for the required test.

F. Reports of test that are part of the submittal requirements which indicate compliance or non-compliance with the specified standard.

G. See also General Conditions Article 16 “Inspections and Tests”.

H. Fire Alarm/Acceptance Testing Procedures:

1. For buildings exceeding the threshold limit, the fire alarm testing shall be as the authority having jurisdiction shall dictate. This will be as determined by the State Fire Marshals Office.
2. For buildings that do not exceed the threshold limit, the fire alarm testing shall be as the authority having jurisdiction shall dictate. This will be determined by the Department of Public Works requirements as set below:
   a. Protective Signaling Systems:

      All protective signaling systems shall meet with acceptance testing requirements of the applicable standards listed in Section 7-6.1.4, NFPA 101/1997 and NFPA 13/19996.

   b. Prior Test Notification:

      At least 5 working days prior to testing, the Fire Alarm Contractor shall notify (in writing) the following people of the proposed date the acceptance tests are to be performed (Also, see Part 2 of Certificate of Compliance).

      - Department of Construction Services Team Representative
      - General Contractor
      - Engineer of Record
      - Equipment Supplier Representative
      - Sprinkler Contractor

   c. Certificates of Compliance
      1) A Fire Alarm System Inspection and Testing Certification and Description form shall be prepared for each system (See NFPA 72/1999 Chapter 7 and Figure 7-5.2.2).
      2) Parts 1 and 3 through 9, shall be completed after the system is installed and the installation of the wiring has been checked. Every alarm device must also be pre-tested to ensure proper operation and correct annunciation at each remote annunciator and control panel. Part 1 of the form (Certification of System Installation) shall be signed by the fire alarm contractor. The signed and completed preliminary

copies of the Certification form shall be forwarded to all parties along with the Prior Test Notification.

3) Part 2, of each applicable form, shall be completed after the operational tests have been completed.
4) After the completion of the operational acceptance tests and sign-off of test witness (with stipulations noted), final copies of the Certificates shall be forwarded to the Department of Construction Services Representatives.

d. Tests:
   1) All tests shall be conducted in accordance with the Manufacturers Testing Recommendations.
   2) All testing equipment, apparatus (i.e. sound level decibel meter, 2-way radio communication, test devices, ladders, tools, lighting, etc.) and personnel shall be supplied by the Fire Alarm Contractor and Sprinkler Contractor.

e. System Documentation:

   Every system shall include the following documentation, which shall be delivered to the Department of Public Works Representatives upon final acceptance of the system. An owner's manual or manufacturer's installation instructions covering all system equipment, including the following:
   1) A detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, intended sequence of operations, expansion capability, application considerations, and limitations.
   2) Operators instructions for basic systems operations including alarm acknowledgment, system reset, interpreting system output (LED's CRT display, and printout), operation of manual evacuation signaling and ancillary function controls, changing printer paper, etc.
   3) A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including testing and maintenance instructions for each type of device installed. This information should include:
      a) A listing of individual system components that require periodic testing and maintenance.
      b) Step by step instructions detailing the requisite testing and maintenance procedures and the intervals at which those procedures should be performed.
      c) A schedule that correlates the testing and maintenance procedures required by paragraph (2) above and with the listing required by paragraph (1) above.
   4) Detailed troubleshooting instructions for each type of trouble condition recognized by the system, including opens, grounds, parity errors, "loop failures," etc. These instructions should include a list of all trouble signals, and step by step instructions describing how to isolate those problems and correct them (or call for service as appropriate).
   5) A service directory, including a list of names and telephone numbers for those who should be called to service on the system.

f. As-Built Drawings:

   The Contractor will produce two sets of as-built drawings and specifications for the fire alarm system, indicating the location (and programmed address, if applicable) of all devices and appliances, the wiring sequences, wiring methods, connection of the components, and

sequence of operation of the protective signaling system as installed, shall be given to DPW representatives. This shall be in Accordance with NFPA 72. Refer also to Section 01700 “Contract Closeout”.

I. Submittals:

1. Unless the Contractor is responsible for this service, the independent testing agency shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the Construction Administrator. If the Contractor is responsible for the service, submit a certified written report, in duplicate, of each inspection, test, or similar service through the Contractor.
2. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
3. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:
    a. Date of issue.
    b. Project title and number.
    c. Name, address, and telephone number of testing agency.
    d. Dates and locations of samples and tests or inspections.
    e. Names of individuals making the inspection or test.
    f. Designation of the Work and test method.
    g. Identification of product and Specification Section.
    h. Complete inspection or test data.
    i. Test results and an interpretation of test results.
    j. Ambient conditions at the time of sample taking and testing.
    k. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.
    l. Name and signature of laboratory inspector.
    m. Recommendations on re-testing.

J. Quality Assurance:

1. Qualifications for Service Agencies: Engage inspection and testing service agencies, including independent testing laboratories, that are pre-qualified as complying with the National Voluntary Laboratory Accreditation Program and that specialize in the types of inspections and tests to be performed.
    a. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the state where the Project is located.

K. Repair and Protection:

1. General: Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes. Comply with Contract Document requirements for Division 1 Section "Cutting and Patching."
2. Protect constructions exposed by or for quality-control service activities, and protect repaired construction.
3. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

01505 TEMPORARY ELECTRICITY AND LIGHTING

NOT USED

01510 TEMPORARY HEATING, COOLING AND VENTILATING AND LIGHTING

A. Provide temporary heat during construction for interior areas included in the Contract to counteract low temperatures or excessive dampness and, in any event, between October 15th and April 15th. Maintain during said period or periods until final completion of the Contract, unless otherwise approved by the Owner in writing. Windows, doors, ventilators and similar openings shall be temporarily closed. Provide heat and ventilation to maintain specified conditions for construction operations and to protect materials and finishes from damage by temperature or humidity. The permanent heating system is not to be used for temporary heating unless approved, in writing, by the Owner. The Contractor shall pay costs. See individual Sections for temperature/humidity limits. Temporary H methods shall comply with OSHA regulations and other applicable codes, statutes, rules and regulations and shall be approved by the Department of Construction Services.

B. Permanent air handling equipment, when used for temporary heating, shall be equipped with disposable "construction" filters. The construction filters shall have an average efficiency at least equal to the filters specified under Division 15, but not less than 30% when tested in accordance with ASHRAE 52-76. The filters shall have an average arrestance of not less than 90% efficiency on one (1) micron size particles. Before turning over the system for final acceptance, the contractor shall remove and dispose of the construction filters; spray clean the heating and cooling coils, and drain pans to "like new" condition; and install the filters specified in Division 15.

C. The General Contractor may use the existing heating system with temporary extensions, radiators or unit heaters, but such use is subject to the Owner's approval. Coordinate use of existing facilities with Owner. Provide additional, temporary extensions and units to satisfy the criteria given in the preceding paragraph. Owner will pay cost of energy used. Take measures to conserve energy. At the termination of construction, return the facilities to their original condition. Before operation of permanent facilities, verify that installation is approved for operation and that filters are in place.

D. Steam from the Agency's lines shall be metered and paid for by the Contractor at a price approved by the Agency and Department of Construction Services. The Contractor shall arrange with his Heating Subcontractor to install and maintain temporary piping, radiators, or unit heaters, reducing valves, steam traps and other necessary fittings and accessories. Traps shall be provided to prevent steam from entering main returns. The temporary layout shall meet the approval of the Architect/Engineer. Condensate meter (or meters) shall be installed to record usage of steam. (The following sentence shall be used when steam is supplied free: "Steam from the Agency's lines will be furnished to the Contractor without cost, but may be discontinued if use is unreasonable or wasteful".) At the termination of construction, return the facilities to their original condition.

01515 TEMPORARY TELEPHONE

A. General Contractor shall use a cellular phone. All calls will be paid by the Contractor.

01520 TEMPORARY WATER

A. NOT USED

01525 TEMPORARY SANITARY FACILITIES

A. Designated existing toilets may be used during construction. It is the responsibility of the Contractor to maintain the facilities in a clean and sanitary condition and return them to their original condition after use. No loitering or smoking will be permitted in these areas.

01530 FIRE PROTECTION

A. The Contractor, during construction, shall be responsible for loss or damage by fire to the work of the Contract until completion. Any fire used within the structure for working purposes shall be extinguished when not in use. Bitumen or tar shall be melted on the ground only. No flammable material shall be stored in the structure in excess of amounts allowed by the authorities. No gasoline shall be stored in or close to the building at any time. The Contractor shall assign a responsible employee to be in charge of fire protection measures.

B. If an EPDM or other single-ply roof is included in the work that requires cleaning of mating surfaces of laps with gasoline, limit amount of gasoline on roof to 2 gallons which shall be in U.L. listed containers. Also provide one 30 B:C fire extinguisher within 75 feet of any point on the roof.

01535 CONSTRUCTION EQUIPMENT

A. The Contractor shall furnish tools, apparatus and appliances, hoists and/or cranes and power for same, scaffolding, runways, ladders, temporary supports and bracing and similar work or material necessary to insure convenience and safety in the execution of the Contract except where this is otherwise specified in any Specification Section. All such items shall meet the approval of the Department of Public Works but responsibility for design, strength and safety shall remain with the Contractor. All such items shall comply with Federal OSHA regulations and applicable codes, statutes, rules and regulations, including compliance with the requirements of the current edition of the "Manual of Accident Prevention in Construction" published by the A.G.C. and the standards of the State Labor Department.

B. Staging, exterior and interior, required for the execution of this Contract, shall be furnished, erected, relocated if necessary and removed by the General Contractor. Staging shall be maintained in a safe condition without charge to and for the use of all trades as needed.

01540 BARRIERS AND ENCLOSURES

A. Provide barriers to prevent public entry into construction areas and to protect existing facilities from damage by construction operations.

B. Provide a fence around construction site; equip with vehicular and pedestrian gates with locks.

C. Provide covered walkways as required by governing authorities for public rights-of-way and for public access to existing buildings.

D. Provide barriers around trees and plants designated to remain. Protect against vehicular traffic, materials' dumping, chemically injurious materials, puddling or running water.

E. Provide temporary, insulated, weathertight closures at openings to the exterior to provide acceptable working conditions and protection for materials, to allow for temporary heating and to prevent entry of unauthorized persons. Provide doors with self-closing hardware and locks.

F. Barriers and enclosures shall be in conformance with code requirements. Do not block egress from occupied buildings unless necessary to further the work of the Contract. In this case, secure the Department's approval of an alternate egress plan.

G. See also General Conditions Article 19 “Protection of the Work, Persons and Property”.

01545 PROTECTION

A. Protect buildings, equipment, furnishings, grounds and plantings from damage. Any damage shall be repaired or otherwise made good at no expense to the State.

B. Provide protective coverings and barricades to prevent damage. The Contractor shall be held responsible for, and must make good at his own expense, any water or other type of damage due to improper coverings. Protect the public and building personnel from injury.

C. Provide temporary protection for installed products. Control traffic in immediate area to minimize damage.

D. Provide protective coverings for walls, projections, jambs, sills and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects and storage. Prohibit traffic and storage on waterproofed and roofed surfaces and on lawn and landscaped areas.

E. Provide temporary partitions and ceilings to separate work areas from Owner-occupied areas to prevent penetration of dust and moisture into Owner-occupied areas and equipment. Erect framing and sheet materials with closed joints and sealed edges at intersections with existing surfaces.

F. See also General Conditions Article 19 “Protection of the Work, Persons and Property”.

01550 SECURITY

A. The Contractor shall be solely responsible for damage, loss or liability due to theft or vandalism.

01555 TRAFFIC WAYS

A. The Contractor may use on-site paved roads and parking areas but shall not encumber same or their access. Public highways shall not be blocked by standing trucks, parked cars, material storage, construction operations or in any other manner.

B. Public roads and existing paved roads, drives and parking areas on Owner's property shall be kept free from scrap or debris due to construction operations and any damage to their surface caused by the Contractor shall be repaired by him at his own expense.

C. If the work of the Contract affects public use of any street, road, highway or thoroughfare, the G. C. shall confer with the police authority having jurisdiction to determine if and how many police are needed for public safety in addition to any barriers and signals that may be needed. The G.C. will be responsible for payment of any needed police services.

01560 TEMPORARY CONTROLS

A. Temporary Environmental Controls: Contractor is to provide the following controls.

1. Rodent and Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Employ this service to perform extermination

and control procedures at regular intervals so the Project will be free of pests and their residues at materials.

2. Dust Control (construction and demolition).
3. Noise Control.
4. Erosion and Sediment Control.
5. Pollution Control.
6. Traffic Control.

01565 STORM WATER CONTROL – NOT USED

01570 CLEANING

A. Maintain areas under Contractor's control free of waste materials, debris and rubbish. Maintain in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces before closing the space.

C. Periodically clean interior areas before start of surface finishing and continue cleaning on an as-needed basis.

D. Control cleaning operations so that dust and other particulates will not adhere to wet or newly-coated surfaces.

E. Remove waste materials, debris and rubbish from site daily and dispose of legally off-site. No scrap/debris shall remain inside the building or anywhere on site upon final acceptance of the project.

F. See also General Conditions Article 24 “Cleaning Up”.

01575 PROJECT SIGNS – NOT USED

01580 FIELD OFFICES AND SHEDS – NOT USED

01585 IDENTIFICATION BADGES

A. Identification Badges for Contractor's Personnel, Visitors & Parking Stickers:

1. The Contractor will provide each person working or visiting at the site with an identification badge, bearing the name of the Contractor and a number. As badges are assigns, a record shall be kept by the Contractor and given to the Construction Administrator and Agency Administrator. Update and correct the records of all badges issued on a semi-monthly basis.
2. Badges are to be worn on outer garment where visible at all times while at the construction site, return them to the Contractor’s field office at the end of each day and pick them up there each morning.
3. All vehicles parking in the Contractor's parking lot and those used around the site require an ID sticker. They will be issued by the Agency. Each contractor shall apply for parking stickers

through the Construction Administrator no more than semi-monthly and shall keep record of all stickers issued.

01600 MATERIALS AND EQUIPMENT CONTROLS

A. Materials and Equipment: Shall be delivered, stored and handled to prevent intrusion of foreign matter and damage by weather or breakage. Packaged materials shall be delivered and stored in original, unbroken packages.

1. Promptly inspect shipments to assure that products comply with requirements, that quantities are correct and products are undamaged.
2. Packages, materials and equipment showing evidence of damage will be rejected and replaced at no additional cost to the Owner.

B. Storage and Protection:

1. Store products in accordance with manufacturers' instructions with seals and labels intact and legible. Store sensitive products in weathertight enclosures; maintain within temperature and humidity range required by manufacturer.
2. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.
3. Store loose granular material on solid surfaces in a well-drained area; prevent mixing with foreign matter.
4. Arrange storage to provide access for inspection. Periodically inspect to insure products are undamaged and are maintained under required conditions. Keep log showing date, time and problems, if any.
5. Stone, masonry units and similar materials shall be stored on platforms or dry skids and shall be adequately covered and protected against damage.
6. The Contractor shall prepare, as directed by the Owner, one area or space in the building for storage of State-owned equipment.

01631 EQUALS AND SUBSTITUTIONS

A. Definitions: Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.

1 Equals or Substitutions General: Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract.

2 Equal: Any deviation from the specification which is defined as follows: A replacement for the specified material, device, procedure, equipment, etc., which is recognized and accepted as substantially equal to the first listed manufacturer or first listed procedure specified, after review, by the Architect and may be rejected or approved at the sole discretion of the owner. All equals must be substantially equivalent to the first manufacturer or first procedure listed in the Specifications with reference to all of the following areas: the substance and function considering quality, workmanship, economy of operation, durability and suitability for purposes intended; size, rating and cost. The equal does not constitute a modification in the scope of

Work, the Schedule or Architect/Engineer's design intent of the specified material, device, procedure, equipment, etc.

3 Substitution: Any deviation from the specified requirements, which is defined as follows: A replacement for the specified material, device, procedure, equipment, etc., which is not recognized or accepted as equal to the first manufacturer or procedure listed in the Specification after review by the Architect and may be rejected or approved by the Owner. The Substitution is not equal to the specified requirement in comparison to the first manufacture or first procedure listed in the Specifications in one or more of the following areas: the substance and function considering quality, workmanship, economy of operation, durability and suitability for purposes intended; size; cost and rating. The Substitution constitutes a modification in the scope of Work, the Schedule or the Architect/Engineer's design intent of the specified material, device, procedure, equipment, etc.

4 The following are not considered to be requests for Equals or Substitutions:

a. Revisions to the Contract Documents requested by the Owner or Architect.

b. Specified options of products and construction methods included in the Contract Documents.

c. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities having jurisdiction.

B. Submittals:

1. Equals and Substitution Request Submittals: The Owner will consider requests for equals or substitutions if received within time period designated in the General Conditions Article 15 "Materials; Standards". Requests received more than the days specified in Article 15 after the start date of the contract will be rejected.

a. The Contractor is required to prepare and submit 3 copies of the required data for the first manufacturer listed or procedure listed in the specifications section with reference to all of the following areas: the substance and function considering quality, workmanship, economy of operation, durability and suitability for purposes intended including the size, rating and cost. All submissions must include all the required data for the first listed manufacturer or procedure as specified, as well as the required data for the proposed Equal or Substitution. This will enable the Owner and Architect to determine that the proposed Equal or Substitution is or is not substantially equal to the first listed manufacturer or procedure.

2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.

3. Provide complete documentation showing compliance with the requirements for equals or substitutions, and the following information, as appropriate on a "Substitution Request" form as required by the Owner:

a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate contractors, that will be necessary to accommodate the proposed Equal or Substitution.

b. A detailed comparison chart of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, durability, and visual effect.

c. Product Data, including Shop Drawings and descriptions of products and fabrication and installation procedures.

d. Samples, where applicable or requested.

e. A statement indicating the effect on the Contractor's Construction Schedule or CPM Schedule compared to the schedule without approval of the Equal or Substitution. Indicate the effect on overall Contract Time.

f. Cost information, broken down, including a proposal of the net change, if any in the Contract Sum.

g. The Contractor's certification that the proposed Equal or Substitution conforms to requirements in the Contract Documents in every respect and is appropriate for the applications indicated.

h. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the Equal or Substitution to perform adequately.

4. Architect's Action: If necessary, the Architect will request additional information or documentation for evaluation within one week of receipt of the original request for equal or substitution request. The Architect will notify the Construction Administrator who will notify the Owner of recommended acceptance or rejection of the proposed equal or substitution, within two (2) weeks of receipt of the request, or one (1) week of receipt of additional information or documentation, whichever is later. The Construction Administrator will give final acceptance or rejection by the Owner not less than one (1) week after notification.

   a. Any request deemed an "Equal" and accepted by the Construction Administrator, Architect, Owner, and Agency will result in written notification to the Contractor and will not be in the form of a change order for an "Equal".

   b. Any request deemed a "Substitution" and rejected or approved by Construction Administrator, Architect, and Owner may result in written notification to the Contractor and may be in the form of a change order if the "Substitution" is approved.

C. Equal or Substitutions:

1. Conditions: The Architect will consider the Contractor's request for Equal or Substitution of a product or method of construction when one or more of the following conditions are satisfied, as determined by the Architect. If the following conditions are not satisfied, the Architect will return the requests to the Construction Administrator without action except to record noncompliance with these requirements.

   a. The proposed request does not require extensive revisions to the Contract Documents.

   b. The proposed request is in accordance with the general intent of the Contract Documents.

   c. The proposed request is timely, fully documented, and/or properly submitted.

   d. The proposed request can be provided within the Contract Time. However, the Architect will not consider the proposed request if it is a result of the Contractor's failure to pursue the Work promptly or coordinate activities properly.

   e. The proposed request will offer the Owner a substantial advantage, in cost, time, energy conservation, or other considerations, after deducting additional responsibilities the Owner must assume. However, if the proposed request requires the Owner to incur additional responsibilities, including but not limited to, additional compensation to the Architect for redesign and evaluation services, increased cost of other construction by the Owner or similar considerations, then the Owner will have just cause to reject the request for Equal or Substitution.

f. The proposed request can receive the necessary approvals, in a timely manner, required by governing authorities having jurisdiction.

g. The proposed request can be provided in a manner that is compatible with the Work as certified by the Contractor.

h. The proposed request can be coordinated with the Work as certified by the Contractor.

i. The proposed request can uphold the warranties required by the Contract Documents as certified by the Contractor.

2. The Contractor's submission and the Architect's review of Submittals, including but not limited to, Samples, Manufacturer's Data, Shop Drawings, or other such items, which are not clearly identified as a request for an Equal or Substitution, will not be considered or accepted as a valid request for an Equal or Substitution, nor does it constitute an approval.

01650 STARTING OF SYSTEMS

A. General:

1. Coordinate schedule for start-up of various equipment and systems.
2. Provide written notification the Construction Administrator thirty (30) Calendar Days prior to start-up of each item.
3. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, and control sequence for other conditions that may cause damage.
4. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
5. Verify in wiring and support components are complete and tested.
6. Execute the start-up under supervision of manufacturer's representative, in accordance with manufacturer's instructions.
7. When referenced in individual specification sections, require manufacturer to provide an authorized representative to be present at the site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
8. Submit a written report in accordance Section 01400 "Quality Control" that the equipment or system has been properly installed and is functioning properly.

B. Demonstration and Instructions:

1. Demonstrate operation and maintenance of Products to Owner and Agency Personnel two (2) weeks prior to substantial completion.
2. Demonstrate Project equipment and instruct in a classroom environment at location designated by the Construction Administrator and instructed by a qualified manufacturer's representative who is knowledgeable about the project.
3. For equipment or systems requiring seasonal operation perform demonstration for season within six (6) months.
4. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner and Agency Personnel in detail to explain all aspects of operation and maintenance.

5. Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance, and shutdown of each item at agreed upon scheduled time and at equipment or designated location.
6. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during demonstration.

C. Testing Adjusting, and Balancing:

1. The Contractor will employ and pay for the testing services of an independent consultant to verify the testing, adjusting, and balancing.
2. Reports will be submitted by the independent testing consultant to the Construction Administrator indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.
3. The Owner may employ and pay for the services of an independent consultant to verify testing, adjusting, and balancing which was performed by the Contractor.

01700 CONTRACT CLOSEOUT

A. Substantial Completion:

1. Preliminary Procedures: Before requesting inspection for Certification of Substantial Completion, complete the following. List exceptions in the request.
   a. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
      1) Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
      2) If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
   b. Advise the Owner of pending insurance changeover requirements.
   c. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
   d. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   e. Submit record drawings, maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
   f. Deliver tools, spare parts, extra stock, and similar items.
   g. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
   h. Demonstration, thru operation and testing, the functions of all systems and/or equipment to the satisfaction of the Owner for compliance to the contract. Complete testing of systems, and instruction of the Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.

i. Complete final cleanup requirements, including touchup painting.

j. Touch up and otherwise repair and restore marred, exposed finishes.

k. DD Form 1354 Transfer and Acceptance of DoD Real Property.

l. NGB 593 Project Inspection Report.

2. Inspection Procedures: The Contract shall be ready and prepared when they request a Substantial Completion inspection. If the inspection reveals that the work is not complete, there are extensive punchlist items and as the items listed above are not complete, the Construction Administrator, Architect, and Owner will determine the inspection has failed.

3. The Contractor is responsible for all costs to re-inspect due to a failed inspection. The Owner will issue a deduct change order to cover all costs for re-inspection.

   a. The Architect will repeat inspection when requested and assured that the Work is substantially complete.

   b. Results of the completed inspection will form the basis of requirements for final acceptance.

B. Final Acceptance:

1. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.

   a. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.

   b. Submit an updated final statement, accounting for final additional changes to the Contract Sum.

   c. Submit a certified copy of the Architect's final inspection list of items to be completed or corrected, endorsed and dated by the Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Architect.

   d. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the Owner took possession of and assumed responsibility for corresponding elements of the Work.

   e. Submit consent of surety to Final Payment.

   f. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

2. Reinspection Procedure: The Inspection Group will re-inspect the Work upon receipt of notice from the Construction Administrator that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Owner.

   a. Upon completion of reinspection, the Construction Administrator will prepare a certificate of final acceptance. If the Work is incomplete, the Construction Administrator will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.

C. As Built Document Submittals:

1. **General:** Do not use record documents for construction purposes. Protect Record Documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the Architect's reference during normal working hours. Keep documents current; do not permanently conceal any work until required information has been recorded. Failure to keep documents current is sufficient cause to withhold progress payments.
    a. The Contractor shall also hire the services of a Surveyor registered in the State of Connecticut to conduct a final survey to determine the location of exterior underground utility lines and to record the results, and update existing electronic media
    b. The record of exterior underground utilities shall be made at the time of installation on Mylar film drawing and AutoCAD (latest version) compatible disks. The drawing shall bear the seal of the Land Surveyor and a statement of accuracy.
2. **As-built Drawings:** The Contractor shall maintain one clean, complete undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
    a. Mark record sets with erasable pencil to distinguish between variations in separate categories of the Work.
    b. Mark all new information that is not shown on Contract Drawings.
    c. Note related change-order numbers where applicable.
    d. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.
    e. Upon completion of the work, the Contractor shall submit Record Drawings to the Construction Administrator for the Owner's Records who will pass them on to the Architect or Engineer for transferring the changes to the Record Drawing Mylar Tracings.
    f. Submit electronic format data of all Coordination Drawings as required by the owner, at no additional cost.
    g. Refer to Section 01400 “Quality Control” Section 1.3 for required as built drawings and specifications for fire alarm systems.
3. **Record Specifications:** The Contractor shall maintain one complete copy of the Project Manual, including Addenda. Include with the Project Manual one copy of other written construction documents, such as Change Orders and modifications issued in printed form during construction.
    a. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
    b. Give particular attention to equals and substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
    c. Note related record drawing information and Product Data.
    d. Upon completion of the Work, submit record Specifications to the Construction Administrator for the Owner's records.

4. **Record Product Data:** The Contractor shall maintain one copy of each Product Data submittal. Note related Change Orders and markup of record drawings and Specifications.
    a. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site and from the manufacturer's installation instructions and recommendations.
    b. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
    c. Upon completion of markup, submit complete set of Record Product Data to the Construction Administrator for the Owner's records.
5. **Record Sample Submitted:** Immediately prior to Substantial Completion, the Contractor shall meet with the Construction Administrator, Architect and the Owner's personnel at the Project Site to determine which Samples are to be transmitted to the Owner for record purposes. Comply with the Owner's instructions regarding delivery to the Owner's Sample storage area.
6. **Miscellaneous Record Submittals:** Refer to other Specification Sections for requirements of miscellaneous record keeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to the Construction Administrator for the Owner's records.
7. **Maintenance Manuals:** Organize operation and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual, heavy-duty, 2-inch, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder according to section 01730 “Operations & Maintenance Data”. Included but not limited to the following types of information:
    a. Emergency instructions.
    b. Spare parts list.
    c. Copies of warranties.
    d. Wiring diagrams.
    e. Recommended "turn-around" cycles.
    f. Inspection procedures.
    g. Shop Drawings and Product Data.
    h. Fixture lamping schedule.

D. Closeout Procedures:

1. Operation and Maintenance Instructions: Arrange for each Installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
    a. Maintenance manuals.
    b. Record documents.
    c. Spare parts and materials.

d. Tools.
e. Lubricants.
f. Fuels.
g. Identification systems.
h. Control sequences.
i. Hazards.
j. Cleaning.
k. Warranties and bonds.
l. Maintenance agreements and similar continuing commitments.

2. As part of instruction for operating equipment, demonstrate the following procedures:
   a. Startup.
   b. Shutdown.
   c. Emergency operations.
   d. Noise and vibration adjustments.
   e. Safety procedures.
   f. Economy and efficiency adjustments.
   g. Effective energy utilization.

E. **Final Cleaning**:

1. **General**: The General Conditions requires general cleaning during construction. Regular site cleaning is included in Division 1 Section 01570 “Cleaning”".
2. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion and Certification of Occupancy.
3. **Interior:**
   a. Remove labels that are not permanent labels.
   b. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Remove paint spots; wash and polish glass
   c. Clean exposed interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
   d. Wash washable surfaces of mechanical, electrical equipment and fixtures and replace filters, clean strainers on mechanical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
   e. Clean and polish finish hardware.
   f. Clean and polish tile and other glazed surfaces.

g. Clean floors; wax and buff resilient tile. Clean vinyl or rubber base.

h. Vacuum and/or dust walls, ceilings, lighting fixtures, ceiling diffusers and other wall and ceiling items.

i. Remove defacements, streaks, fingerprints and erection marks.

4. **Exterior**:

a. Clean the site, including landscape development areas, of rubbish, litter, and other foreign substances. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth, even-textured surface.

b. Clean exposed exterior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances.

c. Clean roofs, gutters and downspouts.

d. Remove waste and surplus materials, rubbish and construction equipment and facilities from the site, and deposit it legally elsewhere.

e. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Remove paint spots; wash and polish glass.

5. **Pest Control:** Engage an experienced, licensed exterminator to make a final inspection and rid the work of rodents, insects, and other pests.

6. **Removal of Protection:** Remove temporary protection and facilities installed for protection of the Work during construction.

7. **Compliance:** Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the site and dispose of lawfully.

a. Where extra materials of value remain after completion of associated Work, they become the Owner's property. Dispose of these materials as directed by the Construction Administrator.

b. Leave building clean and ready for occupancy. If the Contractor fails to clean up, the Owner may do so, with the cost charged to the Contractor. The Owner will issue a credit change order to cover the costs.

01730 OPERATION AND MAINTENANCE DATA

A. The Contractor shall instruct the State's designated personnel in the operation of new equipment and shall provide manuals and if required, provide video tapes of this basic maintenance of the equipment for training purposes. Provide qualified personnel for as long as necessary to instruct the State's personnel.

B. Submit four copies of the manuals in 3-ring, loose-leaf notebooks to the Architect/Engineer for approval. Manuals may consist of plain paper copies of approved shop drawings and catalog cuts. Upon completion and approval, 3 copies will be forwarded to the State and one copy retained by the Architect/Engineer.

C. Manuals shall include:

1. Operating Procedures:
    a. Typewritten procedures for each mode of operation of each piece of equipment. Procedures shall indicate the status of each component of a system in each operating mode.
    b. Procedures shall include names, symbols, valve tags, circuit numbers, schematic wiring diagrams, locations of thermostats, manual starters, control cabinets and other controls of each system.

D. Emergency shut-down procedures for each piece of equipment or system, both automatic and manual, as appropriate.

1. Maintenance Schedule:
    a. Typewritten schedule describing manufacturers schedule of maintenance and maintenance procedures.
2. Catalog Cuts:
    a. To illustrate each piece of installed equipment, including options.
    b. Include equipment descriptions including physical, electrical and mechanical; performance characteristics; installation or erection diagrams.
    c. Include spare parts numbers and names, address and phone number of manufacturer; name, address and phone number of local representative or service department.
    d. Typewritten list of all subcontractors on the project, including name, address and phone number of local representative or service department.
3. Manuals shall be indexed with dividers indicating each system or piece of equipment.

01740 WARRANTIES AND GUARANTEES

A. **Disclaimers and Limitations**: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

B. **Related Damages and Losses:** When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.

C. **Reinstatement of Warranty:** When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

D. **Replacement Cost:** Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

E. **Owner's Recourse:** Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law.

Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.

1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

F. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the Owner reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

G. The Contractor shall guarantee all materials and workmanship for a period of eighteen months from the date of acceptance of the Work. In addition, the Contractor shall furnish the warranties listed below. Submit four copies of each to the Construction Administrator in the supplier's standard form or in the form given below if there is no standard form available.

H. The Contractor shall guarantee all materials and workmanship for a period of eighteen months from the date of acceptance of the Work. In addition, the Contractor shall furnish the warranties listed below. Submit four copies of each to the Construction Administrator in the supplier's standard form or in the form given below if there is no standard form available.

1. Section 223400 Fuel Fired Domestic Water Heater – 5 Years material and workmanship.
2. Section 235216 Condensing Boilers – 10 Years material and workmanship.

I. Submit certification that finish materials are fire rated as specified.

J. Form of Guarantees and Warranties:

Commissioner
Military Department
360 Broad Street
Hartford, Connecticut 06105
(Project Title and Number)

I (We) hereby guarantee and warranty)

the _____ work on the referenced project for a period of _____ years

from _____, 19___ against failures of workmanship and materials in accordance

with the requirements of Section ____, Page ____, Paragraph ____, of the Specifications.

Signed _____

3) General Contractor _____

(or authorized agent)

K. Bonds shall be by approved Surety Companies, made out to the Commissioner, Department of Public Works on companies' standard form.

L. Guarantees, warranties or bonds supplied by Subcontractors, Suppliers or Manufacturers shall reference the project name, number, and location and be certified by the General Contractor to be for the product and installation on the project and must be countersigned by the General Contractor.

M. Submittals:

1. Submit written warranties prior to the date certified for Substantial Completion. If the Architect's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Architect.
2. Forms for special warranties are included in this Section. Prepare a written document utilizing the appropriate form, ready for execution by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Submit a draft to the Owner, through the Construction Administrator, for approval prior to final execution.
    a. Refer to Divisions 2 through 17 Sections for specific content requirements and particular requirements for submitting special warranties.
3. Form of Submittal: At Final Completion compile 2 copies of each required warranty properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
4. Bind warranties and bonds in heavy-duty, commercial-quality, durable 3-ring, vinyl-covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
    a. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address, and telephone number of the Installer.
    b. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project title or name, and name of the Contractor.
    c. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

END OF DIVISION 1- GENERAL REQUIREMENTS

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: Heating and control system upgrades

B. Owner: Connecticut Military Department

C. Engineer Identification: The Contract Documents, dated May 2016, were prepared for this Project by Fuss & O'Neill, Inc.

D. Project Directory

1. The Owner's Representative is:

Name:	George E. Fulton
	Connecticut Military Department
Address:	360 Broad Street, Hartford, CT
Phone:	860- 548-3274

2. The Engineer is:

David R. Jackson, P.E.
Fuss & O'Neill, Inc.
146 Hartford Road
Manchester, CT 06040
(860) 646-2469, ext. 5304

E. The Base Bid includes:

1. Demolition of the underground fuel oil tank, piping, and pump. The work included shall be as specified in this Project Manual and as indicated on the Drawings. For bidding purposes, pricing shall include tank removal of a 5,000-gallon underground storage tank (UST), associated piping system and site restoration.

2. The Contractor is responsible for removing and disposing fuel from the existing UST and removing and disposing of water and residue from existing tank.

3. Clean, remove and dispose of existing underground fuel storage tank system, including all existing piping. Remove and dispose of existing hold down pads and/or dead-men.

4. Restore site to original conditions or as indicated on the Drawings.

5. Demolition of steam boiler and condensate return unit and associated items.

6. Demolition of steam and steam condensate pipe throughout the facility.

7. New high efficiency, natural gas fired, condensing hot water boilers and condensing hot water heater.

8. New hydronic hot water system.

9. Remove and clean existing Assembly Hall steam fin tube radiation. Re-install and reuse fin tube radiation.

10. Remove and clean existing convectors. Re-install and reuse convectors.

11. Remove, clean and refurbish existing convectors and covers. Re-install convectors.

12. New indoor, hydronic, heating and ventilating makeup air units for the drill shed and locker room.

13. New indoor, hydronic, heating, cooling, and ventilating makeup air units for the locker room area.

14. SBI#1: New variable refrigerant flow system for the cooling of office spaces.

15. New direct digital control system for the new equipment and tie-ins with existing system.

16. Special Requirements
    a. Notify the Owner three business days prior to the start of construction. Any time that work at the site is discontinued for more than 3 consecutive days, notify the Owner one business day prior to resuming work.

F. Unit Prices Include:

1. Removal and disposal of excess fuel in the existing UST (following transfer of fuel to the temporary tanks).

2. Excavation, staging, loading, transporting and off-site disposal of contaminated material. (See Section 021110 – Contaminated Material Management).

3. Suitable fill (per Section 022000) to replace removed contaminated soil.

1.3 CONTRACT

A. Project will be constructed under a general construction contract.

1.4 USE OF PREMISES

A. Minimize damage to all access routes and restore damaged areas to their original conditions.

B. If removal of walls, fences, structures, utility lines, poles, guy wires or anchors, or other improvements is necessary for passage of the Contractor's equipment, restore to original condition. Notify the Engineer, the Owner, and all utilities of any intended modification or disruption to their property prior to the start of construction and cooperate with them in the scheduling and performing operations.

C. If, by direct negotiation and bargain with any land owner, lessee or tenant, the right has been secured to use more space or greater privileges in the space provided by the Owner for purposes incidental to the performance of the Work, furnish upon request to the Engineer proper evidence that such additional rights have been properly secured and assurance that no damage to or claim upon the Owner will arise there from. The Owner shall not be liable in any way for any expense incurred by securing any such right to use additional property.

D. The Contractor shall be responsible for and reimburse the Owner and others for any and all losses, damage or expense which the Owner or others may suffer, either directly or indirectly or through any claims of any person or party, for any trespass outside the spaces and rights-of-way provided by the Owner to the Contractor or any violation or disregard of the terms and conditions established for the use or occupancy of those rights or for negligence in the exercise of those rights. The Owner may retain or deduct from any sum or sums due or to become due to the Contractor such amount or amounts as may be proper to insure the Owner against loss or expense by reason of the failure of the Contractor to observe the limits and conditions of the rights-of-way and rights of access provided by the Owner.

1.5 SEQUENCE OF CONSTRUCTION

A. The sequence of construction should be such that facility down-time is minimized to no more than four hours. The following bullets provide a suggested sequence of operations. Bids should describe the proposed sequence of operations if different than as summarized below:

1. Disconnect existing connections between existing day tank and emergency generator and boilers.
2. Empty, clean and properly dispose of remaining fuel and/or water in existing day tank and UST.
3. Remove and properly dispose of existing UST, piping, and appurtenances.

Please note that this is a summarized sequence of construction. The contractor is responsible for any other steps that may not be listed above, but which are necessary to

safely and satisfactorily meet the scope and specifications of the project in accordance with all local, state or federal requirements.

B. Submit proposed construction schedule at the earliest possible time and no later than five days prior to project start-up date.

1.6 WORK HOURS

Unless prior authorization has been given by the Owner, perform Work weekdays between the hours of 7 am and 3:30 pm.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

A. Remove and dispose residual product or sludge in the tanks, if any. (Refer to Division 2 Section "Contaminated Material Management" for work to remove/dispose any residual tank contents)

B. Dewatering of excavations may be necessary to facilitate tank removals. Non-contaminated dewatering will be the responsibility of the Contractor. Contaminated water removal will be conducted by the contractor on a time and materials basis.

C. The loading, transportation and disposal of contaminated soil, if any, shall not delay phases of the Work.

3.2 PROJECT MEETINGS

A. Pre-construction Conference: Prior to the start of construction, attend mandatory pre-construction conference with the representatives of the Engineer, Owner and other interested parties. The time and place shall be arranged by the Owner.

B. Progress Meetings: During the progress of the Work, attend meetings with the Engineer and Owner to address scheduling and overall job coordination. The frequency of these meetings will be at the discretion of the Engineer and Owner but, no more frequently than weekly.

END OF SECTION 010100

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Removal and disposal of residual fuel, sludge, water or debris from existing tank after Owner completes transfer of fuel.

B. Removal and disposal of existing underground fuel oil tank and all associated piping, gauging system, and other accessories.

C. Removal and disposal of existing day tank and all associated piping, gauging system, and other accessories.

1.2 REFERENCES

A. Removal of tanks - latest edition accepted by:
1. NFPA 30 - Flammable and combustible liquids code.
2. Connecticut DEEP - Underground Storage Tank Regulations.
3. OSHA 2226 - Excavation and Trenching Operations.
4. RP 2015 - Cleaning Petroleum Storage Tanks
5. API 1604 - Removal and Disposal of Used Underground Petroleum Storage Tanks
6. NFPA 327 - Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers Without Entry.

1.3 RELATED SECTIONS

A. Related Sections include the following:
1. Division 2 Section 02111 “Contaminated Material Management” for removal, storing and disposal of contaminated excavated material.
2. Division 2 Section 02200 “Earthwork” for excavation and backfilling.

1.4 PAYMENT

A. Contaminated Liquid/Sludge: This Work shall be paid for under the Contract Base Bid. This price will include removing generated contaminated material, contaminated liquid/sludge from storage tanks, and transporting and disposing contaminated soil and material from the site to approved treatment/disposal facilities, preparation of manifests or bills of lading, fees paid, and incidental materials, tools, equipment, and services.

1.5 SUBMITTALS

A. Certification Letters
   1. Training: Certify that personnel engaged in site activities have appropriate training per OSHA 29 CFR 1926.65.
   2. Completion of Work: Signed statement certifying completion of construction in accordance with Federal, State, local industry, environmental, and safety standards.

B. Submit for Owners approval a list of proposed disposal facilities intended to receive removed USTs.

C. Submit for Owners approval a list of proposed disposal facilities intended to receive contaminated liquid/sludge. Owner requires that disposal facilities be permitted by CTDEP.

D. Informational Submittals
   1. Site Specific Health and Safety Plan (HASP).
      a. Written by a Certified Industrial Hygienist or a Certified Industrial Planner.
      b. In conformance with OSHA 29 CFR 1926.65.
      c. Maintain a copy of HASP on-site for review by Owner or other authorities having jurisdiction.
   2. Shipping records and scale tickets for confirmation of payment.
   3. Tank disposal or recycling certificates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all material necessary to perform the work of this section.

2.2 EQUIPMENT

A. Provide all tools and equipment necessary to perform the work of this section.

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall have on site for ready reference at all times when work is in progress all references listed under 1.2 of this section. Failure to produce these references shall be sufficient reason to halt all work in progress until these references are on site.

B. At least one week prior to removal, contractor shall notify local Fire Marshal, Owner, and Engineer in writing of their intent to remove the tank.

C. DEEP shall be notified 30 days prior to removal of the Underground Storage Tank.

D. Two days prior to tank removal, notify local Fire Marshal, DEEP, Owner, and Engineer by phone of date and time tank will be removed from excavation. If tank needs to be entered to complete the cleaning operations, follow appropriate procedures to ensure worker safety. Contractor shall provide Engineer and Owner with copies of Confined Space Entry Permit for each person entering the tank.

E. Prepare a safe workplace by following the safety precautions and cleaning and closure procedures outlined in API 1604. Safety precautions shall include, but not be limited to, no smoking, controlling static electricity, securing the area, locating and marking utilities, determining meteorological conditions and wearing personal safety equipment.

F. Remove all combustible liquids and residue from the tank and piping. Clean tank and dispose of cleaning liquids, combustible liquids, water and residue per DEEP requirements.

G. Excavate to top of tank.

H. Disconnect fuel piping, fill pipe, gauge and all other devices from tank, except the vent line which shall remain connected until the tank is purged.

I. Make tank safe by purging tank of flammable vapors or inerting the tank atmosphere. Test tank atmosphere to determine if it is safe.

3.2 REMOVAL

A. Plug and cap all accessible holes. One plug should have 1/8" vent hole to prevent excessive pressure build-up caused by temperature changes. This vent should be positioned on top of the tank during subsequent transportation.

B. Excavate as required and remove tank from hole. Contractor shall not cut and remove tank in sections. Check for corrosion holes and plug any found with screwed boiler plugs.

C. Prior to transporting tank, test tank atmosphere to determine if it is safe.

D. Transport, render unusable, and dispose of underground tank, piping & appurtenances in a location for which the contractor has secured the necessary permits to do so. Contractor shall provide Owner and Engineer with copies of Tank Disposal Manifests for each tank removed.

E. Excavate, remove and dispose of all tank system piping and appurtenances including top and bottom concrete slabs and/or “deadmen” as appropriate.

F. Cut existing supply/return lines inside building flush with floor, seal with non-shrinking grout and waterproof sealant.

G. Assist the Engineer with the collection of soil samples from within the tank excavation. On-site screening of a portion of the soil samples will be performed by the Engineer. Backfill of excavations cannot commence until the direction to backfill has been given by the Engineer. All soils shall be stockpiled per CTDEEP regulations until such time as the Engineer clears them for removal.

H. No on-site burning is allowed.

3.3 CONTAMINATED SOIL

A. If contaminated soil is discovered at any point during the excavation or removal process, stop work immediately and notify the Engineer.

B. Remove contaminated soil as directed by the Engineer. Separately stockpile any contaminated soil apart from non-contaminated soil encountered during excavation where directed by Owner. Stockpile contaminated soil on 6 mil polyethylene and cover with the same.

END OF SECTION 020500

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Protective measures required during removal of contaminated material.
   2. Staging of contaminated soil.
   3. Loading, transporting, and off-site disposal of contaminated soil and solid waste.

1.3 RELATED SECTIONS

A. Related Sections include the following:
   1. Division 2 Section 02050 “Tank and Piping Demolition” for cleaning and removal of USTs.
   2. Division 2 Section 02200 “Earthwork” for excavation and backfilling.

1.4 MEASUREMENT

A. Contaminated Soil: Actual net weight in tons of material delivered to treatment/disposal facilities from the site, as measured by the permanent scales at the respective facilities. Total weight will be the summation of weight bills issued by such facilities.

1.5 PAYMENT

A. Contaminated Soil: This Work shall be paid for at the Contract unit price for the actual quantity of contaminated soil removed and disposed. This price will include excavating, staging, handling, loading, transporting and disposing contaminated soil and material from the site to a licensed and approved disposal facility, providing suitable fill and backfilling of the resulting void, preparation of manifests or bills of lading, fees paid, and incidental materials, tools, equipment, and services.

	PAY ITEM	UNIT
1.	See Bid Form	Tons

1.6 REFERENCES

A. Regulations of Connecticut State Agencies (RCSA)
   1. 22a-449(c)-100 through 110: Hazardous Waste Management Regulations
   2. 22a-133k-1 through k-3: Remediation Standard Regulations.

B. Environmental Protection Agency (EPA)
   1. 40 CFR 260. Hazardous Waste Regulation.

C. Department of Labor, Occupational Safety and Health Administration (OSHA) Parts 1910 and 1926.

1.7 SUBMITTALS

A. Submit, for Owner's approval, a list of proposed State permitted facilities intended for disposal of contaminated soil.

B. Submit for Owner's signature, waste manifests required for transport of Connecticut regulated wastes.

C. For Information.
   1. Material shipment records required by applicable Federal, State and local regulations.
   2. Scale tickets for confirmation of payment.

1.8 QUALITY ASSURANCE

A. Scales: Scales used for determination of weight for contaminated soil shall be certified by the State in which disposal occurs.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, and certified by the State.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Provide equipment free of contamination. Equipment that has not been thoroughly decontaminated prior to site delivery, as determined by the Engineer, will be prohibited from entering the site.
   1. On-site cleaning of equipment that is not thoroughly decontaminated upon delivery to the site is prohibited.

1.10 PROJECT CONDITIONS

A. Keep contaminated equipment within designated contaminated work area. Decontaminate equipment each time it is removed from contaminated work area to another area on site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Plastic Sheeting: Polyethylene sheeting, 6-mil minimum thickness.

B. Absorbent Boom: 8-inch diameter SPC Oil Sorbent Booms™ or approved equal.

C. Granular Absorbent: Speedi-Dri or approved equal.

D. Hazardous Waste Containers: State and Federal DOT approved containers. Containers shall meet all applicable regulations for the storage and transportation of hazardous waste, including requirements of treatment, storage, and disposal facilities.

E. Vehicles for Transporting Contaminated Liquids and Waste: Meet appropriate State and Federal DOT standards.

PART 3 - EXECUTION

3.1 GENERAL

A. Obtain permits prior to beginning Work.

B. Sweep paved areas daily.

3.2 DECONTAMINATION PROCEDURES

A. Follow the requirements of 29 CFR 1926-65 and the site HASP.

B. Provide for decontamination of personnel, equipment and supplies that enter the contaminated work area or are exposed to contaminated material.

C. Personnel decontamination, at a minimum, shall consist of work practices aimed at limiting the spread of contaminants, use of disposable protective clothing, and proper personal hygiene practices, including no smoking within the work area and washing of exposed skin areas prior to leaving the work area for breaks, lunch, or at the conclusion of each work day.

3.3 WASTE SEGREGATION

A. Prior to performing any work, identify all waste streams intended to be managed as hazardous waste.

B. Do not mix or intermingle hazardous waste and non-hazardous waste streams.

C. Do not mix or intermingle incompatible waste streams.

D. Provide separate stockpiles for contaminated and non-contaminated soil.

3.4 LOCATION OF CONTAMINATED MATERIALS

A. Limits of Excavation
   1. When areas of contamination are encountered, limits of excavation will be determined in the field by the Engineer. The engineer may use field screening techniques to assist in determining the extent of impacted soil, however, lab analysis is required to confirm if the extent of contamination has been achieved (aka Closure Sampling).

3.5 EXCAVATION AND STAGING OF CONTAMINATED SOIL

A. Perform excavation in accordance with Division 2 Section 02200 " Earthwork" and as directed by the Engineer.
   1. Stop excavation and immediately inform Engineer when material not previously identified displays characteristics of contamination.
   2. If contaminated soil is encountered, the Owner or the Engineer, on behalf of the Owner, will notify the Oil and Chemical Spills Section of Hazardous Material Management, Department of Environmental Protection.

B. Construct containment system for stockpiling of contaminated soil or soil suspected to be contaminated to prevent seepage of soil or water into the environment.
   1. Coordinate location of contaminated soil stockpile with the Engineer and the Owner.
   2. Lay down plastic sheeting of sufficient size for contaminated soil stockpile, absorbent boom perimeter, and granular absorbent outer ring.
      a. If containment system is not located on pavement, place a minimum 4-inch thick layer of sand beneath plastic sheet.
   3. Install absorbent boom at perimeter of stockpile, in accordance with manufacturer's recommendations.
   4. Place granular absorbent outside of boom for containment of seepage.
   5. When excavation is ongoing, occasionally mist contaminated stockpile with water during windy or dry conditions.
   6. Cover stockpile, boom and outer ring with plastic sheeting to contain material and prevent infiltration of the elements. Secure in place with tires, sandbags or similar weights.
   7. Install and maintain fencing or other appropriate barricades around waste stockpile area to prevent individuals or vehicles from entering and install lighted barricades when left overnight.

C. Maintain impacted area and containment system until contaminated material is removed from site and excavation is backfilled with clean borrow material. Inspect daily for damage and signs of leakage. Immediately replace damaged materials.

3.6 BACKFILL

A. Backfill excavations in accordance with Division 2 Section 02200 “Earthwork” and as directed by the Engineer.

B. If at the end of a day’s activities excavation of the contaminated soil is not complete, temporarily backfill the excavation with clean stockpiled material such that the excavation is safe as determined by the Engineer. Unsafe excavations may not be left overnight. Perform temporary backfilling in accordance with the following:
   1. Line excavation with plastic sheeting.
   2. Install and maintain fencing or other appropriate barricades to prevent individuals or vehicles from entering the excavation. Install lighted barricades when left overnight.

C. If requested by the Contractor, the Engineer may allow temporary backfilling when size of excavation obstructs site access or disrupts site activities. Perform temporary backfilling in accordance with above.

D. Use clean stockpiled material for backfill of excavations or obtain borrow material from off-site.

3.7 LOADING, TRANSPORT, AND DISPOSAL

A. Load contaminated soil from excavation or stockpile as directed by the Engineer into approved vehicles and transport to the disposal facility.
   1. Contaminated soil must be disposed at a licensed and approved disposal facility.
   2. The “Waste Product Survey” required by the disposal facility will be provided to the driver by the Engineer.

B. Bulk Contaminated Material
   1. Load and transport bulk contaminated material other than soil to the Owner-approved solid waste disposal facility.
   2. Secure load to prevent shifting or release during transport.

C. Materials with contaminant concentrations that exceed the approved disposal facility limits will be re-evaluated on an individual basis in conjunction with standard State disposal requirements.
   1. Soil will be re-sampled and properly classified.
   2. Based on reclassification, manage and manifest out-of-compliance waste in accordance with EPA Hazardous Waste Regulation 40 CFR 260.

3.8 FIELD QUALITY CONTROL

A. Engineer will obtain soil samples from excavated, stockpiled, and in-place soil to determine presence of contamination, and will submit samples for testing, as required, to a certified laboratory.
   1. Assist Engineer in obtaining samples within excavations.

B. Engineer may collect random samples of decontamination fluids or wipe surfaces to ensure that proper decontamination procedures are being followed. If decontamination is determined by the Engineer to be ineffective or insufficient, undertake additional decontamination measures necessary to provide an adequate level of decontamination.

END OF SECTION 021110

PART 1 - GENERAL

A. The extent of earthwork is shown on Drawings. Work under this section also includes, but is not limited to the following:
   1. Preparation of subgrade for lawns, slabs, and pavements.
   2. Backfilling of excavations.
   3. Provision of backfill required to fill cavity left by tank removal, if needed.
   4. Retaining wall backfill and compaction.

1.2 REFERENCES

A. State of Connecticut Department of Transportation - Form 816.

B. OSHA 2207 Construction Industry Standards, U.S. Department of Labor Occupation Safety and Health Administration,

C. AASHTO - American Association of State Highway and Transportation Officials.

1.3 RELATED SECTIONS

A. Related Sections including the following:
   1. Division 2 Section 020500 “Tank and Piping Demolition” for cleaning and removal of USTs.
   2. Division 2 Section 021110 “Contaminated Material Management” for removal, storing and disposal of contaminated excavated material.
   3. Division 2 Section 02480 “Landscape Work” for surface restoration.

1.4 QUALITY ASSURANCE

A. Codes and Standards
   1. Perform excavation work in compliance with applicable requirements of the State of Connecticut Basic Building Code and OSHA Part 1926.
   2. Materials and workmanship shall conform to applicable requirements of "State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges and Incidental Construction", Form 816, and amendments to date, to be referred to hereinafter as "Form 816".

1.5 JOB CONDITIONS

A. Existing Utilities

Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork. The Contractor shall call "Call Before You Dig" at least one week prior to beginning excavation and coordinate work.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

B. Protection of Persons and Property

Barricade open excavations occurring as part of this work and post with warning signs.

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
2. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors and to other work being performed on or near the site.
3. Maintain access to adjacent areas at all times.

PART 2 - PRODUCTS

2.1 SAND (PIPE BEDDING)

A. Natural river or bank sand, washed free of silt, clay, loam, friable, or soluble materials. Sand shall meet requirements of CONDOT Form 816-1995, Section M.11.04, grading A and shall contain no more than 3% of material which will pass through a number 8 sieve and shall be so certified in writing by sand supplier.

2.2 PEA GRAVEL AND CRUSHED STONE

A. Pea gravel or crushed stone shall be used for backfill around tanks and as indicated on the Drawings. Pea gravel shall consist of naturally rounded particles of stones ranging in diameter from 1/8" to 3/4". Crushed stone shall consist of washed crushed stone ranging in size from 1/8" to 1/2" diameter and shall conform to ASTM C-33. Tank backfill shall be free from sand, clay and organic material. Backfill supplier shall certify compliance with these requirements in writing.

2.3 GRAVEL

A. Article M.02.03, Form 816-1995

B. Gravel is to be used for filling under pavements and improvements that is required to achieve the rough grades indicated.

C. Provide borrow material as required to meet project specifications.

2.4 GENERAL FILL

A. Material used for general filling outside of limits of pavements, may be either approved material available from off-site, certified to conform to the following grain-size gradation:

Square Mesh Sieve	% Passing (by Weight)
3 1/2"	100
3/4"	75 - 100
#4	25 - 80
Less than 15% of the materials passing the #4 sieve shall pass a #200 sieve.	

B. Fill shall be clean, free of clay and organic material and capable of satisfactory compaction. Determine the required quantities of borrow material base on grading requirements and quantity of topsoil stockpiled and approved for reuse. If sufficient approved on-site material is not available to meet grading requirements indicated, provide additional approved off-site material at no extra cost to Owner.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which excavating, filling, and grading are to be performed and notify the Engineer, in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 EXCAVATION

A. Excavation consists of removal and selective disposal of materials in performing the work of this project.

B. The Contractor shall assume that all excavation will be earth.

C. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.

1. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

D. Stability of Excavation

Slope sides of excavation in safe condition until completion of backfilling. Scope angles shall conform to OSHA 1926.

E. Shoring and Bracing

Where OSHA requirements are not satisfied by slope of sides of excavations, provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable conditions.

1. Shoring and bracing shall comply with local codes, ordinances, of the State of Connecticut Basic Building Code, OSHA Part 1926.
2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

F. Dewatering

Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Convey water removed from excavations and rain water to collecting or run-off areas. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
3. Groundwater in the excavation cannot be discharged to the ground surface and/or waterbody/stream/wetland without a permit from the CTDEEP. If the Contractor does not wish to get a permit to discharge water then they may have the option to containerize the water (frac tank, drums, etc.) and sample that water for proper disposal determination.

G. Material Storage & Disposal

Stockpile satisfactory excavated materials, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Utilize soil erosion control measures.
2. Dispose of excess waste materials and unsuitable soil.

H. Cold Weather Protection

Protect excavation bottoms, except on rock, against freezing when atmospheric temperature is less than 35 degrees Fahrenheit (1 degree centigrade).

3.3 SUBGRADE PREPARATION

A. Upon completion of mass site earthwork, prepare the subgrade by removing all soft or spongy material and backfilling with satisfactory material.

B. Compact the subgrade uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).

C. Conform to applicable State of Connecticut requirements and in accordance with Form 816, Section 2.09.

D. Subgrade must be approved prior to application of any base materials.

3.4 MATERIAL PLACEMENT/COMPACTION

A. Placement. Lifts shall be as per schedule noted. Do not deposit fill in areas of standing water. Any pockets of sediment and foreign material are to be removed before filling continues.

1. Minimum Compaction Schedule.

Compactor Static Weight/ Dynamic Force	Lift (inches)
10 Tons/20 Tons	15
5 Tons/10 Tons	12
2 Tons/ 4 Tons	8
1 Ton/2 Tons	6
500/lbs/1000 lbs	4

B. Compaction. Each lift shall be compacted. Maintain optimum and proper moisture content to achieve required compaction.

C. Fill to subgrade under structures, pavements, and footings shall be compacted to minimum 95% of modified AASHTO laboratory density (ASTM D-1557, Method C).

D. Fill to subgrade under lawn shall be compacted to minimum 90% modified AASHTO laboratory density (ASTM D-1557, Method C).

E. Moisture Control

Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.

1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
2. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.5 GRADING

A. General

Uniformly grade areas within Contract limit lines, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or

slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines

Grade areas adjacent to building lines to drain away from structures and to prevent ponding.

1. Finish surfaces free from irregular surface changes, and as follows:

a. Lawn or Unpaved Areas

Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.

b. Walks

Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.

c. Pavements

Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2" above or below required subgrade elevation.

C. Compaction

After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.6 MAINTENANCE

A. Protection of Graded Areas

Protect newly graded areas from traffic erosion. Keep free of trash and debris.

1. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

END OF SECTION 022000

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of landscape work is shown on the Drawings and consists of providing topsoil and grass seeding materials to achieve a permanent lawn on all areas disturbed as a result of this project which are not designated for paving or other surface improvements.
   1. Subgrade Elevations: Excavation, filling and grading required to establish elevations shown on drawings are not specified in this section. Refer to Earthwork - Section 02200.

1.2 REFERENCE STANDARDS

A. Materials and workmanship shall conform to applicable requirements of "State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges and Incidental Construction", Form 814 and amendments to date, to be referred to hereinafter as "Form 814".

1.3 QUALITY ASSURANCE

A. Source Quality Control
   1. General
      a. Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.
   2. Do not make substitutions. If specified landscape material is not obtainable, submit to Engineer proof of non-availability and proposal for use of equivalent material. When authorized, adjustment of contract amount will be made.
   3. Analysis and Standards
      a. Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable or as further specified.
   4. Topsoil
      a. Before delivery of topsoil, furnish Engineer with written statement giving location of properties from which topsoil is to be obtained.

1.4 SUBMITTALS

A. Certification
   1. Submit certificates of inspection as required by governmental authorities, and manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.
      a. Submit seed vendor's certified statement for each grass seed mixture required stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed specified.

B. Maintenance Instructions
   1. Submit typewritten instructions recommending procedures to be established by Owner for maintenance of landscape work for one full year. Submit prior to expiration of required maintenance period(s).

1.5 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials
   1. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

1.6 JOB CONDITIONS

A. Installer shall examine the subgrade, verify the elevations, observe the conditions under which work is to be performed, and notify the Engineer of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.

C. Utilities
   1. Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

D. Excavation
   1. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, obstructions, notify Engineer before planting.

E. Planting Time
   1. Plant or install materials during normal planting seasons for each type of landscape work required. Correlate planting with specified maintenance periods to provide maintenance until occupancy by Owner.

1.7 GUARANTEE

A. Guarantee lawns through specified maintenance period, and until final acceptance.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil is specified to be stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.

B. Topsoil shall conform to the requirements of Subarticle M. 13.01-1, Form 814.
   1. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at the project site. Obtain topsoil only from naturally, well-drained sites where topsoil occurs in a depth of not less than 4"; do not obtain from bogs or marshes.

2.2 SOIL AMENDMENTS

A. Lime shall conform to the requirements of Subarticle M.13.02, Form 814.

B. Commercial Fertilizer
   1. Complete fertilizer of neutral character, with some elements derived from organic sources and containing the following percentages of available plant nutrients:
   2. For lawns, provide fertilizer with not less than 4% phosphoric acid and not less than 2% potassium, and percentage of nitrogen required to provide not less than 1 lb. of actual nitrogen per 1,000 sq. ft. of lawn area. Provide nitrogen in a form that will be available to lawn during initial period of growth.

2.3 GRASS MATERIALS

A. Grass seed mixtures shall conform to Subarticle M.13.04, Form 814. Seed shall be Imperial Nursery Mix #4653 or approved equivalent.

2.4 MISCELLANEOUS LANDSCAPE MATERIALS

A. Mulch Hay
   1. Shall conform to Subarticle M.13.05.2, Form 814.

B. Water
   1. Shall conform to Subarticle M.13.07.12, Form 814.

C. Sod
   1. If used, shall conform to Subarticle M.13.08, Form 814.

2.5 PREPARATION OF PLANTING SOIL

A. Before mixing, clean topsoil of roots, plants, sods, stones, clap lumps, and other extraneous materials harmful or toxic to plant growth.

B. Mix specified soil amendments and fertilizers with topsoil at rates specified. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.

PART 3 - EXECUTION

3.1 PREPARATION

A. PREPARATION FOR PLANTING LAWNS
   1. Loosen subgrade of lawn areas to a minimum depth of 6". Remove stones over 1-1/2" in any dimension and sticks, root, rubbish and other extraneous matter. Limit preparation to areas which will be planted promptly after preparation.
      a. Spread planting soil mixture to minimum depth required to meet lines, grades and elevations shown, after light rolling and natural settlement.
   2. Grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll and rake and remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.
   3. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.
   4. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

B. Dispose of subsoil removed from landscape excavations, which is not to be used as backfill elsewhere on same site, as directed by Owner. Do not mix with planting soil.

3.2 PLANTING

A. Seeding New Lawns
   1. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.
   2. Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 mph. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.
   3. Rake seed lightly into top 1/8" of soil, roll lightly, and water with fine spray.
   4. Protect seeded slopes against erosion with erosion netting or other methods acceptable to the Engineer. Embed netting in loam.

3.3 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain lawns for not less than the period stated below, and longer as required to establish an acceptable lawn.
   1. Seeded lawns, not less than 60 days after completion.
      a. If seeded in fall and not given full 60 days of maintenance, or if not considered acceptable at that time, continue maintenance following spring until acceptable lawn is established.

C. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling regrading and replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.

3.4 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

3.5 INSPECTION AND ACCEPTANCE

A. When landscape work is completed, including maintenance, Engineer will, upon request, make an inspection to determine acceptability.

1. Landscape work maybe inspected for acceptance in parts agreeable to Engineer, provided work offered for inspection in complete, including maintenance, and that the area comprises one complete unit of area of substantial size.

B. Where inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until re-inspected by Engineer and found to be acceptable. Remove rejected materials promptly from project site.

END OF SECTION 024800

Section 028213 – Asbestos Abatement

PART 1 GENERAL

1.1 SCOPE

A. Work under this item shall include the abatement of asbestos containing materials (ACM) and associated work by persons who are knowledgeable, qualified, trained and licensed in the removal, treatment, handling, and disposal of ACM and the subsequent cleaning of the affected environment. ACM shall include material composed of any type of asbestos in amounts greater than one percent (1%) by weight. The Contractor performing this work shall possess a valid Asbestos Abatement Contractor license issued by the Connecticut Department of Public Health (CTDPH). Where areas to be abated contain materials with PCBs and asbestos the workers shall follow this Specification as well as Specification 02 84 33.

B. These Specifications govern all work activities that disturb asbestos containing materials. All activities shall be performed in accordance with, but not limited to, the current revision of the OSHA General Industry Standard for Asbestos (29 CFR 1926.1001), the OSHA Asbestos in Construction Regulations (29 CFR 1926.1101), the USEPA Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) Regulations (40 CFR Part 61 Subpart M), the CTDPH Standards for Asbestos Abatement, Licensure and Training (19a-332a-1 through 16, 20-440-1 through 9 & 20-441), and the CTDEEP Special Waste Disposal Regulations (22a-209-8(i)).

C. The asbestos abatement work shall include the removal and disposal of all ACM as identified on the Contract drawings and Specifications prior to the planned renovation/demolition project. The Connecticut Department of Construction Services (CTDCS) will retain the services of a State of Connecticut licensed Project Monitor for protection of its interests and those using the building.

D. Deviations from these Specifications require the written approval of the Engineer and Owner.

E. The Contractor may elect to utilize an Alternative Work Practice (AWP), if approved by the CTDPH and the Engineer/Owner prior to the initiation of the abatement activities. An AWP is a variance from certain CTDPH asbestos regulatory requirements, which must provide the equivalent or a greater measure of asbestos emission control than the standard work practices prescribed by the CTDPH.

1.2 DESCRIPTION OF WORK

A. The following details the extent of each phase of operation designated for this project. Phase areas may be combined or divided at the direction of the Engineer/Construction Manager. Proceed through the sequencing of the work phases under the direction of the Engineer/Construction Manager.

B. The asbestos abatement work shall include the removal of asbestos-containing materials as specified herein. This abatement project was designed by Mr. Donald LePage, a State of Connecticut licensed Asbestos Project Designer (#000233).

Crawl space – Basement

Includes the removal of:

- **Crawl space floor insulation debris (All Sections of Crawl space)**
- **Pipe insulation/mudded fittings (Throughout Crawl space on pipes)**

Crawl space floor insulation debris, as well as 1" of soil shall be removed and disposed of as ACM. Additional soil may need to be removed as ACM if visible debris is found below the 1" depth. The floor soil areas will need to be visually clear by a CT licensed Project Monitor prior to reoccupancy clearance testing. Asbestos removal shall be performed under full containment conditions with a pressure differential and contiguous decontamination system in accordance with CTDPH 19a-332a-5, 6 and 7, OSHA Class I and USEPA NESHAP requirements. Reoccupancy air clearance testing shall utilize Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM) analysis, as applicable per CTDPH 19a-332a-12.

Store Room, Men's Shower and Bathroom – Basement
Bathroom, Office 1, Break Room – 1st Floor
Men's and Women's Rooms, Men's and Women's Locker Rooms – 2nd Floor

Includes the removal of:

- **Pipe insulation/mudded fittings (Overhead and behind walls, sinks, toilets, and showers)**

Contractor shall be responsible for removal of all walls, counters, cabinets, sinks, appliances, trim work, etc., necessary in order to access the ACM. Asbestos removal shall be performed under full containment conditions with a pressure differential and contiguous decontamination system in accordance with CTDPH 19a-332a-5, 6 and 7, OSHA Class I and USEPA NESHAP requirements. Reoccupancy air clearance testing shall utilize Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM) analysis, as applicable per CTDPH 19a-332a-12.

Non-Commissioned Officer's Office – 1st Floor

Includes the removal of:

- **Grey hard flooring (~16 SF)**

Contractor shall be responsible for removal of all furniture, cove base, trim work, carpeting, linoleum, etc., necessary in order to access the ACM. Asbestos removal shall be performed under full containment conditions with a pressure differential and contiguous decontamination system in accordance with CTDPH 19a-332a-5, 6 and 7, OSHA Class I & II and USEPA NESHAP requirements. Reoccupancy air clearance testing shall utilize Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM) analysis, as applicable per CTDPH 19a-332a-12.

Drill Hall – 1st Floor

Includes the removal of:

- **Grey cloth-like vapor barrier between hardwood and subfloor**

Contractor shall be responsible for removal of all trim work and hardwood flooring to access ACM vapor barrier where it will be impacted by the removal of existing steam unit heaters and associated steam pipes, condensate pipes, valves, etc., (4 locations). Asbestos removal shall be performed under full containment conditions with a pressure differential and contiguous decontamination system in accordance with CTDPH 19a-332a-5, 6 and 7, OSHA Class I & II and USEPA NESHAP requirements. Reoccupancy air clearance testing shall utilize Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM) analysis, as applicable per CTDPH 19a-332a-12.

Boiler Room

Includes the removal of:

- **Interior boiler breeching/components/materials of (2) boilers**

Contractor shall be responsible for removal of all walls, appliances, trim work, etc., necessary in order to access the ACM. Work includes the complete dismantling of the two boilers and removal of all associated ACM at the interior and exterior of the boilers, including gaskets, flanges, etc. Asbestos removal shall be performed under full containment conditions with a pressure differential and contiguous decontamination system in accordance with CTDPH 19a-332a-5, 6 and 7, OSHA Class I, Class II and USEPA NESHAP requirements. Reoccupancy air clearance testing shall utilize Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM) analysis, as applicable per CTDPH 19a-332a-12.

Includes the removal of:

- **Electrical rope wiring (North wall and additional wiring assumed behind wall and throughout electrical conduits)**

Contractor shall be responsible for removal of all walls, appliances, trim work, etc., as well as lock out tag out of all electrical sources necessary in order to access the ACM. Asbestos removal shall be performed under full containment conditions with a pressure differential and contiguous decontamination system in accordance with CTDPH 19a-332a-5, 6 and 7, OSHA Class I & II and USEPA NESHAP requirements. Reoccupancy air clearance testing shall utilize Phase Contrast Microscopy (PCM) or Transmission Electron Microscopy (TEM) analysis, as applicable per CTDPH 19a-332a-12.

Further ACM are known to exist within the building, but are not expected to be impacted by the renovation project. These ACM include:

- **Dark brown glue – Basement Storage Room 2 on sheetrock boarded door**
- **Grey door window glaze – Basement Store Room, Basement Storage Room 1, 2nd Floor Offices 4-7, 2nd Floor Siting Room, 2nd Floor Classroom**
- **White fire door insulation – 1st Floor Offices 1-3 & Non-Commissioned Officers' Office, 1st Floor Storage Closet, 1st Floor Museum Office, 1st Floor Bathroom, 2nd Floor Offices 4-7, 2nd Floor Sitting Room, 2nd Floor Classroom**
- **Glue and grout associated with terra cotta flooring – Basement Kitchen, Kitchen Scullery, and Kitchen Storage**
- **Exterior window glaze (assumed) – 2nd Floor exterior windows**
- **Glue daubs (assumed) – Basement Men's Bathroom behind mirrors**

Contractor is advised that the ACM is present and should take precautions so as not to disturb the ACM while performing renovation activity. Refer to Drawing ASB-01 for schematic representations of ACM locations.

Should any of these materials be required to be impacted during construction, or upon discovery of any previously unidentified suspect ACM material during construction activities, work shall cease immediately until the Engineer can determine the extent of any ACM impact and implement proper procedures.

1.3 SUBMITTALS AND NOTICES

A. The Contractor shall submit, in accordance with CTDPH Standard 19a-332a-3, proper notification using the prescribed form, to the Commissioner, State of Connecticut, Department of Public Health not fewer than ten (10) days prior to the commencement of work as follows:

1. Asbestos abatement projects involving greater than ten (10) linear feet (LF) or twenty-five (25) square feet (SF) of ACM (friable or non-friable) within a facility (i.e. interior abatement) and/or greater than 10 LF or 25 SF of friable ACM outside a facility, require an Asbestos Abatement Notification.

2. At sites scheduled for demolition, asbestos abatement of exterior non-friable ACM or interior abatement involving less than 10 LF or 25 SF of ACM (friable or non-friable), and/or exterior abatement involving less than 10 LF or 25 SF of friable ACM require a Demolition Notification. In most cases, the Demolition Contractor is responsible for filing the Demolition Notification not fewer than ten (10) days prior to the commencement of demolition. However, if a portion of the demolition activities are scheduled to be conducted in conjunction with and/or under the supervision of an Asbestos Abatement Contractor (i.e. in the event of a structure which has been condemned, structurally damaged, and/or deemed unsafe for asbestos abatement activities); then it is the responsibility of the Asbestos Abatement Contractor to submit the Demolition Notification.

3. In the event that an Asbestos Abatement Notification has been submitted and the subject facility is scheduled for demolition, a separate Demolition Notification form does not need to be submitted. In such cases, the submission of the Asbestos

Abatement Notification form shall be deemed as satisfying the requirement for the notification of the demolition of the facility.

4. The Contractor filing the proper notification is responsible for all associated fees.

5. If the Contractor intends to dispose of ACM waste within the State of Connecticut, a copy of the Asbestos Abatement/Demolition Notification must also be submitted to the Department of Environmental Protection, Solid Waste Management Unit, and the Contractor must obtain a CTDEEP Special Waste Disposal authorization.

B. Any Alternative Work Practice (AWP) specifically described in these Specifications is pre-approved and is to be utilized at all times. Additional AWP methods may be used if approved by CTDPH and the Engineer/Owner. Should the Contractor desire to use AWP procedures that have not been pre-approved, the Contractor shall submit in writing a description of the proposed methods to the Engineer/Owner and CTDPH for review and approval. Alternative procedures shall provide equivalent or greater protection than procedures which they replace. The Contractor is responsible for all fees associated with filing AWP applications which have not been pre-approved. Submission of AWP applications requires a CTDPH Project Designer License. The Contractor shall not proceed with any AWP other than those listed in this Specification without approval from both the CTDPH and the Engineer/Owner.

C. Seven (7) working days prior to the commencement of asbestos abatement work (Pre-abatement Meeting), the Contractor shall submit to the Engineer/Owner for review and acceptance and/or acknowledgment of the following:

1. Copies of all required notifications.

2. AWP applications/approvals.

3. Permits and licenses for the removal, transport, and disposal of asbestos-containing or contaminated materials, including a CTDPH valid asbestos removal contractor's license.

4. Documentation dated within the previous twelve (12) months, certifying that all employees have received USEPA Model Accreditation Plan approved asbestos worker/supervisor training in the proper handling of materials that contain asbestos; understand the health implications and risks involved, including the illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment as indicated in 29 CFR 1926.1101 on an initial and annual basis, and copies of all employees CTDPH asbestos worker and/or supervisor licenses.

5. Documentation from the Contractor, typed on company letterhead and signed by the Contractor, certifying that all employees listed herein have received the following:

   a. Medical monitoring within the previous twelve (12) months, as required in 29 CFR 1926.1101

b. Respirator fit testing within the previous twelve (12) months, as detailed in 29 CFR 1910.134 (for all employees who must also don a tight-fitting face piece respirator)

6. Copies of the EPA/State-approved certificates for the proposed asbestos landfill.

7. Name and qualifications of the Asbestos Abatement Site Supervisor. This individual shall be the OSHA Competent Person for the abatement activities, shall have a minimum of three years working experience as an Asbestos Abatement Site Supervisor, shall be capable of identifying existing asbestos hazards and shall have the authority to implement corrective measures to eliminate such hazards. The Asbestos Abatement Site Supervisor shall be on-site at all times asbestos abatement is occurring, shall comply with applicable Federal, State and Local regulations which mandate work practices, and shall be capable of performing the work of this contract.

D. No abatement shall commence until a copy of all required submittals have been received and found acceptable to the Engineer. Those employees added to the Contractor's original list will be allowed to perform work only upon submittal to, and receipt of, all required paperwork by the Engineer.

E. Provide the Engineer/Owner, within 30 days of completion of asbestos abatement, a compliance package; which shall include, but not be limited to, the following:

1. Asbestos Abatement Site Supervisor job log;
2. OSHA personnel air sampling data and exposure assessments;
3. Completed waste shipment records.

1.4 SEQUENCE OF WORK

A. The Contractor shall proceed in accordance with the sequence of work as directed by the Engineer/Construction Manager. Work shall be divided into convenient Work Areas, each of which is to be completed as a separate unit.

B. The Contractor shall use the following sequence for the asbestos abatement work:

1. Release of work area to Contractor.

2. A visual inspection of the work area to determine pre-existing damage to facility components.

3. Removal of all moveable objects from the Work Areas undergoing abatement by the Contractor.

4. All temporary utilities required for the project shall be on site and operational prior to the initiation of asbestos work.

5. Abatement of all asbestos-containing materials by the Contractor.

6. Final visual inspections by the Project Monitor.

7. Air sampling by the Project Monitor for re-occupancy.

8. Cleanup by the Contractor. Work Areas must be returned to their original condition or as directed by the Engineer/Project Monitor.

9. Removal of waste from the site.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials shall be delivered to the job site in the original packages, containers, or bundles bearing the name of the manufacturer, the brand name and product technical description.

B. No damaged or deteriorating materials shall be used. If material becomes contaminated with asbestos, the material shall be decontaminated or disposed of as asbestos-containing waste material. The cost to decontaminate and dispose of this material shall be at the expense of the Contractor.

C. Fire retardant polyethylene sheet shall be in roll size to minimize the frequency of joints, with factory label indicating four (4) or six (6) mil thickness.

D. Six (6) mil polyethylene disposable bags shall have pre-printed OSHA/EPA/DOT labels and shall be transparent.

E. Tape (or equivalent) capable of sealing joints in adjacent polyethylene sheets and for the attachment of polyethylene sheets to finished or unfinished surfaces must be capable of adhering under both dry and wet conditions.

F. Surfactant is a chemical wetting agent added to water to improve penetration and shall consist of fifty (50) percent polyoxyethylene ether and fifty (50) percent polyoxyethylene ester, or equivalent. The surfactant shall be mixed with water to provide a concentration one (1) ounce surfactant to five (5) gallons of water, or as directed by the manufacturer.

G. Spray equipment must be capable of mixing necessary chemical agents with water, generating sufficient pressure and volume; and equipped with adequate hose length to access all necessary work areas.

H. Mechanical mastic removal equipment shall be suitable for the application and shall be operated in a manner which prevents damage to the underlying floor. Sanders, grinders, wire brushes and needle-gun type removal equipment shall be equipped with a High Efficiency Particulate Air (HEPA) filtered vacuum dust collection system.

I. Containers for storage, transportation and disposal of asbestos containing waste material shall be impermeable and both air and watertight.

J. Labels and warning signs shall conform to OSHA 29 CFR 1926.1101, USEPA 40 CFR Part 61.152, and USDOT 49 CFR Part 172 as appropriate.

K. Encapsulant, a material used to chemically entrap asbestos fibers to prevent these fibers from becoming airborne, shall be of the type which has been approved by the Engineer. Use shall be in accordance with manufacturer's printed technical data. The encapsulant shall be clear and must be compatible with new materials being installed, if any.

L. Glovebag assembly shall be manufactured of six (6) mil transparent polyethylene or PVC with two (2) inward projecting long sleeve gloves, an internal pouch for tools, and an attached labeled receptacle for waste.

M. Mastic removal chemicals shall be low odor and non-citrus based, with a flash point in excess of 140° F.

N. Any planking, bracing, shoring, barricades and/or temporary sheet piling, necessary to appropriately perform work activities shall conform to all applicable federal, state and local regulations.

O. Air filtration devices and vacuum units shall be equipped with HEPA filters.

2.2 TOOLS AND EQUIPMENT

A. Air monitoring equipment of the type and quantity required to monitor operations and conduct personnel exposure surveillance shall conform to OSHA requirements.

B. Protective clothing, respirators, filter cartridges, air filters and sample filter cassettes shall be provided in sufficient quantities for the project.

C. Electrical equipment, protective devices and power cables shall conform to all applicable codes.

D. Shower stalls and plumbing shall include sufficient hose length and drain system or an acceptable alternate. Showers shall be equipped with hot and cold or warm running water. One shower stall shall be provided for each eight workers. Water is filtered through a 5 micron and a 10 micron filter prior to being discharged into the city sewer/sanitary system.

E. The Contractor may need to supply electrical power to the site by either fuel operated generator(s) or temporary restoration of electrical service. Electrical power supply will be sufficient for maintaining in operation all equipment required for this project throughout the duration of the project.

F. Exhaust air filtration units shall be equipped with HEPA filters capable of providing sufficient air exhaust to create a minimum pressure differential of 0.02 inches of water column, and to allow a sufficient flow of air through the area providing 4 air changes per hour. An automatic warning system shall be incorporated into the equipment to indicate pressure drop or unit failure. No air movement system or air filtering equipment shall discharge unfiltered air outside the Regulated Area. The Contractor shall provide actual airflow measurement of filtration units while the unit is in place and calculate actual air exchange rates.

G. Pressure differential monitoring equipment shall be provided to ensure exhaust air filtration devices provide the minimum pressure differential required between the Work Area and occupied areas of the facility.

H. Vacuum units, of suitable size and capabilities for the project, shall have HEPA filters capable of trapping and retaining at least 99.97 percent of all monodispersed particles of three micrometers in diameter or larger.

I. Ladders and/or scaffolds shall be of adequate length, strength and sufficient quantity to support the work schedule.

J. Other materials such as lumber, nails and hardware necessary to construct and dismantle the decontamination enclosures and the barriers that isolate the Work Area shall be provided as appropriate for the work.

K. Spray equipment shall be capable of mixing wetting agent with water and capable of generating sufficient pressure and volume. Hose length shall be sufficient to reach all of the Regulated area.

L. Mechanical mastic removal equipment shall be suitable for the application and shall be operated in a manner which prevents excessive damage to the underlying floor.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. The Abatement Contractor/Subcontractor shall possess a valid State of Connecticut Asbestos Contractor License. Should any portion of the work be subcontracted, the subcontractor must also possess a valid State of Connecticut Asbestos Contractor License. The Asbestos Abatement Site Supervisor employed by the Contractor shall be in control on the job site at all times during asbestos abatement work. All employees of the Contractor who shall perform work (i.e. Asbestos Abatement Site Supervisor, Asbestos Abatement Worker) shall be properly certified/licensed by the State of Connecticut to perform such duties.

B. All labor, materials, tools, equipment, services, testing, insurance (with specific coverage for work on asbestos), and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these Specifications shall be provided by the Contractor. The Contractor shall be prepared to work all shifts and weekends throughout the course of this project.

C. Prior to beginning work, the Engineer and Contractor shall perform a visual survey of each work area and review conditions at the site for safety reasons. In addition, the Contractor shall instruct all workers in all aspects of personnel protection, work procedures, emergency evacuation procedures and use of equipment including procedures unique to this project.

D. The Contractor shall:

1. Shutdown and isolate heating, cooling, and ventilating air systems to prevent contamination and fiber dispersal to the other areas of the building.

2. Shut down and lock out electrical power, including all receptacles and light fixtures, when feasible. The use or isolation of electrical power will be coordinated with all other ongoing uses of electrical power at the site.

3. Coordinate all power and fire alarm isolation with the appropriate representatives.

4. When necessary, provide temporary power and adequate lighting and ensure safe installation of electrical equipment, including ground fault protection and power cables, in compliance with applicable electrical codes and OSHA requirements. The Contractor is responsible for proper connection and installation of electrical wiring.

E. If sufficient electrical service is unavailable, the Contractor may need to supply electrical power to the site by fuel operated generator(s). Electrical power supply shall be sufficient for all equipment required for this project in operation throughout the duration of the project. If the Contractor elects to supply electrical power to the work site through the use of generators, the Contractor shall ensure that each work area is a manageable size such that removal, final cleaning and reoccupancy testing can be accomplished within one work shift while negative air machines are operating.

F. Negative pressure must be continuously maintained in each work area, until the area achieves satisfactory reoccupancy criteria and is approved by the Project Monitor to be deregulated. Negative air pressure must be maintained twenty-four (24) hours per day and the Contractor shall establish temporary electrical service to the site, rather than utilize generators.

G. Water service may not be available at the site. Contractor shall supply sufficient water for each shift to operate the decontamination shower units as well as to maintain the work areas adequately wet.

H. Ladders and/or scaffolds shall be in compliance with OSHA requirements, and of adequate length, strength and sufficient quantity to support the scope of work. Use of ladders/scaffolds shall be in conformance with OSHA 29 CFR 1926 Subpart L and X requirements.

I. Work performed at heights exceeding six feet (6') shall be performed in accordance with the OSHA Fall Protection Standard 29 CFR 1926 Subpart M including the use of fall arrest systems as applicable.

J. Data provided regarding asbestos sampling conducted throughout the structure(s) is for informational purposes only. Under no circumstances shall this information be the sole means used by the Contractor for determining the presence and location of all asbestos containing materials. The Contractor shall verify all field conditions affecting performance of the work as described in these Specifications in accordance with OSHA, USEPA, USDOT, CTDPH and CTDEEP standards. Compliance with the applicable requirements is solely the responsibility of the Contractor.

K. The Engineer will provide a Project Monitor to oversee the activities of the Contractor. No asbestos work shall be performed until the Project Monitor is on-site. Pre-abatement, during abatement and post-abatement air sampling will be conducted as deemed necessary by the Project Monitor. Waste stream testing will be performed, as necessary, by the Project Monitor prior to waste disposal.

3.2 PREPARATION OF WORK AREA ENCLOSURE SYSTEM

A. Pre-clean the work areas using HEPA filtered equipment (vacuum) and/or wet methods as appropriate, collecting and properly containing all dust and debris as asbestos-containing/asbestos contaminated waste. Vacuum units, of suitable size and capabilities for the project, shall have HEPA filters capable of trapping and retaining at least 99.97 percent of all monodispersed particles of three micrometers in diameter or larger. Do not use methods that raise dust, such as dry sweeping or vacuuming with equipment not equipped with HEPA filters.

B. After pre-cleaning, movable objects shall be removed from the work areas with the utmost care to prevent damage of any kind and relocated to a temporary storage location coordinated with the Engineer. The Contractor is responsible for protecting all fixed objects that are permanent fixtures or are too large to remove and remain inside the Regulated Area. Fixed objects shall be enclosed with one layer of six (6) mil polyethylene sheeting sealed with tape.

C. Where non-ACM insulation exists within a Regulated Area, the Contractor has the option of removing the non-ACM insulation material and disposing of as ACM debris, or decontaminating and protecting non-ACM insulation material with two (2) layers of six (6) mil polyethylene sheeting. Any non-ACM insulation removed shall be replaced with new material of equal or better quality at the Contractor's expense.

3.3 WORKER DECONTAMINATION ENCLOSURE SYSTEM

A. The Contractor shall establish contiguous to the Regulated Area, a Worker Decontamination Enclosure System consisting of Equipment Room, Shower Room and Clean Room in series, as detailed below. Access to the Regulated Area shall only be through this enclosure.

B. Access between rooms in the Worker Decontamination Enclosure System shall be through airlocks. Other effective designs are permissible. The Clean Room, Shower Room and Equipment Room located within the Worker Decontamination Enclosure, shall be contiguously connected with taped airtight edges, thus ensuring the sole source of airflow originates from outside the regulated areas, once the negative pressure differential within the Regulated Area is established.

C. The Clean Room shall be adequately sized to accommodate workers and shall be equipped with a suitable number of hooks, lockers, shelves, etc., for workers to store personal articles and clothing. Changing areas of the Clean Room shall be suitably screened from areas occupied by the public.

D. The Shower Room shall be of sufficient capacity to accommodate the number of workers. One shower stall shall be provided for each eight (8) workers. Showers shall be equipped

with hot and cold or warm running water through the use of electric hot water heaters supplied by the Contractor. No worker or other person shall leave a Regulated Area without showering. Shower water shall be collected and filtered using best available technology and dumped down an approved sanitary drain. Shower stalls and plumbing shall include sufficient hose length and drain system or an acceptable alternate.

3.4 EQUIPMENT DECONTAMINATION ENCLOSURE SYSTEM

A. The Contractor shall establish contiguous to the Regulated Area an Equipment/Waste Removal Decontamination Enclosure System consisting of two (2) totally enclosed chambers divided by a double flap curtained opening. Other effective designs are permissible. This enclosure must be constructed so as to ensure that no personnel enter or exit through this unit.

B. The Contractor shall ensure that no personnel or equipment be permitted to leave the Regulated Area until proper decontamination procedures (including HEPA vacuuming, wet wiping and showering) to remove all asbestos debris have occurred. No asbestos-contaminated materials or persons shall enter the Clean Room.

3.5 SEPARATION OF WORK AREAS FROM OCCUPIED AREAS

A. Seal off all windows, doorways, skylights, ducts, grilles, diffusers, vents, light fixtures, electrical receptacles, suspended ceiling tile systems and any other openings between the Regulated Area and the uncontaminated areas outside of the Regulated Area, including the outside of the building, with critical barriers consisting of a minimum of one (1) layer of six (6) mil polyethylene sheeting securing the edges with tape. Doorways and corridors which will not be used for passage during work and separate the regulated areas from occupied areas must be sealed with fixed critical barriers constructed of 2" x 4" wood or metal framing 16" O.C., with ½" plywood on the occupied side and two layers of six (6) mil polyethylene sheeting on the Regulated Area side to prevent unauthorized access or air flow.

B. The Contractor shall create a negative pressure differential in the range of 0.02 to 0.04 inches of water column between the Regulated Area and surrounding areas by the use of acceptable negative air pressure equipment. Exhaust air filtration units shall be equipped with HEPA filters capable of providing sufficient air exhaust to create a minimum pressure differential of 0.02 inches of water column, and to allow a sufficient flow of air through the area providing 4 air changes per hour. The Contractor shall provide a sufficient quantity of HEPA air filters to maintain the pressure differential throughout the duration of the project. An automatic warning system shall be incorporated into the equipment to indicate pressure drop or unit failure. Continuously monitor the pressure differential between the Regulated Area and surrounding area to ensure exhaust air filtration equipment maintains a minimum pressure differential of 0.02 inches of water column. The Contractor shall provide actual air flow measurement of filtration units while the unit is in place and calculate actual air exchange rates. No air movement system or air filtering equipment shall discharge unfiltered air outside the Regulated Area.

C. A Negative Pressure Enclosure (NPE) shall be constructed via covering of floor and wall surfaces with polyethylene sheeting sealed with tape. Polyethylene shall be applied alternately to floors and walls. Cover floors first, with a layer of six (6) mil polyethylene

sheeting, so that polyethylene extends at least twelve (12) inches up on wall. Cover wall with a layer of four (4) mil polyethylene sheeting to twelve (12) inches beyond the wall/floor intersection, thus overlapping the floor material by a minimum of twenty-four (24) inches. Repeat the process for the second layer of polyethylene. There shall be no seams at wall-to-floor joints. Protect carpet and floor tile with two additional layers of six (6) mil reinforced polyethylene in addition to the prior two layers required.

D. Conspicuously label and maintain emergency and fire exits from the Regulated Area satisfactory to fire officials.

E. Post warning signs meeting the specifications of OSHA 29 CFR 1910.1001 and 29 CFR 1926.1101 at each Regulated Area. In addition, signs shall be posted at all approaches to Regulated Areas so that an employee or building occupant may read the sign and take the necessary protective steps before entering the area. Additional signs may require posting following construction of workplace enclosure barriers.

3.6 ALTERNATE EXTERIOR NON-FRIABLE ASBESTOS SET-UP PROCEDURES

A. In lieu of the establishment of a negative pressure enclosure (NPE) system as described by CTDPH Sections 19a-332a-5(c), 5(d), 5(e), and 5(h), non-friable ACM will be removed from exterior work areas within an outdoor Regulated Area(s). The regulated work area will be established by the use of appropriately labeled barrier tape and postings in compliance with CTDPH 19a-332a-5(a) as well as OSHA 29 CFR 1926.1101. A remote personnel decontamination unit as specified in Section 19a-332a-6 will be required. This method shall only be utilized provided exposure assessment air sampling data collected during the removal of the exterior non-friable materials indicates that the exposure levels during removal of such materials do not exceed 0.1 asbestos f/cc. Should exposure assessment air sampling data exceed this level, and engineering efforts to reduce the airborne fiber levels not be successful in reducing the levels to less than 0.1 f/cc, removal shall occur within these areas under full containment conditions.

3.7 ALTERNATE "SPOT REPAIR" ASBESTOS PROCEDURES

A. In lieu of the establishment of a negative pressure enclosure (NPE) system as described by CTDPH Sections 19a-332a-5(c), 5(d), 5(e), and 5(h), less than 3 LF or 3 SF of ACM will be removed as a "spot repair" in accordance with CTDPH Section 19a-332a-10. A regulated area will be established by the use of appropriately labeled barrier tape and postings in compliance with CTDPH 19a-332a-5(a) as well as OSHA 29 CFR 1926.1101. A remote personnel decontamination unit as specified in Section 19a-332a-6 will be required. Air-tight barriers will be constructed to assure that asbestos fibers released during abatement activities are contained within the work area. (Glovebags are permitted, as specified below.) ACM will be adequately wet prior to disturbance and remain wet until placed in leak-tight container. Following abatement, clean-up methods within the work area will include HEPA-filtered vacuuming or wet cleaning techniques until no visible residue remains.

B. Glovebags utilized to perform "spot repair" activities on asbestos containing pipe insulation/mudded fitting insulation, in conformance with OSHA 29 CFR 1926.1101(g)(5)(ii), shall be:

1. constructed of 6 mil poly, seamless at bottom, unmodified
2. installed so that it completely covers the circumference of pipe or other structure where work is to be done, with impermeable dropcloths placed on all surfaces beneath the work area
3. smoke-tested for leaks and sealed, as needed
4. used only once, may not be moved
5. used only on surfaces with temperatures <150°F
6. collapsed by removing air via HEPA-vacuum, prior to disposal
7. adhered to surfaces which are intact, surfaces with loose and friable material shall be sealed in two layers of 6 mil poly or otherwise rendered intact
8. capable of sustaining integrity at connection site to attached waste bag, which must have equivalent of sliding valve for disconnection (as applicable)
9. performed by a minimum of two (2) persons

C. Glovebags may also be used for "spot repair" abatement procedures involving additional materials (e.g. floor tile/linoleum, transite, etc.) provided that the glovebag is capable of fully enclosing the material to be removed.

3.8 PERSONNEL PROTECTION

A. The Contractor shall utilize all appropriate engineering controls and safety and protective equipment while performing the work in accordance with OSHA, USEPA, USDOT, CTDEEP and CTDPH regulations.

B. The Contractor shall provide and require all workers to wear protective clothing in the Regulated Areas where asbestos fiber concentrations may reasonably be expected to exceed the OSHA established Permissible Exposure Limits (PEL) or where asbestos contamination exists. Protective clothing shall include impervious coveralls with elastic wrists and ankles, head covering, gloves and foot coverings.

C. Respiratory protection shall be provided and selection shall conform to the requirements of OSHA 29 CFR 1910.134 and 29 CFR 1926.1101 as well as the requirements of the CTDPH regulations and 42 CFR Part 84. A formal respiratory protection program must be implemented in accordance with 29 CFR 1926.1101 and 29 CFR 1910.134.

D. All other necessary personnel protective equipment (i.e. hardhat, work boots, safety glasses, hearing protection, etc.) required to perform the asbestos abatement work activities shall conform to all applicable federal, state and local regulations.

E. All other qualified and authorized persons entering into a Regulated Area (i.e. Project Monitor, Regulatory Agency Representative) shall adhere to the requirements of personnel protection as stated in this section.

3.9 ASBESTOS ABATEMENT PROCEDURES

A. The Asbestos Abatement Site Supervisor, as the OSHA Competent Person shall be at the site at all times.

B. The Contractor shall not begin abatement work until authorized by the Project Monitor, following a pre-abatement visual inspection.

C. All workers and authorized persons shall enter and leave the Regulated Area through the Worker Decontamination Enclosure System, leaving contaminated protective clothing in the Equipment Room for reuse or disposal of as asbestos contaminated waste. No one shall eat, drink, smoke, chew gum or tobacco, or apply cosmetics while in a Regulated Area.

D. During removal, the Contractor shall spray asbestos materials with amended water using airless spray equipment capable of providing a "mist" application to reduce the release of airborne fibers. Spray equipment shall be capable of mixing wetting agent with water and capable of generating sufficient pressure and volume. Hose length shall be sufficient to reach all of the Regulated Area. Do not "flood" the area with hose type water supply equipment with the potential to create water releases from the regulated area.

E. The Contractor shall continue to spray the asbestos materials with amended water, as necessary, throughout removal activities to ensure the asbestos materials remain adequately wet. The asbestos materials shall not be allowed to dry out.

F. In order to minimize airborne asbestos concentrations inside the Regulated Area, the Contractor shall remove the adequately wetted asbestos in manageable sections. In addition, asbestos materials removed from any elevated level shall be carefully lowered to the floor.

G. The Contractor shall promptly place the adequately wet asbestos material in disposal containers (six (6) mil polyethylene bags/fiber drum/poly-lined dumpsters, etc.) as it is removed. Large components removed intact may be wrapped in two (2) layers of six (6) mil polyethylene sheeting secured with tape. As the disposal containers are filled, the Contractor shall promptly seal the containers, apply caution labels and clean the containers before transportation to the equipment decontamination area. Bags shall be securely sealed to prevent accidental opening and leakage by taping in gooseneck fashion. Small components and asbestos-containing waste with sharp-edged components (e.g. nails, screws, metal lath, tin sheeting) which could tear polyethylene bags and sheeting shall be placed in clean drums and sealed with locking ring tops. All waste containers shall be leak-tight, (typically consisting of two layers of 6 mil poly (or bags)), and shall be properly labeled and placarded with OSHA Danger labels, DOT shipping labels, markings and placards and USEPA NESHAP generators labels. Containers shall be decontaminated by wet cleaning and HEPA vacuuming within the equipment decontamination area prior to exiting the regulated area. Wet clean each container thoroughly before moving to Holding Area.

H. If at any time during asbestos removal, the Project Monitor should suspect contamination of areas outside the Regulated Area, the Contractor shall immediately stop all abatement work and take steps to decontaminate these areas and eliminate causes of such contamination. Unprotected individuals shall be prohibited from entering contaminated areas until air sampling and/or visual inspections determine decontamination.

I. After completion of abatement work, all surfaces from which asbestos has been removed shall be wet brushed, using a nylon brush, wet wiped and sponged or cleaned by an equivalent method to remove all visible material (wire brushes are not permitted). During this work the surfaces being cleaned shall be kept wet. Cleaning shall also include the use of HEPA filtered vacuum equipment.

3.10 CLEAN-UP PROCEDURES

A. The Contractor shall also remove and containerize all visible accumulations of asbestos-containing and/or asbestos-contaminated debris which may have splattered or collected on the polyethylene engineering controls/barriers.

B. The Contractor shall clean surfaces of contaminated containers and equipment thoroughly by vacuuming with HEPA filtered equipment and wet sponging or wiping before moving such items into the Equipment Decontamination Enclosure System for final cleaning and removal to uncontaminated areas.

C. The Contractor shall remove contamination from the exteriors of the air filtration devices, scaffolding, ladders, extension cords, hoses and other equipment inside the Regulated Area. Cleaning may be accomplished by brushing, HEPA vacuuming and/or wet cleaning. The Contractor shall wet wipe the Regulated Area beginning at the point farthest away from the negative air filtration units using cotton rags or lint free paper towels. Rags and towels shall be disposed of after each use. Workers should avoid the use of dirty rags to insure proper cleaning of surfaces. Mop the entire floor with a clean mop head and amended water. Water shall be changed frequently. For those Regulated Areas where lead is also disturbed, the cleaning shall also include a wet washing with a high phosphate detergent solution and HEPA vacuuming. Waste water shall be filtered using best available technology into leak-proof containers prior to being transported to a sanitary sewer for discharge.

D. Once the Regulated Area surfaces have dried, the Project Monitor shall perform a thorough post abatement visual inspection utilizing protocols from the ASTM Standard E1368-90 *Standard Practice for Visual Inspection of Asbestos Abatement Projects*. All surfaces within the Regulated Area, including but not limited to ledges, beams, and hidden locations shall be inspected for visible residue. Evidence of asbestos contamination identified during this inspection will necessitate further cleaning as heretofore specified. The area shall be re-cleaned at the Contractor's expense, until the standard of cleaning is achieved.

E. Once the area has received a satisfactory post-abatement visual inspection, any equipment, tools or materials not required for completion of the work, shall be removed by the Contractor from the Regulated Area. Negative air filtration devices shall remain in place and operating for the remainder of the clean-up operation.

F. Following the post-abatement visual, the Contractor shall apply a lock-down encapsulant to all surfaces within the Regulated Area from which asbestos has been removed and the cleaned inner layer of polyethylene.

3.11 AIR MONITORING REQUIREMENTS

A. The Contractor shall:

1. Provide air monitoring equipment including sample filter cassettes of the type and quantity required to properly monitor operations and personnel exposure surveillance throughout the duration of the project.

2. Conduct personnel exposure assessment air sampling, as necessary, to assure that workers are using appropriate respiratory protection in accordance with OSHA Standard 1926.1101. Documentation of air sampling results must be recorded at the work site within twenty-four (24) hours and shall be available for review until the job is complete.

B. The Project Monitor, acting as the representative of the Engineer during abatement activities, will:

1. Collect air samples in accordance with the current revision of the NIOSH 7400 Method of Air Sampling for Airborne Asbestos Fibers while overseeing the activities of the Abatement Contractor. Frequency and duration of the air sampling during abatement will be representative of the actual conditions at the abatement site. The size and configuration of the asbestos project will be a factor in the number of samples required to monitor the abatement activities and shall be determined by the Project Monitor. The following schedule of samples may be collected by the Project Monitor:

a. Pre-Abatement (Optional)
   i. Background areas
   ii. Area(s) adjacent to Work Area(s)
   iii. Work Area(s)

b. During Abatement (Optional)
   i. At the exhaust of air filtering device
   ii. Within Regulated Area(s)
   iii. Area(s) adjacent to Regulated Areas(s) (exterior to critical barriers)
   iv. At the Decontamination Enclosure System

c. Post-Abatement (reoccupancy air clearance testing) (**REQUIRED**)
   i. Interior Regulated NPE Area - At least five (5) per homogenous area

Abatement Activity	Pre-Abatement	During Abatement	Post-Abatement
Greater than 160 SF/260 LF – Interior	PCM	PCM	TEM
Greater than 3 LF/3 SF and Less than 160 SF/260 LF – Interior	PCM	PCM	PCM
Spot Removal and Glovebag Procedures (<3 LF/3 SF)	---	PCM	---
Exterior Friable/Non-Friable	---	PCM	---

C. If air samples collected outside of the Regulated Area during abatement activities indicate airborne fiber concentrations greater than original background levels, or greater than 0.1 f/cc, as determined by Phase Contrast Microscopy, whichever is larger, an examination of the Regulated Area perimeter shall be conducted and the integrity of barriers shall be restored. Cleanup of surfaces outside the Regulated Area using HEPA vacuum equipment or wet cleaning techniques shall be done prior to resuming abatement activities.

3.12 POST-ABATEMENT REOCCUPANCY PROCEDURES

A. For interior NPE Regulated Areas, clearance air sampling will be performed by the Project Monitor as specified in the Air Sampling Schedule. Clearance sampling will be undertaken using aggressive sampling techniques. Sampling and analysis of clearance samples will follow State of Connecticut Regulations, Section 19a-332a-12. Areas which do not comply shall continue to be cleaned by and at the Contractors expense, until the specified Standard of Cleaning is achieved as evidenced by results of air testing. When the Regulated Area passes the re-occupancy clearance, controls established by these Specifications may be removed.

1. Air sampling will not begin until after the area has received an acceptable post abatement visual inspection, encapsulation has been completed, and no visible water, liquid encapsulant or condensation remain in the Regulated Area.

2. Sampling equipment will be placed at random throughout the Regulated Area.

3. The following aggressive air sampling procedures will be used within the Regulated Area during all air clearance monitoring:

   a. Before starting the sampling pumps, direct the exhaust from forced air equipment (such as a 1 horsepower leaf blower) against all walls, ceilings, floors, ledges and other surfaces in the Regulated Area.
   b. Pre-calibrate the sampling pump flow rates through the use of a rotameter calibrated to a primary standard.
   c. Start the sampling pumps and sample for the required time.
   d. Post-calibrate the sampling pump flow rates.

4. Air volumes taken for clearance sampling shall be sufficient to accurately determine (to a 95 percent probability) fiber concentrations to 0.010 f/cc of air (1,200 liters).

5. Analysis shall follow the requirements of CTDPH 19a-332a-12.

6. Each homogeneous Regulated Area which does not meet the clearance criteria shall be thoroughly recleaned using HEPA vacuuming and/or wet cleaning, with the negative pressure ventilation system in operation. New samples shall be collected in the Regulated Area as described above. The process shall be repeated until the Regulated Area passes the test, with the cost of repeat sampling being borne entirely by the Contractor.

7. For an asbestos abatement project with more than one homogeneous Regulated Area, the release criterion shall be applied independently to each Regulated Area.

8. These clearance sampling procedures may also be implemented for exterior NPE work areas at the discretion of the Engineer.

3.13 POST ABATEMENT WORK AREA DEREGULATION

A. The Contractor shall remove all remaining polyethylene, including critical barriers, and Decontamination Enclosure Systems leaving negative air filtration devices in operation. HEPA vacuum and/or wet wipe any visible residue which is uncovered during this process. All waste generated during this disassembly process shall be discarded as ACM waste.

B. A final visual inspection of the work area shall be conducted by the Competent Person and the Project Monitor to ensure that all visible accumulations of suspect materials have been removed and that no equipment or materials associated with the abatement project remain.

C. The Contractor shall restore all work areas and auxiliary areas utilized during work to conditions equal to or better than original. Any damage caused during the performance of the work activity shall be repaired by the Contractor at no additional expense to the Engineer.

3.14 WASTE DISPOSAL

A. Unless otherwise specified, all removed materials and debris resulting from execution of this project shall become the responsibility of the Contractor and removed from the premises. Materials not scheduled for reuse shall be removed from the site and disposed of in accordance with all applicable Federal, State and Local requirements.

B. Waste removal dumpsters and cargo areas of transport vehicles shall be lined with a layer of six (6) mil polyethylene sheeting to prevent contamination from leaking or spilled containers. Floor sheeting shall be installed first, and shall be extended up sidewalls 12-inches. Wall sheeting shall overlap floor sheeting 24-inches and shall be taped into place.

C. OSHA "Danger" signs must be attached to vehicles used to transport asbestos-containing waste prior to loading ACM waste. The signs must be posted so that they are plainly visible.

D. Waste haulers and disposal facilities utilized shall match those indicated on the submitted CTDPH notification.

E. Ensure all waste containers (bags, drums, etc.) are properly packed, sealed and labeled with USEPA NESHAP generator labels, OSHA danger labels and DOT shipping labels. For each shipment of ACM waste, the Contractor shall complete an EPA-approved asbestos waste shipment record.

F. Authorized representatives signing waste shipment records on behalf of the generator must have USDOT Shipper Certification training in accordance with HMR 49 CFR Parts 171-180.

G. Transport vehicles hauling ACM waste shall have appropriate USDOT placards visible on all four (4) sides of the vehicle.

H. The Contractor shall dispose of asbestos-containing and/or asbestos contaminated material at an EPA authorized site and must be in compliance with the requirements of the Special Waste Provisions of the Office of Solid Waste Management, Department of Environmental

Protection, State of Connecticut, or other designated agency having jurisdiction over solid waste disposal.

I. Any asbestos-containing and/or asbestos-contaminated waste materials which also contain other hazardous contaminants shall be disposed of in accordance with the EPA's Resource Conservation and Recovery Act (RCRA), CTDEEP and ConnDOT requirements. Materials may be required to be stored on-site and tested by the Project Monitor to determine proper waste disposal requirements.

END OF SECTION 02 82 13

PART 1: GENERAL

1.1 SCOPE

A. Work under this item shall include the remediation of lead hazards at the ***Branford Armory, located at 87 Montowese Street in Branford, CT***, and associated work by persons who are knowledgeable, qualified, and trained in the removal, treatment and handling of lead contaminated materials, including the transportation and disposal of non-hazardous and hazardous lead construction and demolition bulky waste containing or contaminated with lead, the recycling of metallic components covered with lead paint, and the subsequent cleaning of the affected environment. Lead paint includes paint found to contain any detectable amount of lead by Atomic Absorption Spectrophotometry (AAS) or X-Ray Fluorescence (XRF). Lead contaminated dust includes dust found to contain ≥ 40 µg/sf of lead by Atomic Absorption Spectrophotometry (AAS).

B. A recent memo issued from the National Guard Bureau (23 September 2015 and December 2016) states the current U.S. Department of Housing and Urban Development's (HUD) decontamination level of 40 µg /ft^2 is now required to be achieved within all facilities/former ranges, in an effort to protect Soldiers, their Families, the civilian workforce, and the general public.

C. All activities shall be performed in accordance with, but not limited to, the current revision of the OSHA Lead in Construction Regulations (29 CFR 1926.62), the USEPA RCRA Hazardous Waste Regulations (40 CFR Parts 260 through 274), and the CTDEEP Hazardous Waste Regulations (22a-209-1 and 22a-449(c)), as well as with the National Guard Bureau (NGB) Guidelines and Procedures (NG Pam 420-15), the NGB Work Practice Controls for Lead, and the NGB memo dated 6 December 2016. *(See Attachments for specific information regarding NGB guidelines/etc.)*

D. The remediation of lead hazards shall include the clean-up, removal and/or disposal of building components or movable items either coated with lead painted surfaces or covered with lead contaminated dust, as identified in the attached report titled "Assessment for Lead Hazards", submitted by TRC Environmental Corporation (TRC) to the Connecticut Military Department (CTMIL) on October 6, 2015. Refer to the assessment report for site sketches/locations. TRC is referred to in these Specifications as the 'Engineer' and/or "Project Monitor".

E. Deviations from these Specifications require the written approval of the Engineer.

1.2 DESCRIPTION OF WORK

A. Section 1.2 shall detail the extent of each phase of operation designated for this project. Phase areas may be combined or divided at the direction of the Engineer. Proceed through the sequencing of the work phases under the direction of the Engineer.

B. All work activities will occur while the facility remains in operation, and as such the schedule of remediation work is strictly governed by the allowable time frame mandated by the CTMIL. The Contractor shall coordinate activity with on-site facility staff as to days and times that staff will be restricted from access to each work area.

C. Activities listed in the scope of work below shall be performed within an established lead control (regulated) area with a remote hand wash facility/decontamination system, in accordance with OSHA Lead in Construction Standards. Engineering controls, including critical barriers and/or polyethylene sheeting, and a negative pressure enclosure, and work practices shall be utilized, as needed, to prevent the spread of lead dust and debris beyond the work area and limit the generation of airborne lead.

D. CTMIL staff shall remove any smaller items left on the main floor prior to work.

E. **SCOPE OF WORK:**

- **PHASE I- COMPONENT REMOVAL:**

  Phase I work shall include the removal of the two (2) ductwork systems servicing the former range and adjacent areas.

  All steel/metal components shall be recycled.

- **PHASE II- FLOORING/CEILING INSTALLATION:**

  Phase II shall include installation work in the north entrance area and the south-side room.

  North Entrance Area (Flooring): The contractor shall enclose the painted concrete floor using non-slip vinyl/rubber flooring material. Flooring material specifications shall be approved by CTMIL prior to installation. *Prior to installation of ceiling material, the Contractor shall clean the top of the brock mid-wall using wet methods and HEPA vacuuming techniques.*

  South-Side Area (Ceiling-Alternate 1): The contractor shall enclose the exposed floor joists and decking throughout the South-Side Room with a drop-ceiling tile system, using materials that meet applicable building/fire code requirements. Ceiling tile specifications shall be approved by CTMIL prior to installation.

  South-Side Area (Ceiling-Alternate 2): The contractor shall enclose the exposed floor joists and decking throughout the South-Side Room with sheetrock, including final tape/prep/paintwork, using materials that meet applicable building/fire code requirements.

- **PHASE III- FINAL CLEANING:**

  Phase III work shall include the cleaning of all the remaining surfaces throughout the North and South Side Areas. Cleaning of all surfaces shall be performed using wet methods and HEPA vacuuming techniques. ***Note: To help achieve clearance criteria, certain floor surface coatings may need to blasted/ground-down prior to cleaning.***

  As a condition for acceptance of the work performed, the facility is to be tested by certified personnel (Engineer) performing wipe tests after a period of 36 hours. "Wipe Tests" or "Wipe Clearance Samples" will be taken from surfaces including, but not limited to: ceiling (including above if suspended), walls, floors, cage surfaces, heating fan unit surfaces, pipe/conduit and other

various mechanical surfaces, and/or boiler surfaces. The former range areas will be considered clean, if clearance samples for lead concentration, are not greater than or equal to the NGB standard of Forty micrograms per square foot (40 μg/ft2), which is equal to less than Forty parts per million (<40 ppm).

Any smaller items that have been left behind by the CTMIL shall also be included in the cleaning. Only the outer surfaces of closed file cabinets, desks, storage boxes, etc. shall be cleaned.

End. Scope of Work Section.

F. Lead dust contaminated debris generated from any activity, as well as lead dust contaminated equipment (rags, mops, suits, etc.) from clean-up, shall be containerized. The Engineer shall collect samples of these waste materials for analysis via the Toxicity Characteristic Leaching Procedure (TCLP), EPA-1311/7420, for leachable lead (a RCRA metal) to determine if the waste is Hazardous. The contractor shall be responsible for disposal of all waste generated during clean-up/removal activities.

G. The contractor shall be responsible for disposal of all waste generated during clean-up/removal activities. If waste materials are found to be hazardous via TCLP analysis, the waste shall be handled and disposed of in accordance with USEPA/CTDEEP Hazardous Waste Regulations. If the waste materials are determined to be non-hazardous, the waste will be disposed of as non-hazardous construction and demolition (C&D) bulky waste at an approved CTDEEP Solid Waste. All steel and metal waste generated shall be segregated and recycled as scrap metal at an approved facility. The recycling of scrap metal (regardless of LBP concentration and/or contamination) is exempt from USEPA RCRA and CTDEEP Hazardous Waste Regulation.

H. The Contractor shall collect the wash water generated by the worker shower, wash facilities, or steam cleaning operations in 55 gallon drums and filter the water using a 2 stage filtration system composed of a (1.5 micron) porosity in-line cartridge particulate filter followed by an activated carbon filter in-line cartridge.

Any collected filtered water shall be held for testing by the Engineer prior to discharge to the sanitary sewer.

1.4 SUBMITTALS AND NOTICES

A. Prior to the start of any work that will generate hazardous lead waste above conditionally exempt small quantities, the Contractor shall obtain a temporary EPA Hazardous Waste Generators ID, unless otherwise directed by the Engineer.

B. Provide copies of USEPA permits for disposal and transport of hazardous lead bearing waste for each proposed hauler/disposal facility. A licensed hazardous waste transporter and a licensed hazardous waste treatment/disposal facility shall be secured in conformance with all federal and state regulations.

C. The Contractor shall submit the following to the Engineer before or at the start-up of the abatement project:

1. For projects when the intent is to mitigate lead hazards and provide lead-safe conditions for building occupants, a valid CTDPH Lead Abatement Contractor License and copies of employee certifications/licenses as CTDPH Lead Abatement Supervisors or Workers.
2. Copies of all employee certificates, dated within the previous twelve (12) months, relating to OSHA lead awareness and hazard communication training and training in the use of lead-safe work practices.
3. Documentation from the Contractor, typed on company letterhead and signed by the Contractor, certifying that all employees listed therein have received the following:
    i. Medical monitoring dated within the previous twelve (12) months, as required in 29 CFR 1926.62
    ii. Biological monitoring dated within the previous six (6) months, including initial blood lead level and zinc protoporphyrin level test results prior to the workers first entry into the Work Areas. Workers with blood lead levels in excess of fifty (50) micrograms/deciliter will not be permitted in the Regulated Area. The Contractor shall follow management of employee's blood lead levels in accordance with OSHA 29 CFR 1926.62.
    iii. Respiratory fit testing dated within the previous twelve (12) months, for all employees who must don a tight-fitting face piece respirator in order to perform activities impacting lead. This fit testing shall be in accordance with qualitative procedures as detailed in 29 CFR 1910.134.
4. Project time schedule for each phase of work.
5. Copies of state-approved certificates for the proposed non-hazardous construction and demolition (C&D) lead debris disposal facility and any concrete/wood or scrap metal recycling facilities.
6. The name and qualifications of the individual acting as the Competent Person for the duration of project activities impacting lead. This individual shall act as the Contractor's OSHA Competent Person during activities impacting lead, shall have a minimum of three years working experience performing activities that impact lead paint, shall be capable of identifying existing lead hazards and shall have the authority to implement corrective measures to eliminate such hazards. The Competent Person shall be on-site at all times during activities impacting lead, shall comply with applicable Federal, State and Local regulations which mandate work practices, and shall be capable of performing the work of this contract. No other individual shall later be substituted as Competent Person without prior approval by the Engineer.

D. No activity shall commence until a copy of all required submittals have been received and found acceptable to the Engineer. Those employees added to the Contractor's original list will be allowed to perform work only upon submittal of all required paperwork to, and review by, the Engineer.

E. Provide the Engineer, within thirty (30) days of completion of the project site work, a compliance package; which shall include, but not be limited to, the following:

Competent persons (supervisor) job log;

1. OSHA-compliant personnel air sampling data and exposure assessments;
2. Completed waste shipment papers for non-hazardous lead construction and demolition (C&D) bulky waste and/or concrete/wood/scrap metal recycling
3. Completed certified hazardous waste manifests for hazardous lead debris.

PART 2: PRODUCTS

2.1 MATERIALS

A. All materials shall be delivered to the job site in the original packages, containers, or bundles bearing the name of the manufacturer, the brand name and product technical description.

B. No damaged or deteriorating materials shall be used. If material becomes contaminated with lead, the material shall be decontaminated or disposed of as lead-containing waste material. The cost to decontaminate and dispose of this material shall be at the expense of the Contractor.

C. Fire retardant polyethylene sheet shall be in roll size to minimize the frequency of joints, with factory label indicating four (4) or six (6) mil thickness.

D. Six (6) mil polyethylene disposable bags shall have pre-printed OSHA/EPA/DOT labels and shall be transparent.

E. Tape (or equivalent) capable of sealing joints in adjacent polyethylene sheets and for the attachment of polyethylene sheets to finished or unfinished surfaces must be capable of adhering under both dry and wet conditions.

F. The cleaning agent detergent shall be lead specific, such as TriSodium Phosphate (TSP).

G. Labels and warning signs shall conform to OSHA 29 CFR 1926.62, USEPA 40 CFR 260 through 274 and USDOT 49 CFR 172 as appropriate.

H. Any planking, bracing, shoring, barricades and/or temporary sheet piling, necessary to appropriately perform work activities shall conform to all applicable federal, state and local regulations.

I. Air filtration devices and vacuum units shall be equipped with HEPA filters.

2.2 TOOLS AND EQUIPMENT

A. The Contractor shall provide tools and equipment that are suitable for lead related cleanup activities:

1. Air monitoring equipment of the type and quantity required to monitor operations and conduct personnel exposure surveillance in accordance with OSHA requirements.
2. Electrical equipment, protective devices and power cables shall conform to all applicable codes.
3. Where lead exposures are above the OSHA Action Level or PEL, the Contractor shall provide wash facilities/shower stalls and plumbing that include sufficient hose length and drain system or an acceptable alternate. One shower stall shall be provided for each eight workers.

4. Where lead exposures are above the OSHA PEL, the Contractor shall provide exhaust air filtration units that are equipped with HEPA filters to provide local exhaust ventilation at the work area to reduce airborne lead emissions.
5. The Contractor shall provide vacuum units of suitable size and capabilities for the project which have HEPA filters capable of trapping and retaining at least 99.97 percent of all monodispersed particles of three micrometers in diameter or larger.
6. The Contractor shall provide ladders and/or scaffolds of adequate length, strength and sufficient quantity to support the work schedule. Scaffolds shall be equipped with safety rails and kick boards in compliance with OSHA requirements.
7. Protective clothing, respirators, and HEPA P100 filter cartridges shall be provided in sufficient quantities for the project.
8. Equipment suitable for building renovation/demolition and proper waste/debris collection/packing/removal, (e.g. excavators, grapples, backhoes, roll-offs, etc.) shall be provided by the Contractor as required.

PART 3: EXECUTION

3.1 GENERAL REQUIREMENTS

A. All employees of the Contractor who perform work impacting lead shall be properly trained to perform such duties.

B. All labor, materials, tools, equipment, services, testing, insurance (with specific coverage for lead hazard work), and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these Specifications shall be provided by the Contractor.

C. The Engineer, Contractor, and CTMIL shall attend a pre-work site visit to perform the visual survey of the work area.

D. Prior to beginning work, the Engineer and Contractor shall perform a visual survey of each work area and review conditions at the site for safety reasons. In addition, the Contractor shall instruct all workers in all aspects of personnel protection, work procedures, emergency evacuation procedures and use of equipment including procedures unique to this project.

E. The Contractor shall:

1. Shutdown and isolate heating, cooling, and ventilating air systems to prevent contamination and particulate dispersal to the other areas of the building.
2. Shut down and lock out electrical power, including all receptacles and light fixtures, when feasible. The use or isolation of electrical power will be coordinated with all other ongoing uses of electrical power at the site.
3. Coordinate all power and fire alarm isolation with the appropriate representatives.
4. When necessary, provide temporary power and adequate lighting and ensure safe installation of electrical equipment, including ground fault protection and power cables, in compliance with applicable electrical codes and OSHA requirements. The Contractor is responsible for proper connection and installation of electrical wiring.

F. Ladders and/or scaffolds to be utilized throughout this project shall be in compliance with OSHA requirements, and of adequate length, strength and sufficient quantity to support the scope of work. Use of ladders/scaffolds shall be in conformance with OSHA 29 CFR 1926 Subpart L and X requirements.

G. Work performed at heights exceeding six feet (6') shall be performed in accordance with the OSHA Fall Protection Standard 29 CFR 1926 Subpart M including the use of fall arrest systems as applicable.

H. The CTMIL facility will supply the Contractor with sufficient water for each shift to operate the wash facility/decontamination shower units in addition to the water needed at the work area.

I. Lead assessment data is available from the Engineer for informational purposes only. Under no circumstances shall this information be the sole means used by the Contractor for determining the extent of lead contamination. The Contractor shall be responsible for verification of all field conditions affecting performance of the work as described in these Specifications in accordance with OSHA, USEPA, USDOT and CTDEEP standards. Compliance with the applicable requirements is solely the responsibility of the Contractor.

J. All work activities shall be performed in a manner which minimizes the spread of lead dust contamination and generation of airborne lead.

K. The Engineer/CTMIL will provide a Project Monitor to oversee the activities of the Contractor. Environmental sampling, including ambient air sampling, TCLP waste stream sampling and/or dust wipe sampling, shall be conducted by the Project Monitor throughout the project as deemed necessary.

3.2 ESTABLISHMENT OF REGULATED WORK AREAS

A. In all areas where airborne exposures may exceed the OSHA PEL, post warning signs meeting the requirements of OSHA 29 CFR 1926.62 at each regulated area.

B. In addition, signs shall be posted at all approaches to regulated areas so that an employee may read the sign and take the necessary protective steps before entering the area. These signs shall read:

C. Establish a Regulated Area, through the use of appropriate barrier tape, etc. and control unauthorized access into the area throughout the lead paint related activity.

D. Implement appropriate engineering controls such as critical barriers, poly drop cloths, negative pressure, local exhaust ventilation, wet dust suppression methods, etc. to prevent the spread of lead contamination from the Regulated Area.

3.3 WORKER DECONTAMINATION AREAS

A. The Contractor shall provide hand wash facilities in compliance with 29 CFR 1926.51(f) and 29 CFR 1926.62 regardless of airborne lead exposure. This wash facility will consist, at least, of potable water, towels, soap, and a HEPA vacuum.

B. If air monitoring data by the Contractor or Project Monitor shows that employee exposure to airborne lead exceeds the OSHA PEL (50 $\mu g/m^3$), shower rooms must be utilized. The Shower Room shall be of sufficient capacity to accommodate the number of workers. One shower stall shall be provided for each eight (8) workers. Showers shall be equipped with hot and cold or warm running water through the use of electric hot water heaters supplied by the Contractor. Shower water shall be collected and filtered using best available technology and dumped down an approved sanitary drain. Shower stalls and plumbing shall include sufficient hose length and drain system or an acceptable alternate.

3.4 PERSONNEL PROTECTION

A. Exposure Assessments: The Contractor shall initially determine if any employee performing construction tasks impacting lead paint may be exposed to lead at or above the OSHA Action Level of 30 micrograms per cubic meter (30 $\mu g/m^3$). Assessments shall be based on initial air monitoring results as well as other relevant information. The Contractor may rely on historical air monitoring data obtained within the past 12 months under workplace conditions closely resembling the process, type of material, control methods, work practices and environmental conditions used and prevailing in the Contractors current operations to satisfy the exposure assessment requirements. Monitoring shall continue as specified in the OSHA standard until a negative exposure assessment is developed.

B. Until a negative exposure assessment is developed for the required tasks impacting lead paint, the Contractor shall ensure that all workers and authorized person entering the Regulated Area wear protective clothing and respirators in accordance with OSHA 29 CFR 1926.62. Protective clothing shall include impervious coveralls with elastic wrists and ankles, head covering, gloves and foot coverings. Sufficient quantities shall be provided to last throughout the duration of the project.

C. Protective clothing provided by the Contractor and used during chemical removal operations shall be impervious to caustic materials. Gloves provided by the Contractor and used during chemical removal shall be of neoprene composition with glove extenders.

D. Respiratory protective equipment shall be provided and selection shall conform to 30 CFR Part 11, 29 CFR Part 1910.134, and 29 CFR Part 1926.62. A formal respiratory protection program must be implemented in accordance with 29 CFR Part 1926.62 and Part 1910.134.

3.5 LEAD REMEDIATION ACTIVITY PROCEDURES

A. Ensure that the Competent Person is on the job at all times.

B. Do not begin remediation work on a particular phase until authorized by the Engineer, following a pre-abatement visual inspection by the Project Monitor.

C. The Contractor shall ensure proper entry and exit procedures for workers and authorized persons who enter and leave the Regulated Area. All workers and authorized persons shall leave the Regulated Area and proceed directly to the wash or shower facilities where they will HEPA vacuum gross debris from work suit, remove and dispose of work suit, wash and dry face and hands, and vacuum clothes. Do not remove debris by blowing or shaking of clothing.

D. The Contractor shall collect the wash water generated by the worker shower, wash facilities, or steam cleaning operations in 55 gallon drums and filter the water using a 2 stage filtration system composed of a (1.5 micron) porosity in-line cartridge particulate filter followed by an activated carbon filter in-line cartridge.

   The filtered water shall be held for testing by the Engineer prior to discharge to the sanitary sewer.

E. No one shall eat, drink, smoke, chew gum or tobacco, or apply cosmetics while in the Regulated Area.

F. Utilize appropriate engineering controls (e.g. wet methods) as directed by 29 CFR 1926.62 to control lead emissions and contamination. Perform work activities in a manner which minimizes the spread of lead contamination and generation of lead dust.

G. Properly contain wastes containing lead for appropriate transport/disposal.

H. Stop all work in the regulated area and take steps to decontaminate non-work areas and eliminate causes of such contamination should lead contamination be discovered in areas outside of the regulated area.

I. Component Removal/Replacement: Wet down components which are to be removed to reduce the amount of dust generated during the removal process. Remove components utilizing hand tools, and follow appropriate safety procedures during removal. Remove the building components by approved methods which will provide the least disturbance to the substrate material. Do not damage adjacent surfaces. Clean up immediately after component removals have been completed. Remove any dust located behind the component removed.

3.6 AIR MONITORING REQUIREMENTS

A. The Contractor shall:
   1. Provide air monitoring equipment including sample filter cassettes of the type and quantity required to properly monitor operations and personnel exposure surveillance throughout the duration of the project.
   2. Conduct initial exposure monitoring to determine if any employee performing construction tasks impacting lead paint may be exposed to lead at or above the OSHA Action Level of 30 micrograms per cubic meter. Monitoring shall continue as specified in the OSHA standard until a negative exposure assessment is developed.

3. Conduct personnel exposure assessment air sampling, as necessary, to assure that workers are using appropriate respiratory protection in accordance with OSHA Standard 1926.62. Documentation of air sampling results must be recorded at the work site within twenty-four (24) hours and shall be available for review until the job is complete.

B. The Project Monitor will: Collect air samples in accordance with the current revision of the NIOSH 7082 or 7702 Method of Air Sampling for Airborne Lead while overseeing the activities of the Contractor. Frequency and duration of the air sampling during work activities will be representative of the actual conditions at the site. The size and configuration of the project will be a factor in the number of samples required to monitor the activities and shall be determined by the Project Monitor/Engineer.

C. As determined by AAS, XRF, or equivalent analysis, if air samples collected outside of the Regulated Area during work activities indicate airborne lead concentrations greater than original background levels or greater than 30 ug/m^3, whichever is larger, an examination of the Regulated Area perimeter shall be conducted and the integrity of barriers shall be restored. Cleanup of surfaces outside the Regulated Area using HEPA vacuum equipment or wet cleaning techniques shall be done prior to resuming work activities.

D. Remediation work outside the initial designated work area(s) will not be paid for by the Engineer. The Contractor will be responsible for all costs incurred from these activities.

3.7 CLEAN-UP AND VISUAL INSPECTION

A. Remove and containerize all lead waste material and visible accumulations of debris and associated items.

B. During clean up the Contractor shall utilize rags and sponges wetted with lead-specific detergent and water as well as HEPA filtered vacuum equipment.

C. The Project Monitor will conduct a visual inspection of the work areas in order to document that all surfaces have been maintained as free as practicable of accumulations of lead in accordance with OSHA 29 CFR 1926.62(h). If visible accumulations of waste, debris, lead paint chips or dust are found in the work area, the Contractor shall repeat the cleaning, at the Contractor's expense, until the area is in compliance. The visual inspection will detect incomplete work, damage caused by the work activity, and inadequate clean-up of the work site.

D. <u>As a condition for acceptance of the work performed, the facility is to be tested by certified personnel (Engineer) performing wipe tests after a period of 36 hours. "Wipe Tests" or "Wipe Clearance Samples" will be taken from surfaces including, but not limited to: ceiling (including above if suspended), walls, floors, cage surfaces, suspended lights, and boiler surfaces, including pipes/etc. The range will be considered clean, if clearance samples for lead concentration, are not greater than or equal to the NGB standard of Forty micrograms per square foot (40 µg/ft2), which is equal to less than Forty parts per million (<40 ppm).</u>

E. If lead dust wipe levels are above the clearance criteria, the Contractor shall re-clean the work area and retesting shall be conducted at the Contractor's expense. The testing and cleaning sequence shall be repeated until the clearance criteria levels have been achieved.

3.8 POST REMEDIATION WORK AREA DEREGULATION

A. Following the visual inspection, (and clearance testing if appropriate,) any engineering controls implemented may be removed and the Work Area deregulated.

B. A final visual inspection of the work area shall be conducted by the Competent Person and the Project Monitor to ensure that all visible accumulations of suspect materials have been removed and that no equipment or materials associated with the remediation project remain.

C. The Contractor shall restore all work areas and auxiliary areas utilized during work to conditions equal to or better than original. Any damage caused during the performance of the work activity shall be repaired by the Contractor at no additional expense to the Engineer.

3.9 NON-HAZARDOUS WASTE DISPOSAL/RECYCLING

A. Non-metallic building debris waste materials tested and found to be non-hazardous Construction and Demolition (C&D) bulky waste shall be disposed of properly at a CTDEEP approved Solid Waste landfill.

B. Metallic debris shall be segregated and recycled as scrap metal at an approved metal recycling facility. The Contractor shall submit to the Engineer all documentation necessary to demonstrate the selected recycling facility is able to accept lead-painted scrap metal.

3.10 HAZARDOUS LEAD WASTE DISPOSAL

A. If required to dispose of any hazardous waste, the Contractor shall utilize a certified/permitted transporter for hazardous waste in compliance with DOT 49 CFR Part 172 and USEPA 40 CFR 260-274 and a permitted hazardous waste treatment storage disposal facility (TSDF) in compliance with USEPA 40 CFR 260-274.

B. Hazardous lead bearing material must be offered for transportation and transported in compliance with the Code of Federal Regulations, Title 49, Chapter 1, Part 173, Subparts A, B, C, and D and Paragraph 178.118. Transport vehicles (hopper or dump type) must be free from leaks and discharge openings must be securely closed during transportation. All storage containers (roll offs or drums) shall have a protective liner and removable lid. These containers shall not have any indentations or damage that would allow seepage of the contained material.

C. The disposal of hazardous lead bearing material must be in compliance with the requirements of, and authorized by, the Office of Solid Waste Management, Department of Environmental Protection, State of Connecticut, and the USEPA. The disposal of hazardous lead bearing waste shall comply with the requirements of the Resource Conservation and Recovery Act (RCRA).

D. Unless previous waste characterizations have been completed by the Engineer, all generated waste shall be containerized and stored on-site for hazardous waste determination via TCLP testing. TCLP testing and analysis shall be the responsibility of the Engineer.

E. The dumpsters/containers containing hazardous waste are to be kept covered and locked when not in active use for the loading of materials.

F. All containers of hazardous lead bearing material shall be labeled in accordance with 29 CFR 1926.62 and EPA 40 CFR 260-270.

G. All hazardous lead-bearing waste removed from the site by the Contractor shall be containerized in lined roll-offs or barrels. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved containers. Properly label and placard each container to identify the type of waste (49 CFR 172) and the date the container was filled. The disposal containers shall be labeled with a six inch square, yellow, weatherproof, hazardous waste sticker in accordance with U.S. DOT regulations, by the Contractor.

H. The Contractor may not store containerized hazardous lead waste on the job site for in excess of 90 calendar days from the accumulation start date.

I. When required to dispose of hazardous waste, the Contractor shall utilize a certified/permitted transporter for hazardous waste in compliance with USDOT 49 CFR Part 172 and USEPA 40 CFR 260-274 and a permitted hazardous waste treatment storage disposal facility (TSDF) in compliance with USEPA 40 CFR 260-274.

J. The Contractor shall complete a Uniform Hazardous Waste Manifest, EPA Form 8700-22 as well as a Land Disposal Restriction Form (LDR) and submit to the Engineer or qualified CTMIL staff for review and generator sign-off prior to each load of hazardous waste scheduled to leave the site. Completed copies of the manifest shall be delivered by the Contractor to CTMIL within 30 calendar days following the date the load leaves the site.

K. When all necessary procedures have been completed, then the hazardous waste shall be shipped to the hazardous waste disposal facility.

L. Any spillage of debris during disposal operation, i.e., loading, transport and unloading, shall be cleaned up in accordance with the Code of Federal Regulations, Title 40, Chapter 1, Part 25, Subparts C and D, at the Contractor's expense.

M. The Contractor is liable for any fines, costs or remediation costs incurred as a result of the failure to be in compliance with this special provision and all federal, state and local laws.

N. Final payment requisitions for the contract will not be processed until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Engineer.

END

Anthony Minalga,
Lead Planner/Project Designer (#002147)
TRC Environmental Corporation

Reviewed By:

Donald LePage, TRC

SHEET NO. ____ OF ____

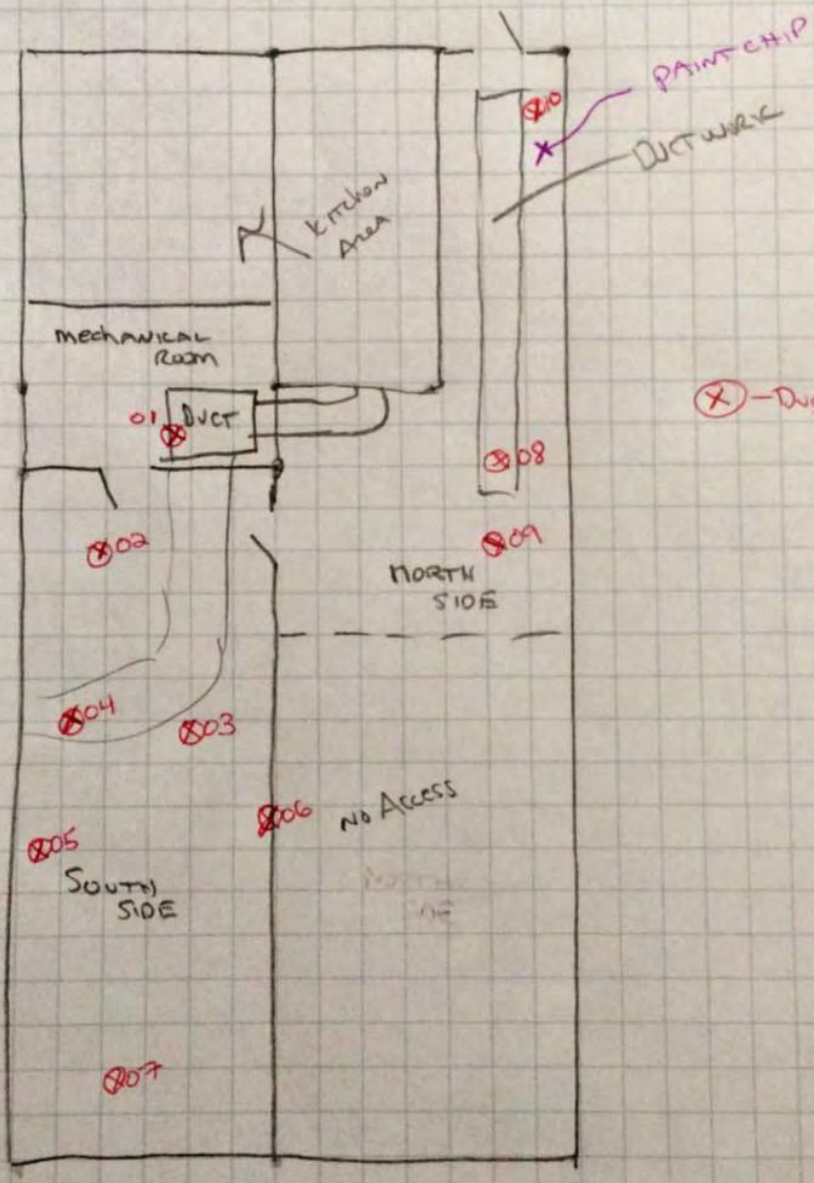
PROJECT NO. 235352.01

DATE 10/6/15

BY AM

CHK'D ____

SUBJECT BRANFORD ARMORY



(X) – DUST WIPE SAMPLE #

ProScience Analytical Services, Inc.
22 Cummings Park, Woburn, MA 01801

Telephone: 781-935-3212
Facsimile: 781-932-4857
Email: chemistry@proscience.net

Laboratory Report

Contact: Anthony Minalga
Client: TRC
Address: 21 Griffin Road North
Windsor, CT 06095

Batch #: C 285666
Date received: 10/7/2015
Date analyzed: 10/7/2015
Date of report: 10/7/2015
Date of revision: 10/13/2015
AIHA-LAP, LLC Lab ID: 102754

Project # 235352.0099
P.O.# C235352
Project Site: Branford Armory
87 Montowese Ave

Lead Analysis In Wipes Using SOP Based on SW846-7420/3051

Results in µg/ft² (Using customer-supplied data)

Lab ID	Client ID	Sample date	Description	Result*	Reporting Limit	Comments
C 532118	1	10/6/15	Old Firing Range - Duct Control Door	33	10	
C 532119	2	10/6/15	Old Firing Range - Floor	67	10	
C 532120	3	10/6/15	Old Firing Range - Floor	48	10	
C 532121	4	10/6/15	Old Firing Range - Top of Duct	50	17	
C 532122	5	10/6/15	Old Firing Range - Metal Shelf	15	10	
C 532123	6	10/6/15	Old Firing Range - Over Brick Wall	190	10	
C 532124	7	10/6/15	Old Firing Range - Floor	78	10	
C 532125	8	10/6/15	Old Firing Range - Inside Duct Control Door	180	10	
C 532126	9	10/6/15	Old Firing Range - Floor	43	10	
C 532127	10	10/6/15	Old Firing Range - Floor by Stairs	82	10	

Simona Peavey, Tech. Manager Chemistry
Aimee Cormier, Lab Director

Unless otherwise indicated, all samples were received in acceptable condition.
*All result apply only to the samples as received and are accurate to no more than two significant figures.
Unless otherwise indicated, all the quality control criteria for the method above have been met.
RL - Reporting Limit(µg/ft²) Blanks are reported in total micrograms; they are not used to correct sample results.
The EPA 403 Final Rule (40 CFR 745.63) requires that all wipe samples of settled dust shall be collected using wipes that meet ASTM E1792. The analytical results, for wipes not meeting ASTM E1792, are outside the scope of our environmental lead accreditation

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AIHA-LAP, LLC Lab ID: 102754

Project # 235352.0099
P.O.# C235352
Project Site: Branford Armory
87 Montowese Ave

Lead Analysis In Wipes Using SOP Based on SW846-7420/3051

Results in µg/ft²

Lab ID	Client ID	Sample date	Description	Result	Reporting Limit	Comments
C 532128	11	10/6/15	1st Floor - Gym - Hall Floor	15	10	
C 532129	12	10/6/15	1st Floor - Gym - Gym Floor	12	10	
C 532130	13	10/6/15	FIELD BLANK	<RL	10	
C 532131	14	10/6/15	FIELD BLANK	<RL	10	

Simona Peavey, Tech. Manager Chemistry
Aimee Cormier, Lab Director

Unless otherwise indicated, all samples were received in acceptable condition.
All result apply only to the samples as received and are accurate to no more than two significant figures.
Unless otherwise indicated, all the quality control criteria for the method above have been met.
RL -Reporting Limit(µg/ft²) Blanks are reported in total micrograms; they are not used to correct sample results.
The EPA 403 Final Rule (40 CFR 745.63) requires that all wipe samples of settled dust shall be collected using wipes that meet ASTM E1792. The analytical results, for wipes not meeting ASTM E1792, are outside the scope of our environmental lead accreditation.

TRC

21 GRIFFIN ROAD NORTH
WINDSOR, CONNECTICUT 06095
TELEPHONE (860) 298-9692
FAX (860) 298-6380

Edition: September 2007
Supersede Previous Edition

CHAIN OF CUSTODY

LAB ID #. C785666

PROJECT NUMBER	PROJECT NAME	PARAMETERS	TURNAROUND TIME
235352.0099	Branford Armory 87 Montowese Ave		24hr 48hr X 3day 5day 24hr 48hr 3day 5day
SIGNATURE	INSPECTOR		
E C	E Sanchez		

FIELD SAMPLE NUMBER	DATE	TIME	TYPE COMP	TYPE GRAB	SAMPLE LOCATION	AIS HH PID Dust					NOTES		
01	10/6/15				01 Firing Range	X					Duct control Door	12X12"	532118
02	"				"	X					FLOOR	12X12"	19
03						X					FLOOR	12X12"	20
04						X					Top of Duct	7X12"	21
05						X					Metal shelf	12X12"	22
06						X					over Brick wall	12"X12"	23
07						X					FLOOR	12X12"	24
08						X					Top of Duct	12X12"	25
09						X					FLOOR	12X12"	26
10					↓	X					Floor by stairs	12X12"	27
11					1st FL gym	X					hall FLOR	12X12"	28
12	↓				↓	X					gym FLOR	12X12"	29

Relinquished by: (Signature)	Date:	Received by: (Signature)	Relinquished by: (Signature)	Date:	Received by: (Signature)
E C	10/6/15	Pierre Lecourt Tetra 10/7/15 9:30AM			
(Printed) E Sanchez	Time: 1400	(Printed)	(Printed)	Time:	(Printed)
Remarks:					Page 1 of 1

TRC

21 GRIFFIN ROAD NORTH
WINDSOR, CONNECTICUT 06095
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Edition: September 2007
Supersede Previous Edition

CHAIN OF CUSTODY

LAB ID #. C725666

PROJECT NUMBER	PROJECT NAME	PARAMETERS	TURNAROUND TIME
235352-0095	Branford Armory 2 Montowese Ave		24hr 48hr X 3day 5day 24hr 48hr 3day 5day
SIGNATURE	INSPECTOR		
E Sanchez	ESanchez		

FIELD SAMPLE NUMBER	DATE	TIME	TYPE COMP	TYPE GRAB	SAMPLE LOCATION	APB +TI PB Asbt					NOTES
13	10/6/15				FB	X					532130
14	"				FB	X					31

Relinquished by: (Signature)	Date:	Received by: (Signature)	Relinquished by: (Signature)	Date:	Received by: (Signature)
E Sanchez	10/6/15				
(Printed) E Sanchez	Time: 1400	(Printed)	(Printed)	Time:	(Printed)
Remarks:					Page 1 of 1

ProScience Analytical Services, Inc.
22 Cummings Park, Woburn, MA 01801

Telephone: 781-935-3212
Facsimile: 781-932-4857
Email: chemistry@proscience.net

Laboratory Report

Contact: Anthony Minalga
Client: TRC
Address: 21 Griffin Road North
Windsor, CT 06095

Batch #: C 285668
Date received: 10/7/2015
Date analyzed: 10/9/2015
Date of report: 10/9/2015

Project # 235352.0099
P.O.# C235352
Project Site: Branford Armory
87 Montowese Ave.

AIHA-LAP, LLC Lab ID 102754

Lead Analysis In Paint Using SOP Based on SW846-7420/3051
Results in weight percent on an "as received" weight basis

Lab ID	Client ID	Sample date	Description	Result	Reporting Limit	Comments
C 532141	1	10/6/15	Old Firing Range - Floor	1.1	0.031	

Simona Peavey, Tech. Manager Chemistry
Aimee Cormier, Lab Director

Unless otherwise indicated, all samples were received in acceptable condition.
All result apply only to the samples as received and are accurate to no more than two significant figures.
Unless otherwise indicated, all the quality control criteria for the method above have been met.
RL-Reporting Limit(%by weight) Note on units: mg/Kg is the same as ppm by weight.

TRC

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WINDSOR, CONNECTICUT 06095
TELEPHONE (860) 298-9692
FAX (860) 298-6380

Edition: September 2007
Supersede Previous Edition

CHAIN OF CUSTODY

LAB ID #. C285668

PROJECT NUMBER	PROJECT NAME	PARAMETERS	TURNAROUND TIME
235352.0095	Branford Armory 97 Montowese Ave		24hr / 48hr / X 3day / 5day
SIGNATURE	INSPECTOR		24hr / 48hr / 3day / 5day
E Sanchez	E Sanchez		

FIELD SAMPLE NUMBER	DATE	TIME	TYPE COMP	TYPE GRAB	SAMPLE LOCATION	ABS HI PB chip				NOTES
01	10/6/15				OH Firing Range	X				Floor 532141

Relinquished by: (Signature)	Date:	Received by: (Signature)	Relinquished by: (Signature)	Date:	Received by: (Signature)
E Sanchez	10/6/15	Pierce Lockwith Cole			
(Printed) E Sanchez	Time: 1400	(Printed) 10-7-15 9:30AM	(Printed)	Time:	(Printed)
Remarks:					Page 1 of 1

State of Connecticut

Lookup Detail View

Name

Name
ANTHONY J MINALGA

License Information

lookup

License Type	License Number	Expiration Date	Granted Date	License Name	License Status	Licensure Actions or Pending Charges
Lead Planner/Project Designer	2147	03/31/2018	07/30/2008	Anthony J. Minalga	ACTIVE	None

Generated on: 6/5/2017 11:58:14 AM

State of Connecticut

Lookup Detail View

Name

Name
TRC ENVIRONMENTAL CORP

License Information

lookup

License Type	License Number	Expiration Date	Granted Date	License Name	License Status	Licensure Actions or Pending Charges
Lead Consultant Contractor	605	01/31/2018	01/05/1996	TRC Environmental Corp.	ACTIVE	None

Generated on: 1/26/2017 11:28:26 AM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Description of work - the extent of concrete work is shown on the Drawings. (Concrete slab at grade)

1.2 REFERENCES

A. State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction Form 814.

B. American Concrete Institute Standard 301 (ACI 301).

1.3 SUBMITTALS

A. Submit reinforcing steel shop drawings, as required by paragraph 5.1.1 of ACI 301.

B. Submit mix design and test results conforming to the requirements of paragraph 3.8 of ACI 301.

C. Submit five (5) copies of manufacturer's data on manufactured products for Engineer's approval.

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for the proper performance of the work of this section.

B. Form 814 and ACI 301 shall be used as standards for the work described herein and related work shown on the Drawings.
   1. Work of this section shall conform to the requirements of DOT Form 814, Section 4.01.01 to 4.01.03, Concrete Pavement.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Base course materials shall be Grade A broken or crushed stone conforming to the requirements of DOT Form 814, Section M.02.01.

B. Concrete - Composition of Concrete Mix shall conform to the requirements of DOT Form 814, Section M.03.01 for Class A and shall be 4000 lb. strength, 6% $\pm$ 1 1/2% air content, maximum 2 1/2" slump.

C. Admixtures - Air Entraining additives shall conform to the requirements of DOT Form 814, Section M.03.01-9.

D. Reinforcing Steel - shall be Grade 60 and shall conform to the requirements of DOT Form 814, Section M.06.01-1.

E. Welded Steel Wire Fabric shall conform to the requirements of DOT Form 814, Section M.06.01-3.

F. Anchor bolts shall be ASTM A 307, galvanized.

G. Curing Materials shall conform to the requirements of DOT Form 814, Section M.03.01-10.

2.2 EQUIPMENT

A. Provide all equipment required to properly perform the work of this section.

PART 3 - EXECUTION

3.1 FORMWORK ERECTION

A. Verify lines, levels, and measurement before proceeding with formwork.

B. Hand trim sides and bottom of earth forms; remove loose dirt.

C. Align form joints.

D. Coordinate work of other Sections and refer to Drawings in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

3.2 REINFORCEMENT

A. Place, support, and secure reinforcement against displacement.

B. Locate reinforcing splices as indicated on Drawings.

3.3 PLACING CONCRETE

A. Preparation
1. Remove foreign matter accumulated in the forms.
2. Rigidly close openings left in the formwork.
3. Wet wood forms sufficiently to tighten up cracks. Wet other materials sufficiently to maintain workability of the concrete.
4. Use only clean tools.

B. Conveying
1. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic.
2. Deposit concrete as nearly as practicable in its final location so as to avoid separation due to rehandling and flowing.
3. Do not use concrete which becomes non-plastic and unworkable, or does not meet required quality control.
4. Remove rejected concrete from the job site.

C. Placing Concrete Slabs
1. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints.
2. Bring slab surfaces to the correct level with a straight edge, and then strike off.
3. Use bullfloats or darbies to smooth the surface, leaving the surface free form bumps and hollows.
4. Do not sprinkle water on the plastic surface. Do not disturb the slab surface prior to start of finishing operations.

3.4 CONSOLIDATION

A. General
1. Consolidate each layer of concrete immediately after placing, by the use of internal concrete vibrators supplemented by hand spading, rodding, or tamping.
2. Do not vibrate forms or reinforcement.
3. Do not use vibrators to transport concrete inside the forms.

3.5 CURING AND PROTECTION

A. Beginning immediately after placement, protect concrete from premature drying, excessively hot and cold temperatures, and mechanical injury.

B. Preservation of Moisture
   1. Unless otherwise directed by the Engineer, apply one of the following procedures to concrete not in contact with forms, immediately after completion of placement and finishing:
      a. Ponding or continuous sprinkling.
      b. Application of absorptive mats or fabric kept continuously wet.
      c. Application of sand kept continuously wet.
      d. Application of waterproof sheet materials specified in Part 2 of this Section.
      e. Application of other moisture-retaining covering as approved by the Engineer.
   2. Where forms are exposed to the sun, minimize moisture loss by keeping the forms wet until they can be removed safely.
   3. Cure concrete by preserving moisture as specified above for at least seven days.

C. Protection from Mechanical Injury
   1. During the curing period, protect the concrete from damaging mechanical disturbances such as heavy shock, load stresses, and excessive vibration.
   2. Protect finished concrete surfaces from damage from construction equipment, materials, and methods, by application of curbing procedures, and by rain and running water.
   3. Do not load self-supporting structures in such a way as to overstress the concrete.
   4. Minimum strengths of concrete to be reached before weight-supporting formwork and shoring may be removed:
      a. Formwork not supporting concrete (such as sides of beams, walls, columns, or similar parts of the work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided that curing and protecting operations are maintained.

3.6 REMEDIAL WORK

A. Repair or replace deficient work as directed by the Engineer and at no additional cost to the Owner.

END OF SECTION 030100

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.3 ACTION SUBMITTALS

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

B. Other Action Submittal:
   1. Design Mixtures: For each concrete mixture.

1.4 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Comply with the following sections of ACI 301, unless modified by requirements in the Contract Documents:
   1. "General Requirements."
   2. "Formwork and Formwork Accessories."
   3. "Reinforcement and Reinforcement Supports."
   4. "Concrete Mixtures."
   5. "Handling, Placing, and Constructing."

C. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

PART 2 - PRODUCTS

2.1 FORMWORK

A. Furnish formwork and formwork accessories according to ACI 301.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
   1. Portland Cement: ASTM C 150, Type I/II. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class C or F.

B. Normal-Weight Aggregate: ASTM C 33, graded, 3/4-inch nominal maximum aggregate size.

C. Water: ASTM C 94/C 94M.

2.4 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260. Concrete for slabs and equipment pads shall not be air entrained.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2.5 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

B. Water: Potable.

C. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 CONCRETE MIXTURES

A. Comply with ACI 301 requirements for concrete mixtures.

B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.

2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

2.7 CONCRETE MIXING

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

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEMS

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

3.3 STEEL REINFORCEMENT

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

3.4 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

C. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3.5 CONCRETE PLACEMENT

A. Comply with ACI 301 for placing concrete.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

C. Do not add water to concrete during delivery, at Project site, or during placement.

D. Consolidate concrete with mechanical vibrating equipment.

E. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 6 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 4000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.6 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch.
   1. Apply to concrete surfaces not exposed to public view.

3.7 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
   1. Do not further disturb surfaces before starting finishing operations.

C. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.

D. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.

B. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

C. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests: Perform according to ACI 301.
   1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

3.10 REPAIRS

A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 033053

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Firestopping, materials and installation details shall be project and application specific and shall form an effective barrier against the spread of fire while maintaining the integrity of fire rated and smoke tight construction. Systems shall be used for sealing through-penetrations of Fire Rated Assemblies and unrated smoke-tight assemblies.

C. Coordination firestopping and penetration requirements with the work of all other divisions.

1.3 SUBMITTALS

A. Drawings: For each unique situation, submit Manufacturer's detail drawings and applicable UL or FM system numbers for Firestop Systems to be installed.

B. Installation Instructions: For 2 Hr., 1 Hr., and 20 Min. smoke barrier, submit Manufacturer's installation instructions for each unique Firestop System to be installed.

C. Product Data: Submit Manufacturer's printed data sheet for all products used in the Firestop System, a recommendation shall be obtained from the Manufacturer, in writing, for the specific application.

D. Manufacturer's Letters: For installations or configurations not covered by a Firestop System, a recommendation shall be obtained from the Manufacturer, in writing, for the specific application.

E. Contractor Experience: Contractor shall show evidence of having previously firestopped similar types of construction.

1.4 INFORMATIONAL SUBMITTALS

A. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Experienced personnel in installing penetration firestopping similar in material, design, and extent required for this project. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements.

B. Firestopping products shall be UL listed and approved for intended application and use.

C. Example/Mock-Up: For each unique situation, prepare job site example/mock-up of typical Firestop Systems proposed for use in the project. Approved mock-ups will be left in place as part of the finished project and will constitute the quality standard for the remaining work.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means to ventilate or, where this is inadequate, forced-air circulation.

C. Do not proceed with installation of Firestop Systems when job site conditions are outside the limits permitted by the Manufacturer.

D. Do not use materials that show signs of damage.

E. Do not use materials that are beyond their shelf life.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to the site in Manufacturer's original, unopened containers with labels indicating brand and type, and bearing UL label.

B. Storage: Store materials in accordance with the Manufacturer's directions and recommendations.

C. Material Safety Data Sheets will be available on the job site for all materials. Follow Manufacturer's guidelines for use and handling.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

1.9 SEQUENCING AND SCHEDULING

A. Pre-Installation Conference: Convene a pre-installation conference to establish procedure to maintain optimum working conditions and to coordinate this work with related and adjacent work.

B. Sequence: Perform work of this and other sections in proper sequence to prevent damage to the Firestop Systems and to ensure that their installation will occur prior to enclosing or concealing work.

C. Install all Firestop Systems after voids and joints are prepared sufficiently to accept the applicable Firestop System.

D. Do not cover Firestop Systems until they have been properly inspected and accepted by the authority having jurisdiction and Engineer.

1.10 WARRANTIES

A. Contractor shall warrant the Firestop Systems, where installed in conformance with the listed Firestop System and the Manufacturer's recommendations. Contractor shall repair or replace, within one year, any systems not properly installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to meeting all firestop system requirements provide one of the following:
   1. Hilti, Inc.
   2. 3M Fire Protection Products.
   3. Approved equal.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

C. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

E. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

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

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if

required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Contractor shall inspect firestopping and shall not enclose work until the authority having jurisdiction has inspected the work.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.6 PENETRATION FIRESTOPPING SCHEDULE

A. The fire ratings of the assemblies throughout the building are specifically indicated on the architectural drawings

B. Provide firestopping of the following assemblies unless indicated otherwise:

1. Floor/ceiling assemblies - 1 HOUR.
2. Stair tower enclosures - 2 HOURS.
3. Storage room - 1 HOUR
4. Boiler and Mechanical Rooms - 1 HOUR
5. Electrical Rooms & Data Closets- 1 HOUR
6. Egress Corridors – 1 HOUR

C. Firestopping materials/construction shall maintain the fire rating of the wall/floor assembly being penetrated and ensure smoke tight construction.

D. Smoke tight construction shall be treated as one-hour rated construction for the purpose of properly applying firestopping materials in accordance with manufacturer's instructions.

END OF SECTION 07 84 13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fixed, extruded-aluminum louvers.
   2. Control Damper.

1.3 RELATED WORK

A. Section 233300 Air Duct Accessories

1.4 REFERENCES

A. AMCA 500-D – Laboratory Methods for Testing Dampers for Ratings.

B. AMCA 511 – Certified Ratings Program for Air Control Devices.

C. IECC - International Energy Conservation Code

D. ASHRAE Standard 62 – Ventilation for Acceptable Indoor Air Quality

1.5 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).

C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.6 SUBMITTALS

A. Product Data for louver.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Product Data for damper.
   1. Include leakage, velocity, pressure drop and maximum pressure data
   2. Indicate materials, construction, and dimensions.
   3. Include pressure drop data for all damper sizes in accordance with AMCA 500-D test figures 5.2 (Ducted Inlet, Free Outlet), 5.3 (Ducted Inlet, Ducted Outlet) and 5.5 (Free Inlet, Free Outlet).
   4. Include a copy of Installation Instructions.

1.7 QUALITY ASSURANCE

A. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

B. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM, DRINABLE LOUVERS

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Carnes Company, Inc.
   b. Greenheck Fan Corporation.
   c. Ruskin Company; Tomkins PLC.

B. Fabrication:
   1. Performance Ratings: AMCA licensed.
   2. Frame:

a. Material: Extruded aluminum, Alloy 6063-T5.
b. Wall Thickness: 0.081 inch (2.1 mm), nominal.
c. Depth: 4 inches (102 mm).
d. Downspouts and caulking surfaces.

3. Blades:
   a. Style: Drainable.
   b. Material: Extruded aluminum, Alloy 6063-T5.
   c. Wall Thickness: 0.081 inch (2.1 mm), nominal.
   d. Angle: 37.5 degrees.
   e. Centers: 5-3/32 inches (129 mm), nominal.
4. Bird Screen:
   a. Material: Aluminum, 1/2 inch mesh x 0.063 inch (13 mm mesh x 1.6 mm), intercrimp.
   b. Frame: Removable, rewireable.
5. Gutters: Drain gutter in head frame and each blade.
6. Downspouts: Downspouts in jambs to drain water from louver for minimum water cascade from blade to blade.
7. Vertical Supports: Hidden vertical supports to allow continuous line appearance up to 120 inches (3,048 mm).
8. Sill: Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
9. Assembly: Factory assemble louver components. All welded construction.
10. Extended Sills: Extruded aluminum, Alloy 6063-T5. Minimum nominal wall thickness 0.060 inch (1.5 mm).

C. Performance Data:
1. Free Area Size: 2.51 square feet for louver size of 30 inch width x 25 inch height.
2. Maximum Recommended Air Flow Thru Free Area: 497 feet per minute.
3. Air Flow: 1,250 cubic feet per minute.
4. Maximum Pressure Drop: 0.04 inches w.g.
5. Provide standard mill finish.
6. Clean louver surfaces in accordance with manufacturer's instructions.

2.2 HVAC Control Damper

A. Low leakage control damper for low to medium pressure and velocity systems. control damper intended to be used with electric actuators.

1. Leakage:
   a. Dampers shall have a maximum leakage of Class 1 @ 4 in. wg or Class 1A @ 1 in. wg as defined by AMCA (Leakage class 1 is defined as 8 cfm/ sq. ft. @ 4 in. wg and class 1A is defined as 3 cfm/ sq. ft. @ 1 in. wg. at -40°F). Tested in accordance with AMCA standard 500-D.

b. Damper shall meet or exceed the IECC (International Energy Conservation Code) requirements for damper leakage ratings of 3 cfm/ sq. ft @ 1 in. wg or 8 cfm/sq. ft. @ 4in. wg or less when integral to the building envelope.

2. Differential Pressure:

c. Dampers shall have a maximum differential pressure rating of 5 in. wg

3. Velocity:
   d. Dampers shall have a maximum velocity rating of 3000 fpm.

C. Construction:
1. Frame:
   a. Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. Stainless steel frame is optional.

2. Blades:
   a. Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1" deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal. Blade operation is parallel or opposed. Stainless steel blade is optional.

3. Blade Stops:
   a. Each blade stop (at top and bottom of damper frame) shall occupy no more than ½" of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

4. Seals:
   a. Blade Edge: Blade seals shall be TPE comes standard which are mechanically fastened to each blade. Silicone blade seal is optional.

   b. Jamb: Flexible stainless steel compression type

5. Linkage: Concealed in jamb.
   a. Plated steel material. Stainless steel is optional.

6. Axles: Minimum ½ inch dia.
   a. Plated steel. Stainless steel axle is optional.

7. Bearings:
   Axle bearings shall be synthetic (acetal) sleeve rotating in polished extruded holes in the damper frame. Bronze and stainless steel bearings are optional.

8. Finish: Paint coatings are optional.
   a. Mill Galvanized finish is standard.

2.4 MATERIALS

A. Fasteners: Use types and sizes to suit unit installation conditions.
   1. Use [**Phillips flat-head**] [**hex-head or Phillips pan-head**] [**tamper-resistant**] screws for exposed fasteners unless otherwise indicated.
   2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
   4. For fastening stainless steel, use 300 series stainless-steel fasteners.
   5. For color-finished louvers, use fasteners with heads that match color of louvers.

B. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089119

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 22 11 19 "Domestic Water Piping Specialties."

1.2 SUMMARY

A. Section Includes:
   1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:
   1. Retain subparagraph below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
   2. Section 221113 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Architect and Owner no fewer than seven (7) days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61.

C. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

D. Copper Unions:
1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

E. Copper Pressure-Seal-Joint Systems, Pipe and Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Elkhart Products Corporation.
   b. NIBCO Inc.
   c. Viega.
   d. Evans Components, Inc.

2. Pressure-Seal-Joint systems must be approved for use in Massachusetts by the Board of Plumbers and Gas Fitters.

3. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
4. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

F. Appurtenances for Grooved-End Copper Tubing:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Anvil International.
   b. Grinnell, by Tyco
   c. Anvil International
   d. Victaulic Company.
2. Mechanical Couplings for Grooved-End Copper Tubing:

   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.

d. Bolts and nuts.
e. Minimum Pressure Rating: 300 psig.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. McDonald, A. Y. Mfg. Co.
b. Watts; a division of Watts Water Technologies, Inc.
c. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig minimum at 250 deg F.

4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Matco-Norca.
   b. Watts; a division of Watts Water Technologies, Inc.
   c. Wilkins; a Zurn company.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
1. Pressure Rating: 150 psig minimum at 250 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Non-conducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Elster Perfection Corporation.
   b. Grinnell Mechanical Products; Tyco Fire Products LP.
   c. Matco-Norca.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

E. Install domestic water piping level and plumb.

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

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. 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.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

L. Install piping free of sags and bends.

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

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipplesunions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits..

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Vertical Piping: MSS Type 8 or 42 clamps.
2. Individual, Straight, Horizontal Piping Runs:
    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

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

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

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

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Portions of testing and inspecting requirements in this article are taken from model plumbing codes. Verify requirements are applicable to location of this Project.
   2. Piping Inspections:

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

         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

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

3. Piping Tests:

    a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

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

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

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

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

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

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

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

3.10 PIPING SCHEDULE

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

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

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

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type Lwrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B)] [ASTM B 88, Type M (ASTM B 88M, Type C)]; [cast-] [or] wrought-copper, solder-joint fittings; and brazed or soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B)] [or] [ASTM B 88, Type M (ASTM B 88M, Type C)]; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B)] [or] [ASTM B 88, Type M (ASTM B 88M, Type C)]; grooved-joint, copper-tube appurtenances; and grooved joints.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball or globe valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end bibs with shutoff ball valve and end cap.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

E. Specification Section 221116 – Domestic Water Piping

1.2 SUMMARY

A. Section Includes:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
6. Drain valves.
7. Air vents.
8. Mixing Valves
9. Expansion Tanks

1.3 SUBMITTALS

A. See Section 013300 – Submittals – Shop drawings, product data, and samples.

B. Product Data: For each type of product.

C. Shop Drawings: For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals. Refer to Specifications section 017700 for additional information.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF

B. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.2 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Standard: ASSE 1001.
   2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   3. Body: Brass or Bronze.
   4. Inlet and Outlet Connections: Threaded.

B. Hose-Connection Vacuum Breakers:
   1. Standard: ASSE 1011.
   2. Body: Brass or Bronze,
   3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

C. Pressure Vacuum Breakers:
   1. Standard: ASSE 1020.
   2. Operation: Continuous-pressure applications.
   3. Pressure Loss: 5 psig maximum, through middle third of flow range.
   4. Accessories:
      a. Valves: Ball type, on inlet and outlet.

2.3 BACKFLOW PREVENTERS

A. Dual-Check-Valve Reduced Pressure Zone Backflow Preventers:
   1. Avalible Manufactures:
      a. Watts Model 9D
      b. Conbraco Industries, Inc.
      c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1012.
   3. Operation: Continuous-pressure applications.
   4. Size: As indicated on plan
   5. Body: Bronze with union inlet.

2.4 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
   1. Standard: ASSE 1003.
   2. Pressure Rating: Initial working pressure of 150 psig.
   3. Size: To match pipe size.
   4. Design Outlet Pressure Setting: 15 psig.
   5. Body: Bronze or Brass for NPS 2 and smaller
   6. End Connections: Threaded for NPS 2 and smaller;

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Type: Ball valve with two readout ports for flow measurement, and memory-setting indicator.
2. Body: Brass or bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Non-metal construction materials consist of Teflon or EPDM

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller, cast iron with interior lining that complies with AWWA C550 or that is FDA approved.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inch.
6. Drain: Pipe plug.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Handle: Vinyl-covered steel.
7. Inlet: Threaded or solder joint.
8. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 200 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS ½ minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.9 MIXING VALVES

A. Primary, Temperature-Actuated, Domestic Hot Water Mixing Valves:

1. Available Manufacturers: Provide basis of design as scheduled on drawing or comparable listed below.
   a. Armstrong International, Inc.
   b. Leonard Valve Company.
   c. Symmons Industries, Inc.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 120 deg F, adjustable.
9. Flow rates (GPM):
   a. Minimum 0.5
   b. Maximum 8

2.9 EXPANSION TANKS

A. Diaphragm or Bladder-Type Expansion Tanks:
   1. Manufacturers:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett Domestic Pump.
      d. Taco, Inc.

B. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature.

C. Listed and labeled according to applicable ASME Boiler and Pressure Vessel Code.

D. Diaphragm or Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Bladder shall be full-expansion and replaceable.

E. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. locate backflow devices at code compliant height.
   3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install hot water recirculation line back to cold water supply of pipe as required per manufactures installation instructions, provide required balancing/bypass valves.

E. Install Y-pattern strainers for water on supply side of each mixing valve or tempering valve

F. Install air vents at high points of water piping in boiler room Install drain piping and discharge onto floor.

3.2 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Double-check, backflow-prevention assemblies.
4. Water pressure-reducing valves.
5. Calibrated balancing valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Test each pressure vacuum breaker and backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.
1. Report shall include balanced flow across indirect water heaters.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

END OF SECTION 221119

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.

1.5 SUBMITTALS

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

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate pressure ratings and capacities. Includebypass fittings and meter bars.
6. Dielectric fittings.

B. For projects in Massachusetts, all Submitted equipment shall be Approved by the Massachusetts Board of State Examiners of Plumbers and Gas Fitters.

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

D. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

E. Welding certificates.

F. Field quality-control reports.

G. Operation and Maintenance Data: For motorized gas valves pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

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

1.8 PROJECT CONDITIONS

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

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two weeks in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's and Gas Company’s written permission.

1.9 COORDINATION

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

B. Coordinate and field verify equipment load and inlet pressure requirements with existing gas service.

C. Coordinate installation and tie-in of new natural gas piping with Utility.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe:

1. ANSI/ASME B36.10, Welded and Seamless Wrought-Steel Pipe, schedule 40.
2. ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless, Schedule 40, Type E or S, Grade B.
3. ASTM A 106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service, schedule 40.

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

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

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

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

11. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

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

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

    b. Steel flanges and tube with epoxy finish.
    c. Buna-nitrile seals.

d. Stainless-steel bolts, washers, and nuts.
e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Operating-Pressure Rating: 0.5 psig.
4. End Fittings: Zinc-coated steel.
5. Threaded Ends: Comply with ASME B1.20.1.
6. Maximum Length: 72 inches.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig (862 kPa).
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
10.

D. Two-Piece, Full-Port, Stainless-Steel Ball Valves with Stainless-Steel Trim: MSS SP-110.

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

    a. Spirax-Sarco
    b. Apollo Valve
    c. BrassCraft Manufacturing Company; a Masco company.
    d. Conbraco Industries, Inc.; Apollo Div.
    e. Lyall, R. W. & Company, Inc.
    f. McDonald, A. Y. Mfg. Co.
    g. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Stainless Steel, complying with ASTM A 351 CF8M.
3. Ball: Ball Stainless steel AISI 316.
4. Stem: Stem Stainless steel AISI 316 / AISI 420.
5. Seats: Carbon and graphite R-PTFE PDR 0.8; blowout proof.
6. Packing: Carbon and graphite R-PTFE PDR 0.8 with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig .
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, **p**rovide products by one of the following:

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. Contractor shall provide pressure regulators if local Natural Gas company does not. Contractor shall coordinate with the local Gas company.

B. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

C. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    d. Invensys.
    e. Richards Industries; Jordan Valve Div.

3. Body and Diaphragm Case: Cast iron or die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.
5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
7. Orifice: Aluminum; interchangeable.
8. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
9. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
10. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Overpressure Protection Device: Factory mounted on pressure regulator.
12. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
13. Maximum Inlet Pressure: 80 psig.

D. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

3. Body and Diaphragm Case: Cast iron or die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.
5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
7. Orifice: Aluminum; interchangeable.
8. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
9. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
10. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Overpressure Protection Device: Factory mounted on pressure regulator.
12. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
13. Maximum Inlet Pressure: See drawings. If not listed on drawings use 2 psig..

E. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Canadian Meter Company Inc.
    b. Eaton Corporation; Controls Div.
    c. Harper Wyman Co.
    d. Maxitrol Company.
    e. SCP, Inc.

3. Body and Diaphragm Case: Die-cast aluminum.
4. Springs: Zinc-plated steel; interchangeable.

5. Diaphragm Plate: Zinc-plated steel.
6. Seat Disc: Nitrile rubber.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
9. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
10. Maximum Inlet Pressure: 0.5 psig, unless otherwise noted on Drawings.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Description:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig minimum.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried from 18 inches to 36 below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 18 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

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

E. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators. For welding specifications and procedures, use:

    a. API 1104, Standard for Welding Pipelines and Related Facilities;
    b. AWS B2.1, Standard for Welding Procedure and Performance Qualification
    c. ASME Boiler and Pressure Vessel Code, Section IX.

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints:

1. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
2. Use AWS B2.2, “Standard for Brazing Procedure and Performance Qualification” for brazing specifications and procedures.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch .

D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch .
2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel flat or semigloss.
    d. Color: By Architect and Owner.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex flat, low sheen, eggshell, satin, or semigloss.
d. Color: By Architect and Owner.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd flat, eggshell, or semigloss.
d. Color: By Architect and Owner.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use minimum 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 PIPING SCHEDULE

B. Aboveground natural-gas piping shall be:
1. Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
1.
2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 221623

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Commercial, power-vent, gas-fired, storage, domestic-water heaters.
2. Domestic-water heater accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. Warranty: Sample of special warranty.

C. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

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

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
    a. Structural failures including storage tank and supports.
    b. Faulty operation of controls.
    c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
    a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
        1) Storage Tank: Five years.
        2) Controls and Other Components: Five years.

PART 2 - PRODUCTS

A. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. American Water Heaters
    b. Bock Water Heaters, Inc.
    c. Bradford White Corporation
    d. GSW Water Heating
    e. HESco Industries, Inc.
    f. Lochinvar Corporation
    g. PVI Industries, LLC
    h. RECO USA
    i. Rheem Manufacturing Company
    j. A.O. Smith
    k. State Industries

B. The heater tank shall be constructed of 316L stainless steel. The primary condensing heat exchanger shall be constructed of 90/10 cupronickel. The secondary heat exchanger shall be constructed of 800H stainless steel and 90/10 cupronickel. Solar models shall have an additional heat exchanger on the bottom of the tank to connect to a solar system.

C. Tank insulation shall be 2" thick water blown foam. Insulation shall be enclosed in a plastic jacket. All components shall be located on the front of the heater for easy service access. All related hardware shall be constructed of stainless steel studs with brass nuts. All water connection nipples shall be constructed of stainless steel and attached to the side of the tank. Multi Fit models shall have additional top mounted piping connections to increase installation flexibility. The top and bottom of the tank shall be smooth.

D. The heaters shall be ETL listed and will exceed the minimum efficiency requirements of ASHRAE 90.1b-1992. All heaters shall be approved in accordance with ANSI Z 21.10.3. All heaters will be supplied with a factory installed ASME rated temperature and pressure relief valve, a low water cutoff, a high temperature switch, an upper hot water sensor, a lower cold water sensor, and a condensate trap assembly ready for easy connection to a field supplied condensate drain.

E. The heater shall have an integrated digital controller device with integral diagnostics, LED fault and temperature settings for establishing set point and temperature differential. Ignition shall be direct spark and take place at a speed pre-set for the burner blower. The control shall utilize an algorithm to fully adjust the burner modulating firing rate while maintaining the desired temperature. In Sanitizer models, the controller is set to provide 184 F operating temperature with an adjustable 2 F differential to maintain temperature for sanitation purposes. The pre-mix stainless steel burner uses a 120 volt motor with pulse wave modulation control to change the fan speed, thus the combustion air volume of fuel and air through the burner to establish a continuous BTU input range equal to the water heating set point requirement. The digital LED control display shall provide means, via push buttons, for adjustments of operating temperatures, differential adjustment, ECO reset, service mode, and real time status mode. The control shall have low voltage inputs to accept a 0-10 volt from a building management system or outdoor sensor to alter the set point of the water heater. The unit will also have line voltage outputs for connection to a condensate pump and alarm output that will alert user of fault in the water heater for service. In addition, there shall be provided a computer connection for history, including all fault codes and hours of operation above 50% input, below 50% input, as well as real time status reporting of all operations. The burner assembly shall be mounted so as to be easily removed as an integral unit for ease of service.

F. The heater combustion system can be designed for either two pipe (intake and exhaust) closed combustion, or a single pipe system taking mechanical room air and piping exhaust outside. Schedule 40 or 80 PVC or stainless steel piping materials are approved for venting applications. (NOTE: Foam core pipe is not an approved exhaust venting material.) The vent connections (intake and exhaust) shall be located on the bottom of the heater.

G. Appliance venting can be installed using several different methods, including:

H. Vertical Venting shall be done either as a balanced or unbalanced system. An unbalanced system shall ONLY be allowed when the exhaust is installed vertically and the intake horizontally. Both exhaust and intake must remain within the heater's combined equivalent length. (Refer to heater installation manual venting section for additional venting requirements.)

I. Indoor Combustion Venting from a Confined or Unconfined Space – Where the exhaust runs vertically and combustion air is drawn either from the mechanical room or from outdoors.

J. The total combined length of exhaust and intake vents cannot exceed 85 combined feet for 2" venting or 200 combined feet for 3" venting. Adequate combustion air must be supplied when drawing air from the mechanical room. Avoid the room contaminates listed in the installation manual.

K. The heater shall be in compliance with the NOx emissions limit set forth in SCAQMD Rule 1146.2. The heater shall be factory assembled, test-fired for correct BTU input, and adjusted for proper combustion parameters. Complete operating and installation

2.2 Domestic Water Heater Accessories

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.

K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heater and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.

2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.

4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 23 Section "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."

H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

I. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves

specified in Division 22 Section "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

K. Fill domestic-water heaters with water.

L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Division 23 Section "Facility Natural-Gas Piping."

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

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01.

C. Prepare test and inspection reports.

END OF SECTION 233400

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Selective removal and disposal of existing HVAC equipment, ductwork, piping and controls as shown or otherwise indicated on the drawings.

B. Disconnect and cap existing fuel oil piping. Owner is responsible for abandonment of existing fuel oil storage tank, containment piping and leak/inventory system.

C. Retain portions of the HVAC system and/or turn over to the owner for reuse as shown or otherwise indicated on the drawings.

D. Coordinate removals with existing conditions, new work, work from other divisions and the owner.

E. The Contractor shall be responsible for removal, and unless otherwise indicated, the disposal of Mercury prior to demolition or general renovation, from all areas where renovation or demolition operations will disturb the material. Typically Mercury is found in wall-mounted thermostats, thermometers of wall mounted thermostats, and in mercoid switches, manometers, etc. for various HVAC equipment and devices.

F. The Contractor shall be responsible for coordinating the activities of all trades to prevent the above mentioned materials from being disposed of as general waste. All costs associated with separating the above mentioned hazardous materials, including fines for illegal transport or disposal, are the responsibility of the Contractor.

G. Draining of liquid charged systems including hydronic hot/chilled water systems and removal of oils and heat transfer fluids/liquids that are potentially hazardous from site.

1.2 PROJECT CONDITIONS

A. Contractor shall coordinate any and all disruption of utilities with the owner in writing 2 weeks prior to dismantling, disconnecting or shutdown of any utility serving the building.

B. Contractor shall maintain operation of the heating system throughout the entire school/heating season – September 15 through May 10. Do not remove existing heating system if new system will not be operational at beginning of heating season.

1.3 QUALITY ASSURANCES

A. Only the best of workmanship in accordance with present standards and generally accepted construction practices will be acceptable. Any work which the workmanship is judged by the

Engineer to be below the present standards or generally accepted construction practices shall be replaced with properly done work at the Contractor's expense.

1.4 SITE CONDITIONS

A. The Drawings shall be taken in a sense as diagrammatic. Locations of mechanical and electrical equipment are not intended to show every offset and fitting, nor every obstruction difficulty that may be encountered.

B. It is the responsibility of the Contractor to inspect all work areas for mercury sources, and to notify all workmen of the importance of proper handling of materials containing mercury.

C. It is the responsibility of the Contractor to inspect and identify any and all liquids requiring drainage and to understand where and how liquids may be drained.

1.5 PROJECT CONTROL

A. The Contractor shall ensure no debris from demolition or construction remains at the close of each workday and that work areas adjacent to the work area are maintained in a safe and useable condition.

B. The Contractor shall ensure that no hazardous materials are stored on site. All drums and containers used as required by these specifications shall be removed from site at the close of each workday and areas adjacent to the work area are maintained in a safe and useable condition.

1.6 SEQUENCING AND SCHEDULING

A. All piping to be completely drained prior to commencing demolition.

B. All power to equipment being removed shall be disconnected by electrical contractor prior to commencing demolition.

C. Schedule and coordinate demolition with new construction to minimize frequency and duration of work in occupied areas.

D. Coordinate with the removal of hazardous materials to ensure demolition work is executed smoothly without frequent interruptions and to minimize frequency and duration of work in occupied areas.

E. Coordinate demolition work with the owner and building occupants to minimize disruption to building occupants.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all necessary materials and equipment, labor and training to perform the work of this section.

2.2 WASTE CONTAINERS

A. Waste containers shall meet EPA and local standards.

2.3 EQUIPMENT

A. Provide all tools and equipment necessary to perform the work of this section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field conditions prior to commencing work. Report discrepancies to Engineer before disturbing existing installation.

B. Beginning of demolition means installer accepts existing conditions.

C. Premature or excessive demolition or failure to retain components of the existing systems shall result in the Contractor providing replacement at no additional cost to the Owner.

D. Failure to complete new heating system in time for the opening of school means Contractor shall reinstall existing system in part or totally or provide temporary heat, as required, to maintain 70 deg F in the building. The Contractor shall perform demolition in a manner which preserves to the greatest possible extent the facility to re-establish the heating system, until the operation of the new system is a certainty for the subsequent heating season.

3.2 MERCURY

A. Mercury may be found in wall mounted thermostats, thermometers of wall mounted thermostats or in mercoid switches, manometers, etc. for HVAC equipment. Inspect all work areas for the presence of mercury sources. Remove (intact) all equipment that contains mercury without exposing the mercury to atmosphere.

B. Place all mercury containing materials in EPA approved drums with locking tops for recycling or disposal. Pad the drums to prevent the spillage of mercury. Provide drums, EPA labels and delivery services to an EPA approved recycling facility or landfill for all steel drums that contain mercury.

C. If mercury is spilled from its enclosure onto furnishings, floors or any open area of the building, the Contractor shall hire a professional toxic spill company to come and properly remove the mercury. All costs related to a mercury spill are the responsibility of the Contractor.

3.3 DRAINING OF HYDRONIC SYSTEMS

A. Drain hydronic systems to sanitary only after inspecting drain water for undue amounts of sludge, oil or other contaminants that could be considered hazardous or toxic.

B. Hydronic systems may not be drained to storm sewer systems, storm drains, ponds, streams or to grade.

C. Any potentially hazardous liquids such as oil or chemicals, either found inside equipment or distribution systems shall be drained into EPA approved drums with locking tops for recycling or disposal. Cover the drums to prevent spillage. Provide drums, EPA labels and delivery services to an EPA approved recycling facility or landfill.

3.4 PREPARATION

A. Drain piping as described above.

B. Disconnect electrical power as described above.

3.5 REMOVAL

A. Remove and dispose of existing mechanical materials and equipment as shown on Drawings; subject to the limitations described elsewhere in the Contract Documents.

B. Coordinate demolition of existing equipment with all other subcontractors to avoid any conflicts which may affect safety, cost to the owner, or schedule.

3.6 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain, or are to be reused, and are being addressed by the modifications indicated by the Contract Documents.

END OF SECTION 230510

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

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

B. Efficiency: Premium Energy efficiency, as defined in NEMA MG 1, or by the current local utility company standard, whichever is more stringent.

C. Service Factor: 1.15.

D. Inverter duty rated and/or variable speed rated.

E. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

F. Multispeed Motors: Separate winding for each speed.

G. Rotor: Random-wound, squirrel cage.

H. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

I. Temperature Rise: Match insulation rating, minimum Class B.

J. Insulation: Class F.

K. 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.

L. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

B. Motors Used with Variable Frequency Controllers:
   1. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   3. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   4. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   5. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

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

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type. Inverter duty rated and/or variable speed rated.

C. Premium efficiency as defined by current local utility standards.

D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

E. Motors 1/20 HP and Smaller: Shaded-pole type.

F. 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.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Flexible-hose packless expansion joints.
2. Metal-bellows packless expansion joints.
3. Rubber packless expansion joints.
4. Grooved-joint expansion joints.
5. Pipe loops and swing connections.
6. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

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

B. Delegated drawing showing locations of expansion fittings

C. Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified registered professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.5 SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of expansion joint, from manufacturer.

C. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mason Industries
      b. Flex-Hose Co., Inc.
      c. Flexicraft Industries.
      d. Metraflex, Inc.
      e. Unisource Manufacturing, Inc.
   2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
   3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
   4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint or brazed end connections.
      a. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
   5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded or brazed end connections.

a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Stainless-steel fittings with threaded end connections.

a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless-steel fittings with flanged end connections.

a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless-steel fittings with flanged end connections.

a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

B. Metal-Bellows Packless Expansion Joints:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Mason Industries
b. Flex-Hose Co., Inc.
c. Flexicraft Industries.
d. Metraflex, Inc.
e. Unisource Manufacturing, Inc.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 175 psig (1200 kPa) unless otherwise indicated.
5. Configuration: Single joint, single joint with base, and, double joint with base class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

a. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint, brazed, or threaded.

c. End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

C. Non-Metallic Packless Expansion Joints:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Mason Industries, Inc.; Mercer Rubber Co.
   d. Metraflex, Inc.
   e. Unisource Manufacturing, Inc.

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
4. Spherical Type: Multiple spheres with external control rods.
5. Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig at 220 deg F.
6. Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 150 psig at 200 deg F.
7. Minimum Pressure Rating for NPS 8 to NPS 12 (DN 200 to DN 300): 150 psig at 200 deg F.
8. Submit manufacturer's recommended material for fluids containing:
   a. Acids, Alkalies, or Chemicals.
   b. Gas, Hydrocarbons, or Oil
   c. Water.
9. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawing or comparable product by one of the following:

   a. Adsco Manufacturing LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flexicraft Industries.
   e. Flex-Weld, Inc.
   f. Hyspan Precision Products, Inc.
   g. Metraflex, Inc.

h. Senior Flexonics Pathway.
i. Unisource Manufacturing, Inc.
j. U.S. Bellows, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:
1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened concrete, with tension and shear capacities appropriate for application.

a. Stud: Threaded, zinc-coated carbon steel.
b. Expansion Plug: Zinc-coated steel.
c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened concrete, with tension and shear capacities appropriate for application.

a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-NMEJ-702.

D. Install grooved-joint expansion joints to grooved-end steel piping

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure. Review attachment to building structure with the project's structural engineer before installation.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:
   1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
   3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

1.3 SUBMITTALS

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

1.4 DEFINITIONS/ACRONYMS

A. PE – polyethylene

B. HDPE – high density polyethylene

C. PP - polypropylene

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; hot-dip galvanized.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, hot-dip galvanized with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
3. Wade
4. Josam

C. Description: Manufactured, watertight and dust-tight cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS & FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Link-Seal

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements:
   a. Silicone, Nitrile or EPDM-rubber interlocking links shaped to fit surface of pipe.
   b. Select seal material based upon best design and listing for temperature, pressure, and chemical resistance requirements for each specific installation.
   c. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Hot dip galvanized carbon steel or stainless steel.
3. Connecting Bolts and Nuts:
   a. Carbon steel, with corrosion-resistant coating, or stainless steel. Match hardware to pressure plate material.
   b. Provide bolts of mandatory length required to secure pressure plates to sealing elements according to manufacturer's installation requirements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc
   2. Presealed Systems.
   3. Metraflex Company
   4. Link-Seal

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.

      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6 (DN 150) Galvanized-steel-pipe sleeves, HDPE sleeves or Sleeve-seal fittings.
      b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe or HDPE sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves or HDPE sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or HDPE sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6 (DN 150)Galvanized-steel-pipe sleeves or HDPE sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or HDPE sleeves with sleeve-seal system..

        1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6 (DN 150) Galvanized-steel-pipe sleeves, HDPE sleeves or Sleeve-seal fittings.
    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe or HDPE sleeves.

5. Interior Partitions:

    a. Piping Smaller Than NPS 6 (DN 150) Galvanized-steel-pipe sleeves, HDPE sleeves or Sleeve-seal fittings.
    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe or HDPE sleeves.

END OF SECTION 230517

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gages.
   3. Test plugs.

B. Related Sections:
   1. Division 23 Section 23 21 13 "Hydronic Piping".

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

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

B. Shop Drawings: Schedule for thermometers and gages, indicating manufacturer's number, scale range, location and application for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

D. Pressure gauges shall be calibrated in units of pounds per square inch (psi).

Thermometers shall be calibrated in units of degrees of Fahrenheit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Ashcroft
   2. Palmer - Wahl Instruments Inc.
   3. Trerice, H. O. Co.
   4. Weiss Instruments, Inc.
   5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Chrome-plated brass, 9 inches long.

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

C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

D. Window: Glass.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

G. Accuracy: Plus or minus 1 percent of range, or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 THERMOWELLS

A. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES – LIQUID FILLED

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

   1. Case: Liquid-filled type, drawn steel or cast aluminum 6-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 metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

B. 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.

2.5 TEST PLUGS

A. 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.

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

C. 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.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install liquid-in-glass thermometers and pressure gauges in piping as shown on the drawings.

B. Provide the following temperature ranges for thermometers:
1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.

C. Provide the following ranges for pressure gauges:
1. Operating pressure shall be mid-span reading, 2 psi scale divisions.

3.2 INSTALLATIONS

A. Install pressure gages where shown or otherwise indicated by the Contract Documents.

B. Install thermometers where shown or otherwise indicated by the Contract Documents. Install direct-mounting thermometers and adjust vertical and tilted positions.

C. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

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

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

F. Install test plugs in tees in piping.

3.3 CONNECTIONS

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

3.4 ADJUSTING

A. Adjust faces of gages to proper angle for best visibility.

END OF SECTION 230519

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.
   3. Bronze butterfly valves.

B. Related Sections:
   1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

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

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller[**except plug valves**].

4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every [**5**] [**10**] <**Insert number**> plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

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

H. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.2 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
   a. Crane Co.; Crane Valve Group; Jenkins Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.

2. Description:

   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig (2070 kPa).
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

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

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

3.3 ADJUSTING

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

END OF SECTION 230523

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for PLUMBING piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment..

1.4 SUBMITTALS

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

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel .

B. Stainless-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

B. Shop drawings sealed by a registered professional structural engineer shall include details and calculations for each use of trapeze pipe hangers.

2.3 METAL FRAMING SYSTEMS

A. Shop drawings sealed by a registered professional structural engineer shall include details and calculations for each use of trapeze pipe hangers.

B. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.
      b. Thomas & Betts Corporation.
      c. Unistrut Corporation; Tyco International, Ltd.
      d. Wesanco, Inc.

   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   3. Standard: MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   7. Metallic Coating: Hot-dipped galvanized.
   8. Paint Coating: Epoxy.
   9. Plastic Coating: Polyurethane, Epoxy, or Polyester.

C. Non-MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International; a subsidiary of Mueller Water Products Inc.
      b. NIBCO INC.
      c. PHD Manufacturing, Inc.
      d. PHS Industries, Inc.

   2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Standard: Comply with MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   7. Coating: Paint.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ERICO International Corporation.
   2. National Pipe Hanger Corporation.
   3. PHS Industries, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

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

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

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

2.5 FASTENER SYSTEMS

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

2.6 PIPE STANDS

A. Shop drawings sealed by a registered professional structural engineer shall include details and calculations for each use of trapeze pipe hangers.

B. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

C. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

D. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

E. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

F. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

G. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

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

B. Shop drawings sealed by a registered professional structural engineer shall include details and calculations for each use of trapeze pipe hangers.

2.8 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. 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 mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

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

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

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

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6 : 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14 : 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24 : 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, or metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

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

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F , pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 , requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 , to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 , with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 , with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 , from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 , from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. 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. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

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

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. 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.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches .

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where allowed by Structural Engineer in concrete construction.

END OF SECTION 230529

PART 1 - GENERAL

1.1 DESCRIPTION

A. Intent

1. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the Specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. It is the intent of the seismic portion of this Specification to keep all mechanical building system components in place during a seismic event.
4. All such systems must be installed in strict accordance with seismic codes, component manufacturer and building construction standards. Whenever a conflict occurs between the manufacturer or construction standards, the most stringent shall apply.
5. This Specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).
6. Any variance or non-compliance with these Specification requirements shall be corrected by the Contractor in an approved manner.
7. Seismic restraints shall be designed in accordance with seismic force levels as detailed in Table 1.06-1.

B. The work in this section includes, but is not limited to the following:

1. Vibration isolation for piping, ductwork and equipment.
2. Equipment isolation bases.
3. Flexible piping connections.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Certification of seismic restraint designs and installation supervision.
7. Certification of seismic attachment of housekeeping pads.
8. All mechanical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical. (Equipment not listed is still included in this Specification)

AC Units	Comp Room Units	Pumps

Air Distribution Boxes	Condensers	Rooftop Units
Air Handling Units	Condensing Units	Tanks (All types)
Air Separators	Cooling Towers	Unit Heaters
Boilers	Ductwork	Variable Frequency Drives
Cabinet Heaters	Fans	Water Heaters
Chillers	Heat Exchangers	
Compressors	Piping	

C. Definitions

1. Life Safety Systems: All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust systems.

   a. All medical and life support systems.
   b. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.

2. Positive Attachment: A cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, or any other equipment are not acceptable on this Project as seismic anchor points.

3. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the pipe or duct.

4. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the pipe, or duct.

1.2 SUBMITTAL

A. The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Descriptive Data:

   a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the Specification.
   b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive Drawings.

2. Shop Drawings:

a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
b. Provide all details of suspension and support for ceiling hung equipment.
c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
e. Submittals for all directional seismic snubbers shall include the load deflection curves up to 1/2" deflection in the x, y and z planes.

3. Seismic Certification and Analysis:

a. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
b. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads, as well as, one test or analysis at 45 degrees to the weakest mode.
c. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in Table 1.06-1 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

C. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

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

E. Design seismic-restraint hangers and supports for piping and equipment..

1.4 CODE AND STANDARDS REQUIREMENTS

A. Typical Applicable codes and Standards

1. International Building Code (IBC) (Correct edition adopted by CT)
2. Connecticut State Building Code

1.5 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide vibration isolation and seismic restraints as scheduled or specified.
3. Provide calculations and materials if required for restraint of unisolated equipment.
4. Provide installation instructions, Drawings and trained field supervision to insure proper installation and performance.
5. Provide field survey of the installation and submit letter to Engineer stating that the seismic and vibration isolation equipment has been installed in accordance with the manufacturer's instructions.

1.6 RELATED WORK

A. Housekeeping Pads

1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the Drawings.
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be

used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments

1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc., in accordance with the requirements of the vibration vendor's calculations.

1.7 SEISMIC FORCE LEVELS

A. Seismic analysis shall be in accordance with the International Building Code.

PART 2 - PRODUCTS

2.1 INTENT

A. All vibration isolators and seismic restraints described in this Section shall be the product of a single manufacturer. Mason Industry's products are the basis of these Specifications; products of other manufacturers are acceptable provided their systems strictly comply with the Specification and have the approval of the Engineer. Submittals and certification sheets shall be in accordance with Part 1.02 of this Specification.

B. For the purposes of this Project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater than 1/4 inch.

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolator and Seismic Restraint Types
The numbers of the following paragraphs correlate to the graphic representations at the end of this Article.

1. Two layers of 3/4-inch thick neoprene pad consisting of 2-inch square waffle modules separated horizontally by a 16 gage galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Not Used

3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge-bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal-to-metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Not Used
6. Not Used
7. Not Used
8. Not Used
9. Not Used
10. Hangers shall consist of rigid steel frames containing minimum 1-¼ inch thick neoprene elements at the top and a steel spring with general characteristics as in Type 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger Drawing showing the 30 degree capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
11. Precompressed hangers shall be as specified in Paragraph 2.3 A.10., but they shall also be locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a Drawing of the hanger showing the 30 degree capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.

    Types 12 - 14 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Types apply to hanging equipment as well.

12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of 2 and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an anchorage

preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis, or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.

13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.
14. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an anchorage preapproval "R" number from OSHPD in the state of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an anchorage preapproval "R" number from OSHPD in the State of California. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. Rated loadings shall not exceed 1000 psi. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an anchorage preapproval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1225 as manufactured by Mason Industries, Inc.
17. Not Used
18. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
19. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O

Evaluation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.

20. Not Used
21. Not Used
22. Not Used
23. Not Used
24. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3 inches and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

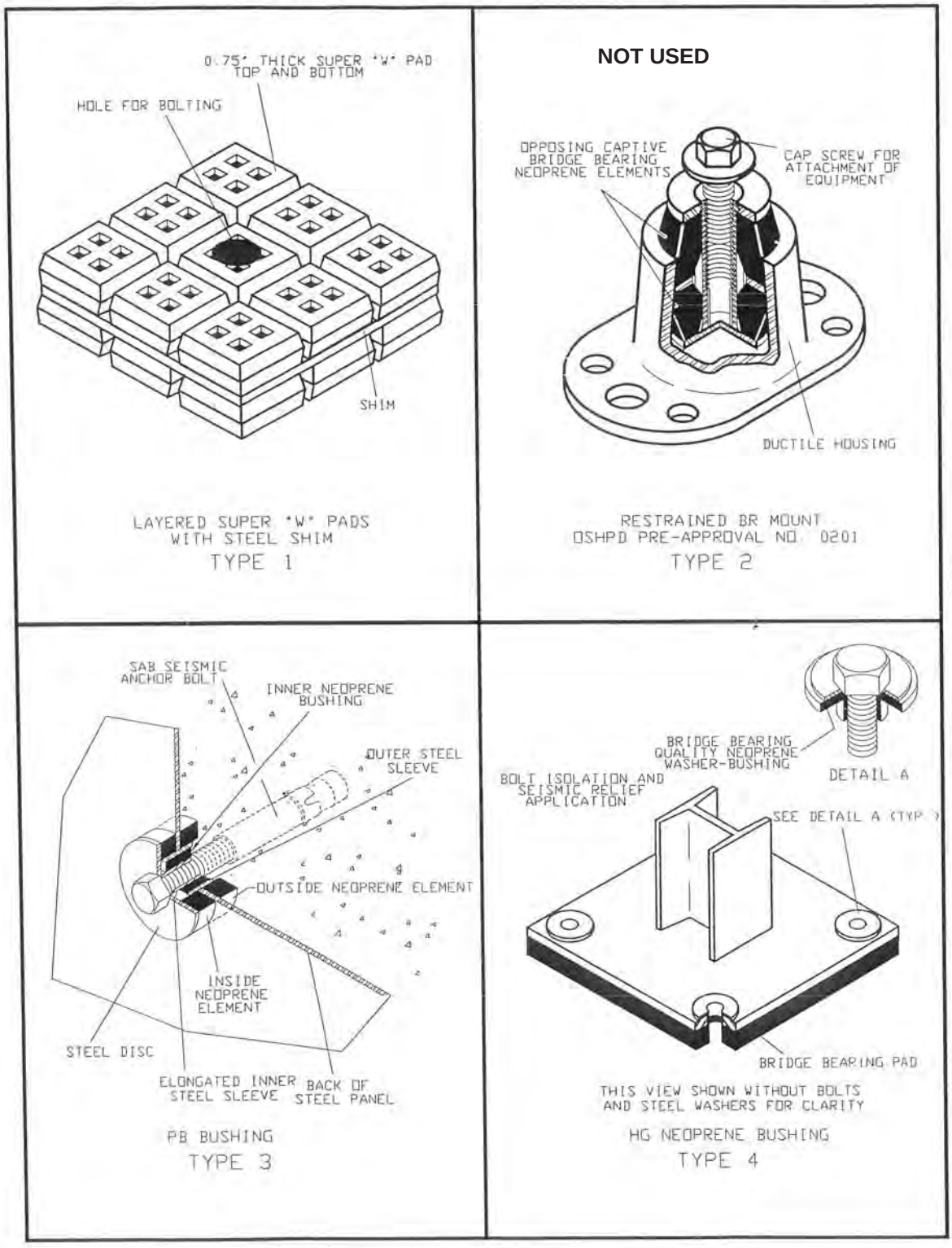
    a. Flanged Male Nipples

3 x 14	10 x 26	1/2 x 9	1-1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2-1/2 x 18
6 x 20	16 x 32	1-1/4 x 12	8 x 22

    b. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. Not Used
26. Not Used
27. Not Used
28. Not Used
29. Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than its top. The upper portion shall have holes for rebar to pass through. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor. Housekeeping pad anchors shall be type HPA and stud wedge anchor shall be type SAS both as manufactured by Mason Industries, Inc.

VIBRATION ISOLATION AND SEISMIC RESTRAINT TYPES

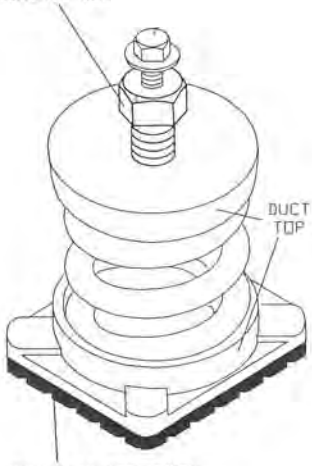


VIBRATION ISOLATION AND SEISIC RESTRAINT TYPES

CAP SCREW SECURES EQUIPMENT TO ADJUSTMENT BOLT

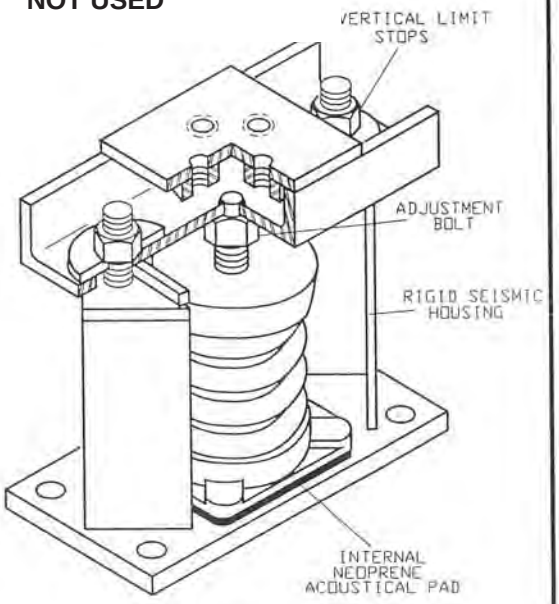
ADJUSTMENT BOL

NOT USED



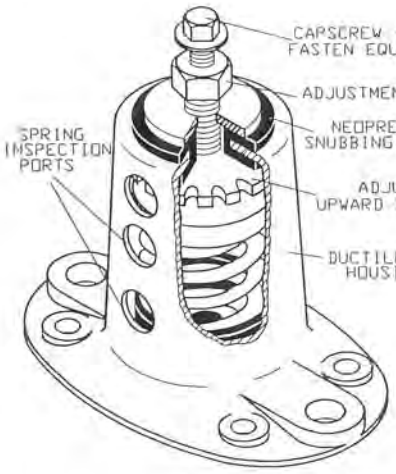
SLF SPRING MOUNT
TYPE 5

NOT USED



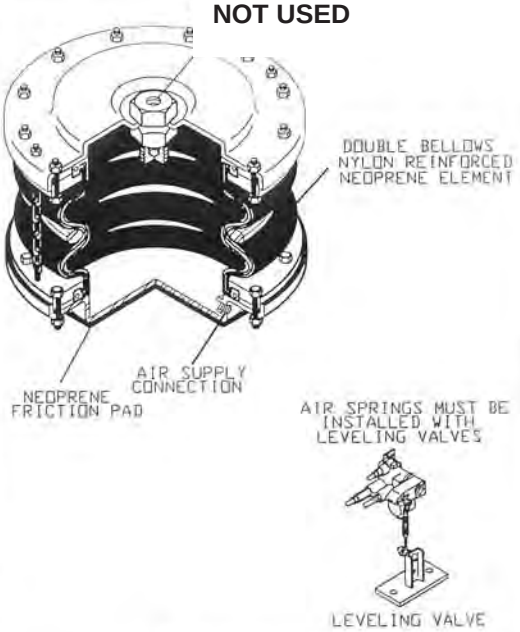
SLR SPRING MOUNT
TYPE 6

NOT USED



SSLFH HOUSED SPRING MOUNT
OSHPD PRE-APPROVAL NO. 0198 AND 0199
TYPE 7

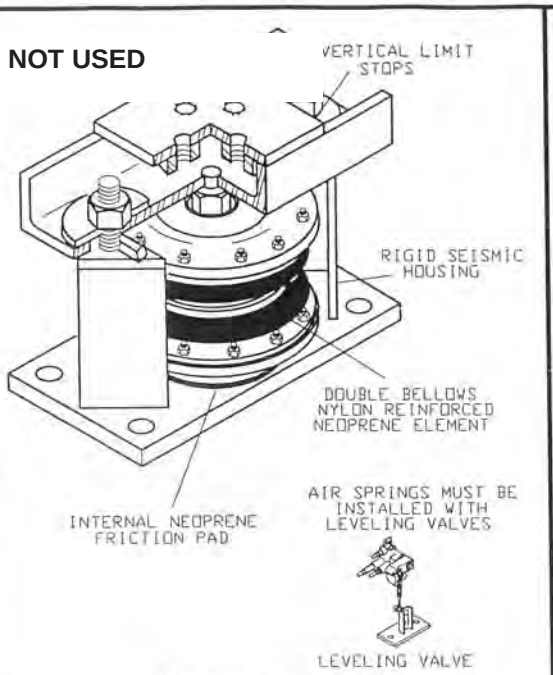
NOT USED



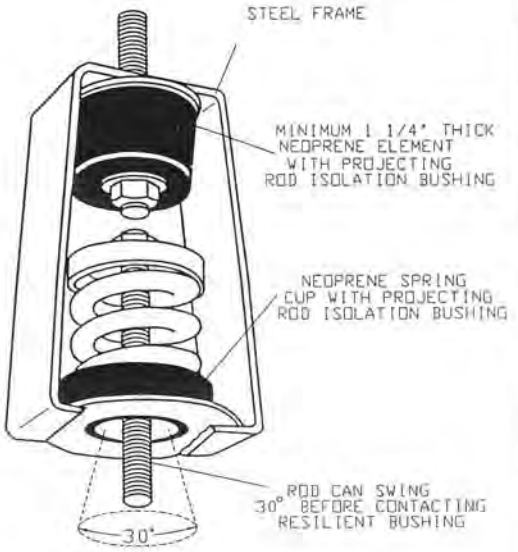
MT AIR SPRING MOUNT
TYPE 8

VIBRATION ISOLATION AND SEISMIC RESTRAINT TYPES

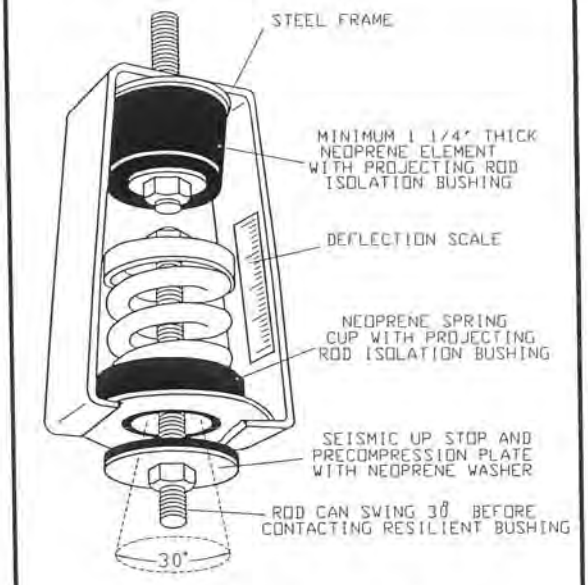
NOT USED



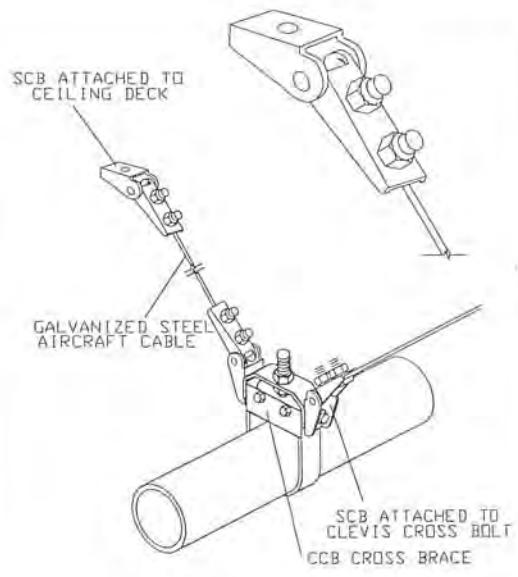
SLR AIR SPRING MOUNT
TYPE 9



30N SPRING AND NEOPRENE HANGER
TYPE 10

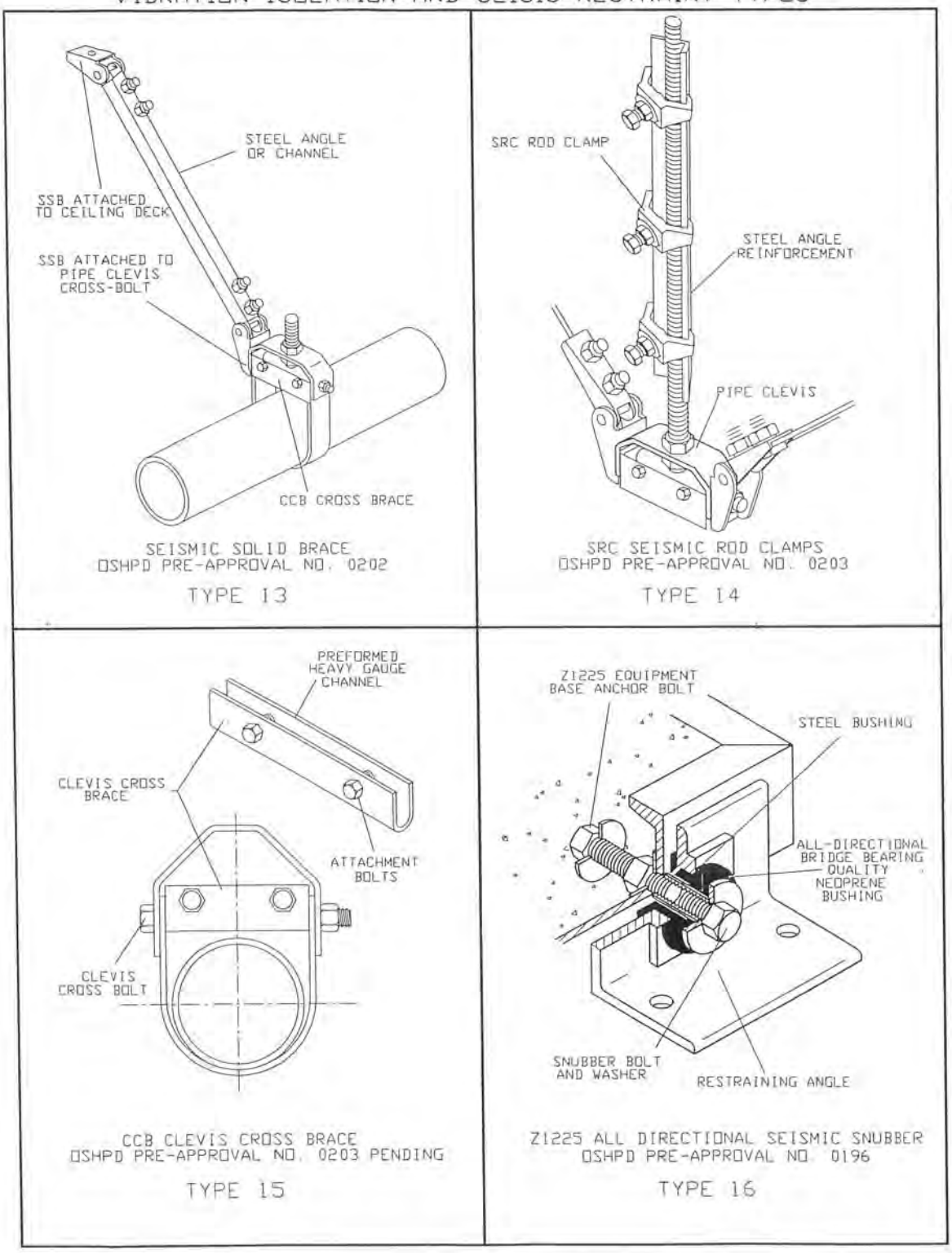


PC30N PRECOMPRESSED
SPRING AND NEOPRENE HANGER
TYPE 11

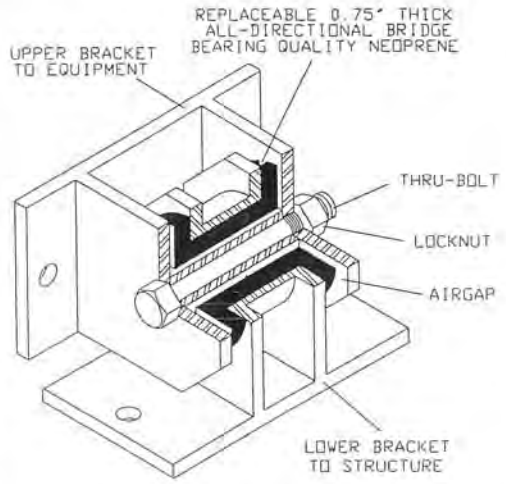


SCB, SCBH, AND SCBV CABLE RESTRAINTS
OSPD PRE-APPROVAL NO. 0202
TYPE 12

VIBRATION ISOLATION AND SEISIC RESTRAINT TYPES



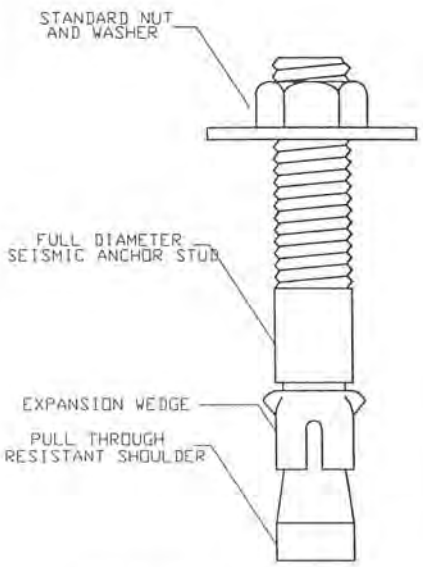
VIBRATION ISOLATION AND SEISMIC RESTRAINT TYPES



NOT USED

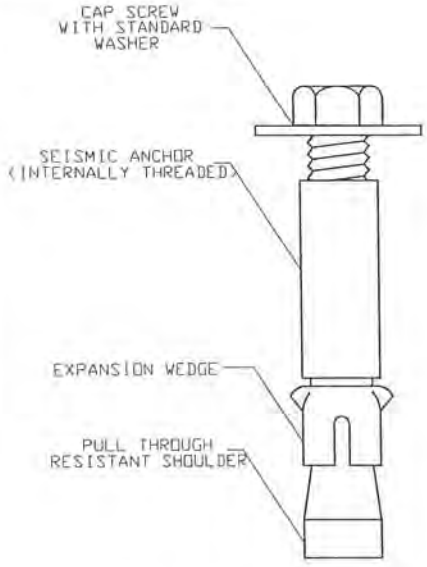
Z1011 ALL DIRECTIONAL SEISMIC SNUBBER
OSHPD PRE-APPROVAL NO. 0197 PENDING

TYPE 17



SAS SEISMIC ANCHOR STUD
ICBO APPROVAL REPORT NO. 1821

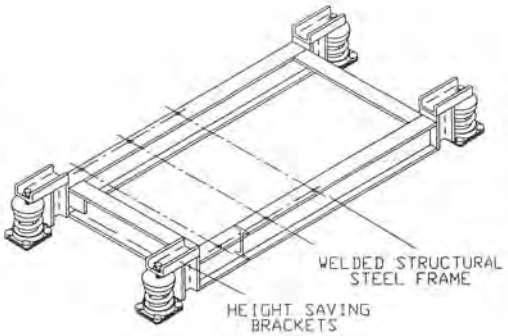
TYPE 18



SAB SEISMIC ANCHOR BOLT
ICBO APPROVAL REPORT NO. 5063

TYPE 19

NOT USED

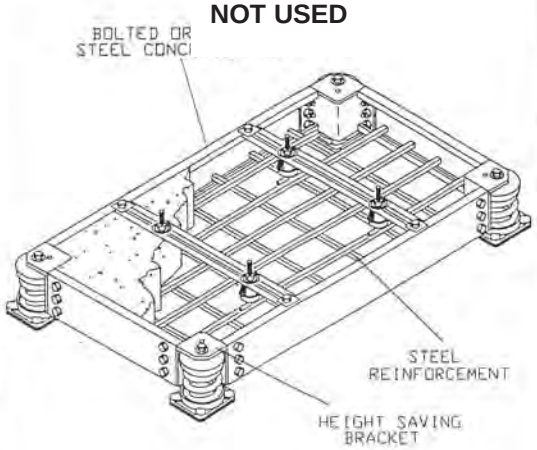


WF WIDE FLANGE STEEL BASE

TYPE 20

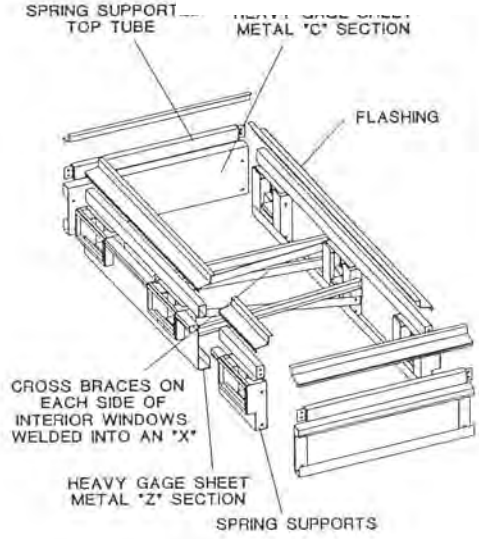
VIBRATION ISOLATION AND SEISMIC RESTRAINT TYPES

NOT USED



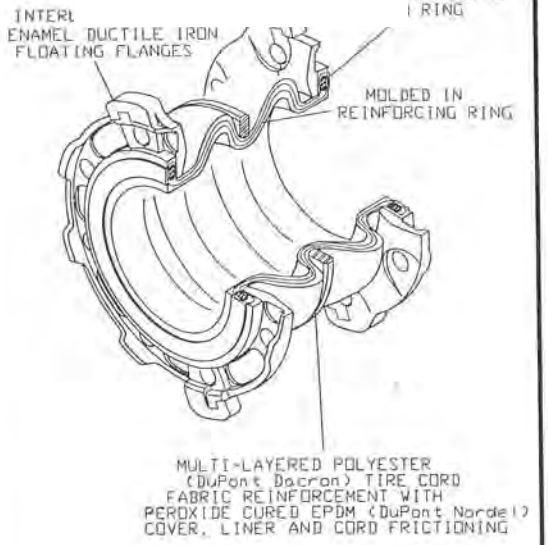
BMK CONCRETE FORM BASE
TYPE 21

NOT USED

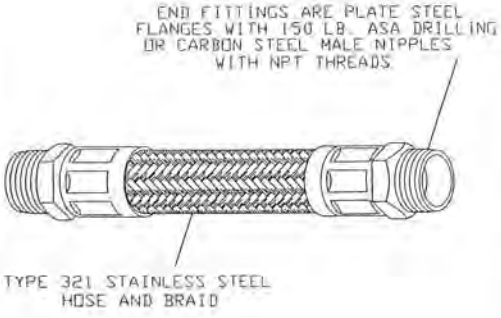


RSC SEISMIC ROOFTOP CURB
SPECIFICATION 22

NOT USED

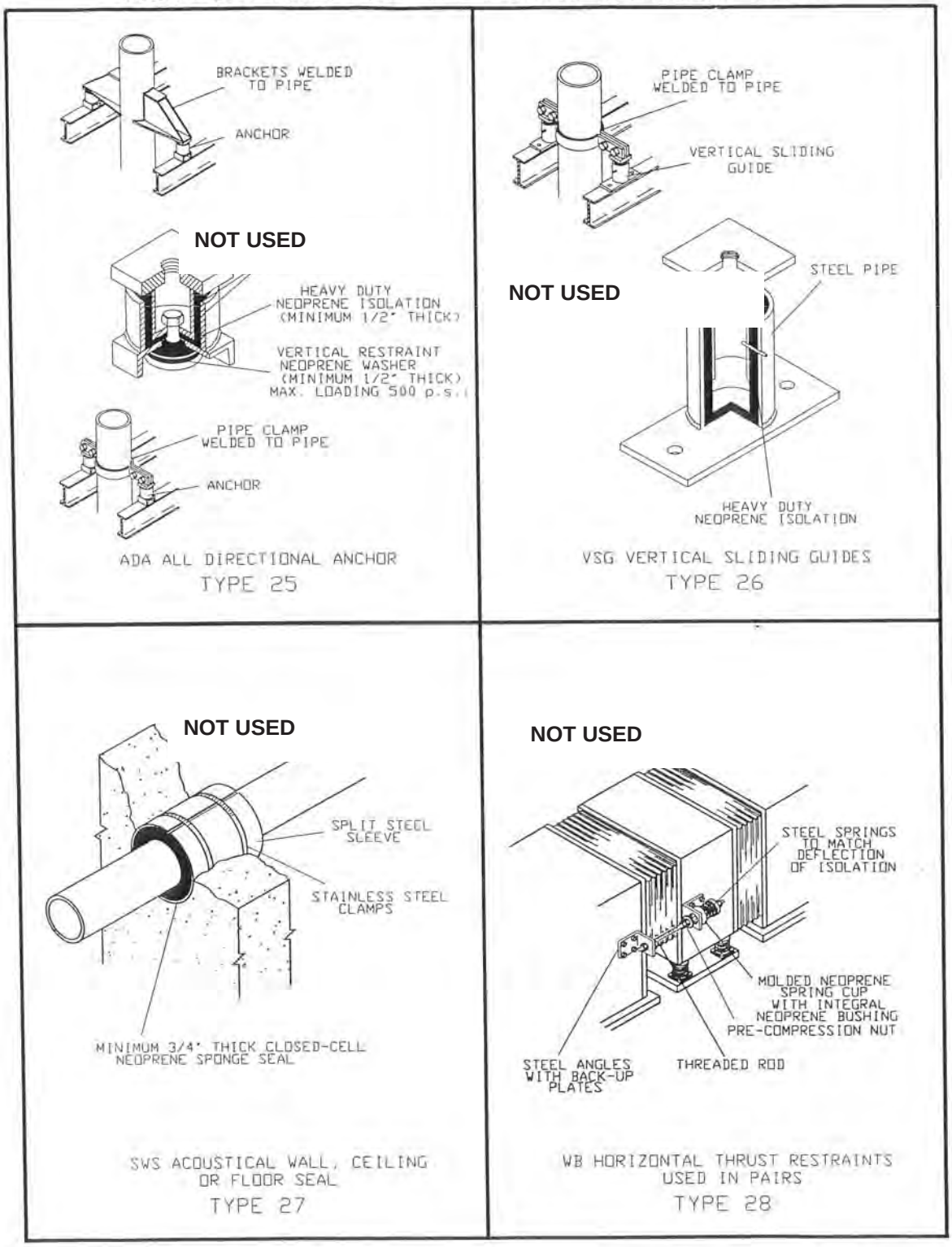


SFDEJ MOLDED EXPANSION JOINT
TYPE 23



BSS STAINLESS STEEL HOSE
TYPE 24

VIBRATION ISOLATION AND SEISMIC RESTRAINT TYPES



PART 3 - EXECUTION

2.3 GENERAL

A. All vibration isolators and seismic restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic restraints shall not cause any change in position of equipment, piping or ductwork resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The Contractor shall not install any equipment, piping, or duct that makes a rigid connection with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate with Work of other sections to avoid rigid contact with the building.

F. Any conflicts with Work of other sections which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Architect's/Engineer's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the Contractor's expense.

G. Bring to the Architect's/Engineer's attention any discrepancies between the Types and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the Contractor's expense.

I. Overstressing of the building structure shall not occur because of overhead support of equipment. Contractor shall submit loads to the Engineer for approval. Generally, bracing may occur from:

1. Flanges of structural beams.
2. Upper truss cords in bar joist construction.
3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Type 12 cable restraints shall be installed with slight slack to avoid short circuiting the isolated suspended equipment or piping.

K. Type 12 cable assemblies are installed taut on non-isolated systems. Type 13 seismic solid braces may be used in place of cables on rigidly attached systems only.

L. At locations where Type 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with Type 14 braces.

M. At all locations where Type 12 or 13 restraints are attached to pipe clevises, the clevis cross bolt shall be reinforced with Type 15 braces.

N. Drill-in concrete anchors for ceiling and wall installation shall be Type 18, and Type 19 female wedge type for floor mounted equipment.

O. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this Project.

P. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24 inches or specified movements exceed Type 23 capabilities.

Q. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide Type 27 wall seals.

R. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be Type 28 (see selection guide).

S. Locate isolation hangers as near to the overhead support structure as possible.

3.2 SEISMIC RESTRAINTS

A. Vibration Isolation of Piping

1. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in Type 11. Type 11 hangers shall also be used in all transverse braced isolated locations. Brace hanger rods with Type 14 SRC clamps. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in Type 10. Floor supported piping shall rest on isolators as described in Type 6. Heat exchangers and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces, the first three hangers shall have 0.75-inch deflection for pipe sizes up to and including 3 inches, 1-1/2 inches deflection for pipe sizes up to and including 6 inches, and 2-1/2 inches deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install Type 23 expansion joints or Type 24 stainless hoses.

B. Seismic Restraint of Piping

1. Seismically restrain all piping listed as a, b or c below. Use Type 12 cables if isolated. Type 12 or 13 restraints may be used on unisolated piping.

    a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1 inch I.D. or larger.
    b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1-1/4 inches I.D. and larger.
    c. All other piping 2-1/2 inches diameter and larger.

2. Transverse piping restraints shall be at 40 feet maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80 feet maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to, or greater than, the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping, transverse restraints shall be at 20 feet maximum and longitudinal restraints at 40 feet maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or TEE, or combined stresses are within allowable limits at longer distances.
7. Use hold-down clamps to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines will not be allowed as a restraint for main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly shall be braced by means of Type 10 hangers of Type 5 floor isolators. Spring deflection shall be a minimum of 0.75 inches.

C. Seismic Restraint of Ductwork

1. Seismically restrain all duct work with Type 12 or 13 restraints as listed below:

    a. Restrain rectangular ducts with cross-sectional area of 6 sq.ft. or larger.
    b. Restrain round ducts with diameters of 28 inches or larger.
    c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.

2. Transverse restraints shall occur at 30-foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60-foot intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal

restraint for a duct Section connected perpendicular to it if the restraints are installed within 4 feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.

4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than, or equal, to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non-bearing partitions, which have ducts running through them may, replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

D. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules on the Drawings.

3.3 SEISMIC RESTRAINT EXCLUSIONS

A. Piping

1. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12 inches in length from the structure to the structural connection of the clevis or trapeze.

B. Ductwork

1. Rectangular, square or oval ducts less than 6 sq.ft. in cross-sectional area.
2. Round duct less than 28 inches in diameter.
3. Duct supported by hanger rods where the point of attachment is less than 12 inches in length from the structure to the structural connection of the ductwork. Suspended equipment.

END OF SECTION 230548

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Stencils.
   6. Valve tags.
   7. Warning tags.

1.3 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black, Blue or Red.
3. Background Color: White or Yellow.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving,1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels based on ANSI/ASME A13.1 Pipe Labeling Requirements: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White or Yellow.

C. Background Color: Blue.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire..
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting" or Section 099600 "High Performance Coatings".

B. Stenciled Pipe Label Option: Stenciled labels may only be provided instead of manufactured pipe labels, at Architect/Engineer’s option. Install stenciled pipe labels complying with ASME A13 on each piping system.
1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Domestic-Water Piping:
      a. Background Color: White.
      b. Letter Color: Blue.
   2. Condenser-Water Piping:
      a. Background Color: Blue.
      b. Letter Color: Yellow.
   3. Heating Water Piping:
      a. Background Color: White.
      b. Letter Color: Red.
   4. Refrigerant Piping:
      a. Background Color: White.
      b. Letter Color: Black.
   5. Low-Pressure Steam Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   6. High-Pressure Steam Piping:
      a. Background Color: Yellow.
      b. Letter Color: Red.

7. Steam Condensate Piping:

    a. Background Color: Blue.
    b. Letter Color: Yellow.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
    1. Blue: For cold-air supply ducts.
    2. Yellow: For return-air ducts.
    3. Green: For outdoor-air ducts.
    4. Red: For exhaust-air ducts.
    5. Orange: For relief-air ducts.
    6.
    7. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 2 inch high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; 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 subparagraphs:
    1. Valve-Tag Size and Shape:

        a. Chilled Water: 1-1/2 inches, round .
        b. Condenser Water: 1-1/2 inches, round .
        c. Refrigerant: 1-1/2 inches, round .
        d. Hot Water: 1-1/2 inches, round .
        e. Gas: 1-1/2 inches, round .
        f. Low-Pressure Steam: 1-1/2 inches, round .
        g. High-Pressure Steam: 1-1/2 inches, round .
        h. Steam Condensate: 1-1/2 inches, round .

2. Valve-Tag Color:

    a. Chilled Water: Green.
    b. Condenser Water: Natural.
    c. Refrigerant: Natural.
    d. Hot Water: Red .
    e. Gas: Yellow.
    f. Low-Pressure Steam: Natural.
    g. High-Pressure Steam: Natural.
    h. Steam Condensate: Orange.

3. Letter Color:

    a. Chilled Water: Black.
    b. Condenser Water: Black.
    c. Refrigerant: Black.
    d. Hot Water: Black.
    e. Gas: Black.
    f. Low-Pressure Steam: Black.
    g. High-Pressure Steam: Black.
    h. Steam Condensate: Black.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Dual-duct systems.
      c. Variable-air-volume systems.
      d. Multizone systems.
      e. Induction-unit systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB reports.

C. Sample report forms.

D. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer and Commissioning Authority.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide **seven** days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on [**air**] [**and**] [**water**] distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:
   1. Wing’s Testing and Balancing.
   2. Brennan.
   3. Air Balancing Service Company.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts"and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

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

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in [**AABC's "National Standards for Total System Balance"**] [**ASHRAE 111**] [**NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"**] [**SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing"**] and in this Section.

   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in [**inch-pound (IP)**] [**and**] [**metric (SI)**] units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
      a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from [**Architect**] [**Owner**] [**Construction Manager**] [**Commissioning Authority**] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.

      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

   2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at maximum airflow through the cooling coil.

B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.8 GENERAL 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 the 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 liquid level in expansion tank.
   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 indicated 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.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

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

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   2. Motor horsepower rating.
   3. Motor rpm.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each fan.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the refrigerant charge.
   4. Check the condition of filters.
   5. Check the condition of coils.
   6. Check the operation of the drain pan and condensate-drain trap.
   7. Check bearings and other lubricated parts for proper lubrication.
   8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   4. Balance each air outlet.

3.15 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.

3.16 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.17 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:

       a. Indicated versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches (mm), and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.

c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):

a. Total air flow 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. Filter static-pressure differential in inches wg (Pa).
f. Preheat-coil static-pressure differential in inches wg (Pa).
g. Cooling-coil static-pressure differential in inches wg (Pa).
h. Heating-coil static-pressure differential in inches wg (Pa).
i. Outdoor airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).

f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Gas- fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h (kW).
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches (mm), and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).

l. Operating set point in Btu/h (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h (kW).

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:
3. Motor make, and frame type and size.
a. Horsepower and rpm.
b. Volts, phase, and hertz.
c. Full-load amperage and service factor.
d. Sheave make, size in inches (mm), and bore.
e. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
f. Number, make, and size of belts.

4. Test Data (Indicated and Actual Values):

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).

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F (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. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

J. Air-Terminal-Device Reports:
1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:

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 (Indicated and Actual Values):

a. Air flow 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).

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm (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.

2. Test Data (Indicated and Actual Values):

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:
1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.18 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:

      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.
   2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
   3. Commissioning Authority may randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
   2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

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PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide insulation for the following systems:
1. All new and existing hydronic piping and cold water makeup piping.
2. All new domestic water piping.
3. All existing piping disturbed by this project.
4. Mechanical equipment including air separators and expansion tanks.

1.2 SUBMITTALS

A. Product data and installation instructions on all materials shall be submitted to Engineer for approval. The Contractor shall indicate in his submittal material thickness, where each material shall be used, and method of application.

1.3 DELIVERY, STORAGE AND HANDLING

A. Store insulation with factory shipping packaging in a dry location protected from the outdoor elements including extreme heat and cold.

B. Protect insulation from damage during transit, delivery, storage and during entire construction period.

C. Installing contractor is responsible for any and all damage to insulation.

D. Do not deliver insulating materials until interior building work is suitably complete and ready to accept the materials without compromising any storage or protection requirements of this specification and the manufacturer's warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
1. Manville/Schuller
2. CertainTeed/Manson
3. Owens/Corning
4. Knauf

2.2 MATERIALS

A. Pipe Insulation

1. Insulation for hot and cold water piping shall equal to Manville "Micro-Lok AP" molded all-purpose fiberglass pipe insulation.
2. Insulation for refrigeration piping shall equal to Armstrong flexible foam.
3. Insulation thickness shall be:

Fluid Type	Pipe Size (in.)	Insulation Thickness
Hot Water/cold water	1/2” – 1-1/4”	1-1/2”
	1-1/2” +	2”
Refrigeration Piping (RL & RS)	1/2” – 1”	1-1/2”
Refrigeration Piping (RL & RS)	1-1/4” – 4”	1-1/2”
Condensate Piping	1/2” – 4”	1/2”

B. Interior insulation jacket shall be equal to Manville ASJ.

C. Provide weatherproof aluminum jacket for all exterior piping exposed to the elements.

D. Valve and Fitting Insulation: Equal to Manville molded fiberglass insulation with Zeston 2000 series 25/50 Class A covers.

E. Tank and Heat Exchanger Insulation: Equal to Manville Pipe and Tank insulation, (flexible board type insulation) 2" thick, with all purpose jacket. The fiber orientation of the insulation shall be perpendicular to the board surface.

F. All insulation and covering systems shall have Fire Hazard Classification not exceeding 25 Flame Spread, 50 Fuel Contribution, and 50 Smoke Developed when tested under ASTM E84 and UL723.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipe, Valve, and Fitting Insulation
1. Insulate all piping, fittings, valves and trim.
2. Install all insulation according to manufacturer's instructions. All butt joints are to be tight and sealed with ASJ butt laps. Secure longitudinal seams with outward clinch staples or a suitable lap adhesive. Provide stenciled pipe labels and flow direction arrows on all insulated piping.
3. Fasten throats of fitting covers with stainless steel serrated tacks. Use of steel staples to fasten covers is not acceptable. Seal seams and all overlaps of fitting covers to

insulation jacket with PVC tape. Seal all exposed fiberglass with lagging mastic, including pipe hanger gaps, ends and valve protrusions.

4. Completed work shall be smooth and straight. Fitting covers shall fit tight to pipe insulation with no gaps or fishmouths in throat seams or joints. Completed insulation work judged aesthetically unacceptable by the Engineer shall be corrected by the contractor at no cost to Owner.
5. Provide saddles to protect insulation at all pipe hangers. Do not penetrate insulation vapor barrier at hangers.
6. Do not insulate plastic air conditioning condensate piping.

B. Tank and Heat Exchanger Insulation

1. Install according to manufacturer's instructions. All lap seams shall be stapled with outward cinch staples on 4" centers. All longitudinal and circumferential joints shall be sealed with a 3" wide strip of pressure sensitive tape. No exposed surfaces of insulation are allowed.

END OF SECTION 230700

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SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.

B. Related Sections:
1. Section 233113 "Metal Ducts" for duct liners.

1.3 Submittals

A. Product Data and installation instructions on all materials shall be submitted to Engineer for approval. The Contractor shall indicate in the submittal material thickness, insulation location, and method of application.

1.4 Quality Assurance

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 Delivery, Storage, And Handling

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 Coordination

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.1 Insulation Materials

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

A. Insulate new ductwork and disturbed ductwork.

B. Mineral fiber or fiberglass blanket bonded with a thermosetting resin. Comply with ASTM C553 Type II and ASTM C1290 Type III.

C. Properties
1. Thickness nominal 2” installed
2. Density 1.0 lb/ft3
3. Installed R-Valve of 6.0
4. Mold Resistance ASTM C1338, no growth
5. Vapor restarting jacket FSK or FRK
6. 25/50 flame spread/ smoke generation ASTM E84
7. Water vapor permeance ASTM E96 of 0.02 perms
8. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Owens Corning.

PART 3 - EXECUTION

3.1 Examination

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 Preparation

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 General Installation Requirements

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

1. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
2. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 Installation Of Mineral-Fiber Insulation

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for **100** percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 Field Quality Control

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 Testing AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
   1. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
   2. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
   3. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R Contractor and Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. It is the contractor's responsibility to provide written response to the CxA proposed corrective action plans within (15) working days.

K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

L. Contractor will pay for the extra CxA costs associated with witnessing functional tests beyond one failed functional test.

3.4 Hvac&R systems, subsystems, and equipment Testing Procedures

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor and Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to

Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of boiler systems and domestic hot water system and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

END OF SECTION 230800

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PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

A. All work under this specification shall be coordinated and provided by a single Building Management System (BMS) Contractor.

B. The work of this specification shall be scheduled, coordinated, and interfaced with the associated work of other trades.

C. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

D. BMS system to be coordinated with the Connecticut Army National Guard, CFMO Energy Manager, and connect to the head-end equipment at the Hartford Armory.

E. Acceptable Manufacturers - Subject to compliance with requirements, all controllers and workstation software shall be manufactured by one of the following:
   1. Johnson Controls, Inc.
   2. Automated Logic
   3. Allerton

   Branford Armory does not currently have any DDC system. All new HVAC controls must seamlessly integrate into the central network system in Hartford Amory.

1.2 SUBMITTALS

A. Shop Drawings, Product Data, and Samples:
   1. The BMS contractor shall submit a list of all shop drawings with submittals dates within 60 days of contract award.
   2. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
   3. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.
   4. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
   5. The BMS Contractor shall correct any errors or omissions noted in the first review.

6. At a minimum, submit the following:

    a. BMS network architecture diagrams including all nodes and interconnections.

    b. Systems schematics, sequences and flow diagrams.

    c. Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.

    d. Samples of Graphic Display screen types and associated menus.

    e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

    f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.

    g. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.

    h. Room Schedule including a separate line for each terminal unit indicating location and address.

    i. Details of all BMS interfaces and connections to the work of other trades.

    j. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

B. Record Documents:

1. Operation and Maintenance Manuals

    a. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:

    b. Table of contents.

    c. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

d. Manufacturers product data sheets or catalog pages for all products including software.

e. System Operator's manuals.

f. Archive copy of all site-specific databases and sequences.

g. BMS network diagrams.

h. Interfaces to all third-party products and work by other trades.

i. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

1.3 WARRANTY

A. Standard Material and Labor Warranty.
1. Provide a one-year labor and material warranty on the BMS.
2. f within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Maintain an adequate supply of materials within 50 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

PART 2 - PRODUCTS

2.1 DESCRIPTION

B. The Building Management System shall consist of the following:
1. Network Automation Engine(s)
2. Field Equipment Controller(s)
3. Input/Output Module (s)
4. Distributed User Interface(s)
5. Network processing, data storage and communications equipment
6. Other components required for a complete and working BMS

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.2 USER INTERFACE

2.3 User Interface Application Components

A. Operator Interface

1. An integrated browser based client application shall be used as the user operator interface program.
2. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
3. The user interface software shall provide help menus and instructions for each operation and/or application.
4. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
5. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
    a. User access for selective information retrieval and control command execution
    b. Monitoring and reporting
    c. Alarm, non-normal, and return to normal condition annunciation
    d. Selective operator override and other control actions
    e. Information archiving, manipulation, formatting, display and reporting
    f. FMS internal performance supervision and diagnostics
    g. On-line access to user HELP menus
    h. On-line access to current FMS as-built records and documentation
    i. Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.
6. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

B. Navigation Trees

1. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
2. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

3. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

C. Alarms

1. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
   a. Log date and time of alarm occurrence.
   b. Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
   c. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
   d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
   e. Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
   f. Any attribute of any object in the system may be designated to report an alarm.
2. The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
3. The FMS shall annunciate application alarms at minimum, as required by Part 3.

D. Reports and Summaries

1. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
   a. All points in the BMS
   b. All points in each BMS application
   c. All points in a specific controller
   d. All points in a user-defined group of points
   e. All points currently in alarm
   f. All points locked out
   g. All BMS schedules
   h. All user defined and adjustable variables, schedules, interlocks and the like.
2. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
3. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

4. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

E. Schedules

1. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
   a. Weekly schedules
   b. Exception Schedules
   c. Monthly calendars.
2. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
3. It shall be possible to define one or more exception schedules for each schedule including references to calendars
4. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
5. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
6. Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
7. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

F. Password

1. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
2. Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
3. The system shall allow each user to change his or her password at will.
4. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
5. A minimum of five levels of access shall be supported individually or in any combination as follows:
   a. Level 1 = View Data
   b. Level 2 = Command
   c. Level 3 = Operator Overrides
   d. Level 4 = Database Modification
   e. Level 5 = Database Configuration
   f. Level 6 = All privileges, including Password Add/Modify
6. A minimum of 100 unique passwords shall be supported.
7. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

8. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

G. Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

H. Dynamic Color Graphics

1. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
2. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.

   The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
3. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
   a. All graphics shall be fully scalable
   b. The graphics shall support a maintained aspect ratio.
   c. Multiple fonts shall be supported.
   d. Unique background shall be assignable on a per graphic basis.
   e. The color of all animations and values on displays shall indicate if the status of the object attribute.
4. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
5. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
   a. The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
   b. In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
6. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

I. Historical trending and data collection

1. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
   a. Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
      Defined time interval
      Upon a change of value
   b. Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

2. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
3. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.

J. Trend data viewing and analysis
   1. Provide a trend viewing utility that shall have access to all database points.
   2. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
   3. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
   4. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
   5. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
   6. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
   7. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.4 NETWORK AUTOMATION ENGINES (NAE)

A. Network Automation Engines.
   1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
   2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.

3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

    a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

    b. The NAE shall support up a minimum of four (4) concurrent users.

    c. The web based user shall have the capability to access all system data through one NAE.

    d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

    e. Systems that require the user to address more than one NAE to access all system information are not acceptable.'

    f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

    g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

    h. he web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
        - Configuration
        - Commissioning
        - Data Archiving
        - Monitoring
        - Commanding
        - System Diagnostics

    i. Systems that require workstation software or modified web browsers are not acceptable.

    j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:

    a. Power On/Off

    b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic

    c. Ethernet Connection Speed – 10 Mbps/100 Mbps

    d. FC Bus A – Normal Communications/No Field Communications

    e. FC Bus B – Normal Communications/No Field Communications

    f. Peer Communication – Data Traffic Between NAE Devices

    g. Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running

    h. Bat Fault – Battery Defective, Data Protection Battery Not Installed

    i. 24 VAC – 24 VAC Present/Loss Of 24VAC

    j. Fault – General Fault

    k. Modem RX – NAE Modem Receiving Data

    l. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

    a. Two (2) USB port

    b. Two (2) URS 232 serial data communication port

    c. Two (2) RS-485 port

    d. One (1) Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

    a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

    b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).

2.4 DDC SYSTEM CONTROLLERS

A. Field Equipment Controller (**FEC X610)**:

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller.
2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The FEC shall include a removable base to allow pre-wiring without the controller.
6. The FEC shall include troubleshooting LED indicators to identify the following conditions:

    a. Power On

    b. Power Off

    c. Download or Startup in progress, not ready for normal operation

    d. No Faults

    e. Device Fault

    f. Field Controller Bus - Normal Data Transmission

    g. Field Controller Bus - No Data Transmission

h. Field Controller Bus - No Communication

i. Sensor-Actuator Bus - Normal Data Transmission

j. Sensor-Actuator Bus - No Data Transmission

k. Sensor-Actuator Bus - No Communication

7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
8. The FEC shall support the following types of inputs and outputs:

a. Universal Inputs - shall be configured to monitor any of the following:
- Analog Input, Voltage Mode
- Analog Input, Current Mode
- Analog Input, Resistive Mode
- Binary Input, Dry Contact Maintained Mode
- Binary Input, Pulse Counter Mode

b. Binary Inputs - shall be configured to monitor either of the following:

- Dry Contact Maintained Mode

- Pulse Counter Mode

c. Analog Outputs - shall be configured to output either of the following
- Analog Output, Voltage Mode
- Analog Output, current Mode

d. Binary Outputs - shall output the following:
- 24 VAC Triac

e. Configurable Outputs - shall be capable of the following:
- Analog Output, Voltage Mode
- Binary Output Mode

9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).

a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

b. The FC Bus shall support communications between the FECs and the NAE.

c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.

d. The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.

e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

    a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

    b. The SA Bus shall support a minimum of 10 devices per trunk.

    c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.

11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
12. The FEC shall support, but not be limited to, the following:

    a. Hot water

    b. Makeup air units

    c. Terminal units

    d. Special programs as required for systems control

2.5 FIELD DEVICES

A. Network Sensors **(NS-XXX700X**)

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

    a. Zone Temperature

    b. Zone setpoint

2. The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The Network Sensors shall include the following items:

    a. Plain space mounted sensors with temperature sensing only.

4. The NS shall be available with either screw terminals or phone jack.
5. The NS shall be available in either surface mount or wall mount styles.

2.6 INPUT DEVICES

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors:

1. General Requirements

   a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

   b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

   c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Hot Water	± .5°F.
Room Temp	± .5°F.
Duct Temperature	± .5°F.
All Others	± .75°F.

2. Room Temperature Sensors

   a. Room sensors shall be constructed for either surface or wall box mounting.

   b. Room sensors shall have the following options when specified:
      - Setpoint reset slide switch providing a +3 degree (adjustable) range.
      - A momentary override request push button for activation of after-hours operation.

3. Thermo wells

   a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.

   b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.

   c. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

   d. Thermo wells shall be constructed of 316 stainless steel.

4. Outside Air Sensors

a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

5. Duct Mount Sensors

a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

6. Averaging Sensors

a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

7. Acceptable Manufacturers: Johnson Controls, Setra.

C. Status and Safety Switches

1. General Requirements

a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through

the window of the device. It shall accept over-current up to twice its trip point range.

b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

d. Acceptable manufacturers: Veris Industries

3. Air Filter Status Switches

a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

c. Provide appropriate scale range and differential adjustment for intended service.

d. Acceptable manufacturers: Johnson Controls, Cleveland Controls

4. Air Flow Switches

a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

b. Acceptable manufacturers: Johnson Controls, Cleveland Controls

5. Air Pressure Safety Switches

a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

c. Acceptable manufacturers: Johnson Controls, Cleveland Controls

6. Water Flow Switches

a. Water flow switches shall be equal to the Johnson Controls P74.

7. Low Temperature Limit Switches

a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

d. The low temperature limit switch shall be equal to Johnson Controls A70.

2.7 OUTPUT DEVICES

A. Actuators

1. General Requirements

a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.

2. Electronic Damper Actuators

a. Electronic damper actuators shall be direct shaft mount.

b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.

c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to

indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

e. Acceptable manufacturers: Johnson Controls, Mamac.

3. Electronic Valve Actuators

a. Electronic valve actuators shall be manufactured by the valve manufacturer.

b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.

c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or boiler.

f. Acceptable manufacturers: Johnson Controls

B. Control Dampers

1. The BMS Contractor shall furnish all automatic dampers if one is provided by the equipment manufacturer. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, and Vent Products 5800.
7. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays
   1. Control Pilot Relays
      a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
      b. Mounting Bases shall be snap-mount.
      c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
      d. Contacts shall be rated for 10 amps at 120VAC.
      e. Relays shall have an integral indicator light and check button.
      f. Acceptable manufacturers: Johnson Controls, Lectro

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
2. Hot water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Ball valves shall be used for hot water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
6. Acceptable manufacturers: Johnson Controls

PART 3 - PERFORMANCE / EXECUTION

3.1 BMS SPECIFIC REQUIREMENTS

A. Graphic Displays
   1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.

2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

B. Actuation / Control Type
   1. Primary Equipment
      a. Controls shall be provided by equipment manufacturer as specified herein.
      b. All damper and valve actuation shall be electric.
   2. Air Handling Equipment
      a. All air handers shall be controlled with a HVAC-DDC Controller
      b. All damper and valve actuation shall be electric.
   3. Terminal Equipment:
      a. Terminal Units shall have electric damper and valve actuation.
      b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2 INSTALLATION PRACTICES

A. BMS Wiring
   1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
   2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
   3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
   4. Class 2 Wiring
      a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
      b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BMS Line Voltage Power Source
1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.
2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.

C. BMS Panel Installation
1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

3.3 COMMISSIONING

A. Fully commission all aspects of the Building Management system work.

B. Acceptance Check Sheet
1. Prepare a check sheet that includes all points for all functions of BMS as indicated on the point list included in this specification.
2. Submit the check sheet to the Engineer and the Commissioning Agent for approval.
3. The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor.

3.4 TRAINING

A. The BMS contractor shall provide the following training services:
1. Provide 4 hours of training by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

END OF SECTION 230900

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. This section defines the arrangement of the controls, manner, and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are generally specified in other sections. Provide all labor and material required to satisfy the requirements of this section whether or not specified elsewhere.

C. Related Sections include the following:
1. Section 230900 "Direct Digital Control System" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

A. DDC: Direct digital control.

1.4 BOILER SYSTEM CONTROL SEQUENCES

A. Heating System (Boiler Control):
1. Building Heating System (Boiler) Control: The DDC system shall monitor the hot water supply and return temperatures for each boiler and the building distribution loop. Control of the boilers shall be by boiler manufacturer. The boiler control system shall provide outside air temperature reset, boiler staging (lead/lag) in cascade arrangement in sequence to maintain supply hot water temperature in accordance with the following reset schedule (adj):

OUTDOOR AIR TEMP	SUPPLY WATER TEMP
0°F	185°F
60°F	100°F
65°F	Warm Weather Shut-Down (WWSD)

2. Boiler Pump Control: The boiler controller shall command that the respective boiler circulation pump operates and the DDC system shall input command and control each boiler pump on/off. Alarm DDC system on pump failure.

3. Building pumps (P-1, 2, 3, and 4) shall operate when any boiler operates.

B. Building Hot Water Pumps (P-1, 2, 3, 4):

1. The DDC system shall control and monitor the building heating system pumps. The DDC system shall provide lead/lag control of pumps and shall alternate weekly.
2. Lead pump shall run when outside air temperature drops below 60 degree F or when commanded by the operator's workstation.
3. Should lead pump fail as indicated by status point, lag pump shall run, and alarm shall occur.
4. Alarm loop temperature and pump failures.
5. Interlock building distribution pumps with operation of boilers.

1.5 AIR-HANDLING-UNIT CONTROL SEQUENCES (MAU-1 AND MAU-2)

A. General:
1. The system will operate occupied and unoccupied based on a time schedule. The unit shall use a setback heating temperature set point during unoccupied periods. All schedules shall be coordinated with the Owner.
2. Temperature control will be accomplished by resetting discharge temperature of the unit to maintain space temperature.
3. All units to have a normal mode (unoccupied mode) and occupied mode. Occupants may temporarily switch thermostat to occupied mode.
4. The local thermostat shall be equipped with a setpoint adjustment to allow the occupant to increase or decrease the room setpoints by +/- 5 degree F.

B. Supply Fan Control:
1. Unoccupied mode: supply fan will remain de-energized with the outside air damper in the minimum open position (10%) and the return air damper in the maximum open position. The control valve shall modulate to maintain a space temperature of 45 degree as measured by the mixed air temperature. If the space temperature drops below 50 degree setback temperature (adj.), the perimeter radiation control valves will modulate to maintain the nigh setback temperature and the AHU will remain off.
2. Standby mode: perimeter radiation will modulate to maintain higher occupied temperature (adj.) MAU supply fan shall remain off.
3. Occupied mode: Supply fan shall start, and the outside air and return air dampers shall modulate. The temperature control sequence shall be enabled.
4. Economizer mode: when outside air temperature is above 65 degree and system is in occupied mode, the unit shall run in economizer mode regardless of the CO2 readings.

The unit shall override the demand controlled ventilation algorithm to modulate the outside air dampers to open to its maximum position.

C. CO2 Control:
1. The DDC shall monitor CO2 level in the room sensors in designated areas. The DDC shall modulate the outside air damper of the MAU open past the minimum air position setpoint. As CO2 level rises, outdoor air damper shall open; as co2 level drops, outside air damper shall modulate back to its minimum air position setpoint.

2. The MAU shall modulate its heating control to maintain the discharge air temperature setpoint if the mixed air temperature falls below the AHU discharge air temperature setpoint. Once the space CO2 level drops below the CO2 setpoint, the outside air dampers shall modulate to maintain the base ventilation rate.

D. Freeze Protection:
1. The run-around loop pump shall run in order to circulate water through the heating coil whenever:
   a. Supply air temperature drops below 55 degree F (adj.)
   b. Outside temperature is blow 35 degree F.
2. If the hot water coil low-temp stat drops below the setpoint, the unit shall shut down and generate an alarm upon receiving a freezestat status.

E. Alarm under any of the following conditions:
1. If space temperature drops below 45 degree F for 5 minutes.
2. If supply fan status fails to duplicate command.
3. If mixed air temperature drops below 45 degree F for 5 minutes.

1.6 AIR CONDITIONING CONTROL SEQUENCES (HP, CU)

A. General:
1. The system will operate occupied and unoccupied based on a time schedule. All schedules shall be coordinated with the Owner.
2. The unit shall operate when the outside temperature is greater than 70 degree F.
3. The unit shall be off when the outside temperature is less than 67 degree F.

1.7 TERMINAL UNIT OPERATING SEQUENCE (convectors)

A. Hydronic Convectors or Radiators:
1. General
   a. Perimeter spaces with no forced mechanical air conditioning will have hot water convectors or radiators for space heating. Each zone will have a modulating two-way hot water control valve.
2. Temperature Control – Normal Operation

a. A wall mounted thermostat shall be provided for each zone. Each thermostat shall have a display with temperature and setpoint. The occupant shall be able to adjust the setpoint +/- 3ºF. The thermostat shall also have a button for unoccupied override. The zone setpoint shall be adjustable through the BMS. The BMS shall control the hot water valve to the baseboard heaters. When the zone temperature falls below the setpoint, the control valve shall modulate open. When zone temperature is above set point, the control valve will modulate closed. When the outside air temperature is greater than 78ºF (adj.) the hot water control valves shall be commanded closed.

3. Night Setback
   a. During unoccupied hours the temperature setpoint shall be 55ºF (adj) for the assembly hall.
   b. During unoccupied hours the temperature setpoint shall be 65ºF (adj) for all other spaces.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Aboveground Hydronic Pipe and Pipe Fittings
   1. Heating hot water supply and return
   2. Equipment drains

B. Valves

1.2 RELATED WORK

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 48- Vibration Isolation and Seismic Restraints

C. Section 23 07 00 - Mechanical Insulation

D. Section 23 21 14 - Hydronic Specialties

1.3 REFERENCES

A. ANSI/ASME Section 9 - Welding and Brazing Qualifications

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Classes 150 and 300

C. ANSI/ASME B16.29 - Wrought Copper Fittings

D. ANSI/AWS D1.1 - Structural Welding Code

E. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated Welded and Seamless, for Ordinary Uses

F. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses

G. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

H. ASTM B88 - Seamless Copper Water Tube

I. ASTM D1785, D2467 - PVC Pipe and Fittings

1.4 QUALITY ASSURANCE

A. All pipe shall be manufactured in the United States of America.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Conform to ANSI/ASME Section 9.

D. Welders Certification: In accordance with ANSI/ASME Section 9.

1.5 SUBMITTALS

A. Product data on all products and materials of this section shall be submitted in accordance with Special Conditions and Section 23 05 00.

PART 2 - PRODUCTS

2.1 ABOVEGROUND HEATING HOT WATER PIPING

A. STEEL PIPE
1. ASTM A53 or A120, Schedule 40, black, plain end.
2. Fittings: ANSI/ASTM B16.3, malleable iron Class 150, or ASTM A234, forged steel Class 125.
3. Joints: Screwed, or ANSI/AWS D1.1, welded.
4. Mechanical Pipe Coupling System
   a. Grooved pipe with mechanical couplings may be used with schedule 40 black steel pipe in systems where circulating water does not exceed 200^{o} F. Do not use in anti-freeze protected water or steam systems.
   b. Grooved pipe coupling system shall be manufactured by Victaulic or approved equal.
   c. Couplings shall be self-centering and shall engage and lock in place the grooved or shouldered ends of pipe and pipe fittings in a positive watertight couplings. Couplings shall be designed to permit some angular pipe deflection, contraction, and expansion. Coupling clamp shall be ductile iron conforming to ASTM A536, Grade 65-45-12. Gasket shall be molded rubber conforming to ASTM D2000, the "line call-out" number shall be suitable for a water temperature of 230^{o} F. Coupling nuts and bolts shall be steel conforming to ASTM A183. Fittings shall be grooved malleable iron conforming to ASTM A47, Grade 32510 or ductile iron conforming to ASTM A536, Grade 65-45-12 or malleable iron conforming to ASTM A47, Grade 32510. Mechanical couplings and fittings shall be of the same manufacturer. Before assembling couplings, coat pipe ends and outsides of gaskets with lubricant approved by the coupling manufacturer to facilitate installation.

2.2 JOINING MATERIALS

A. Refer to individual specification sections for special joining materials not listed below.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

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

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

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

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.4 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-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face or ring type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure, where required to suit system pressures.

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

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

2.5 FLANGES, UNIONS, AND COUPLINGS FOR STEEL PIPE

A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded piping.

B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges.

C. Dielectric Connections: 2 Inch and Below - Union with galvanized or plate steel threaded end, copper solder end, or any other dissimilar pipe materials, water impervious isolation barrier. Over 2 Inch - Dielectric isolation flange.

2.6 ACCEPTABLE MANUFACTURERS – VALVES

A. Milwaukee

B. Stockham

C. Nibco

2.7 GATE VALVES

A. Up to 2 Inches: Bronze body, bronze trim, union bonnet, rising stem, handwheel, inside screw, solid wedge or disc, threaded ends. Minimum safe working pressure rating shall be 125 psig. Equal to Milwaukee 1151.

B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, solid wedge, flanged ends. Minimum safe working pressure rating shall be 125 psig. Equal to Milwaukee F-2885-M.

2.8 GLOBE VALVES

A. 2 Inch and Smaller: 150 LB Bronze body and trim, union bonnet, rising stem and handwheel, renewable Buna-N disc, threaded or sweat ends, gland packed, packable under pressure. Equal to Milwaukee 590S (threaded) or 1590S (sweat).

B. 2-1/2 Inch and Greater: 125 LB Iron body, bronze trim, replaceable bronze disc, bolted bonnet, gland packed, flanged ends. Equal to Milwaukee F2981.

2.9 BALL VALVES

A. Up to 1-1/2 Inches: Bronze one piece body, stainless steel ball and shaft, teflon seats and stuffing box ring, lever handle, solder or threaded ends. Class 125, minimum safe working pressure rating shall be 125 psig. Equal to Milwaukee BA-100-S (threaded) or BA-150-S (sweat).

2.10 SWING CHECK VALVES

A. Up to 2 Inches: Bronze or iron body, 45 degree swing disc, screwed ends. Minimum gage working pressure rating shall be 125 psig. Equal to Milwaukee fig 508.

B. Over 2 Inches: Iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends. Minimum safe working pressure rating shall be 125 psig. Equal to Milwaukee F-2974-M.

2.11 DRAIN VALVES

A. Equal to Milwaukee fig. BA-150-H (sweat) or Milwaukee fig. BA-100-H (threaded) with 3/4-inch hose connection.

2.12 BUTTERFLY VALVES

A. 200 psi Iron body, stainless steel disc, minus 30 degrees F to 275 degrees F EPT replaceable liner, wafer or lug mounting. A 10-Position locking lever handle for 3" and under, worm gear drive for sizes greater than 3 inches. Equal to Milwaukee "M" series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipe drawings are diagrammatic and indicate general location and connections. Piping may have to be offset, lowered, or raised as required or directed at the site. This does not relieve this Division from responsibility for proper erection of piping systems in every respect.

B. All piping shall be run concealed throughout finished spaces either in furred spaces, shafts, chases, basements, under floor slabs or above ceilings. Piping buried below grade or below concrete slabs shall be run in PVC electrical conduit.

C. Joints
   1. Joints above grade in copper pipe shall be soldered with 95/5 tin-antimony solder using non-corrosive flux. Joints in type K copper below grade shall not be permitted.
   2. Joints in steel pipe of all sizes may be made by welding or by flanges. Screwed joints may be made in steel pipe less than 4 inches in diameter. Screwed Joints shall be made with Teflon tape, Teflon liquid or other approved non-hardening joint compound applied to male threads only.
   3. Cut piping accurately for fabrication to measurements established at site and work into place without springing or forcing.
   4. Remove burr and cutting slag from pipes.
   5. Make changes in direction with proper fittings.
   6. Do not use reducing bushings, street elbows, or close nipples.

D. Arrange piping not to interfere with removal of other equipment, ducts, or devices, or block access to doors, windows, or access openings. Provide accessible, ground joint unions in piping at connections to equipment.

E. Make provision for expansion and contraction of piping systems without placing undue strain on pipes, fittings, valves, and equipment. Piping shall be properly pitched and drain valves provided at low points to ensure ability to completely drain system. Manual air vents shall be provided at high points of piping to allow complete air purging. These details are to be provided whether or not they are shown on the drawings.

F. Provide standard steel or wrought iron sleeves wherever pipes pass through masonry walls or partitions. Provide sleeves at all locations where pipes pass through partitions or floors. Sleeves shall be sized two sizes over pipe size to facilitate proper firestopping.

G. Make offsets, transitions, and changes in direction of pipes, ducts, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on drawings. Furnish and install traps, air vents, sanitary vents, pull boxes, etc., as required to affect these offsets, transitions, and changes in direction.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with surface finish to insure neat, clean appearance.

J. Install valves with stems upright or horizontal, not inverted.

K. Labeling: Label piping in accordance with specification section 23 05 53.

3.2 APPLICATION

A. Install dielectric unions or flanges where joining dissimilar materials.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

D. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers. Ball valves may be used in sizes 1-1/4 inches and smaller.

E. Install ball, globe, or butterfly valves for throttling, bypass, or manual flow control services.

F. Provide 3/4 inch gate drain valves at main shut-off valves, low points of piping, bases of vertical risers, at equipment, and as otherwise indicated.

G. Use butterfly valves in chilled water systems (but not hot water or glycol) interchangeably with gate and globe valves in pipe sizes 2-1/2 inch and larger. Do not use a butterfly valve to terminate piping dead ends unless a blank-off plate is also provided.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Finished Space:
         1) Bare Piping with Fitting or Sleeve Protruding from Wall: One piece, deep-pattern type with polished chrome-plated finish.
         2) Insulated Piping: One piece, stamped-steel type with spring clips with polished chrome-plated finish.
      b. Unfinished Space:
         1) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass type with rough brass finish.
         2) Insulated Piping: One piece, stamped-steel type with spring clips with polished rough brass finish.

M. Sleeves are not required for core-drilled holes.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

O. Refer to equipment specifications in other sections of these Specifications for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 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. Install dielectric coupling, nipple, unions, or flanges to connect piping materials of dissimilar metals.

3.6 FIELD QUALITY CONTROL

A. All piping systems shall be hydrostatically tested to 3 times operating pressure or as required by the authority having jurisdiction (AHJ) and proven leak free prior to insulating. Leaking pipe, joints, or fittings shall be removed, replaced and retested. System components and equipment subject to damage from pressure testing shall be isolated by valves or removed prior to leak testing.

3.7 CLEANING

A. All control valves shall be locked into a wide open position and all strainer baskets, with the exception of the air separator strainer, shall be removed during cleaning and flushing. Remove and clean air separator strainer after final flushing.

B. Flush all piping with cold water to remove chips and scale, repeating this step until no trace of contamination is found.

C. Next fill all heating piping with a 2 percent solution of trisodium phosphate and water, and bring to a temperature of 200 degrees F. To determine quantity of trisodium phosphate to be

provided, Contractor shall determine volume of system by filling system through a meter (provided by Contractor).

D. Circulate hot water through all piping and heating elements for 2 hours, then completely drain while still hot. Repeat this step until no sign of oil or sediment is found.

E. Charge system with water and inhibitor solution. Coordinate with owners water treatment contractor.

END OF SECTION 232113

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Expansion tanks.

B. Air vents.

C. Air separators.

D. Strainers.

E. Combination pump discharge valves (triple duty valves).

F. Relief valves.

G. Balance valves.

H. Pump suction fittings.

I. Filter Feeder.

1.2 RELATED WORK

A. Section 23 21 13 - Hydronic Piping.

1.3 REFERENCES

A. ANSI/ASME - Boilers and Pressure Vessels Code.

1.4 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.5 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.6 SUBMITTALS

A. Product data.

B. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model, and dimensions.

C. Submit operation and maintenance data.

D. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - HYDRONIC SPECIALTIES

A. Bell and Gossett

B. Taco

C. Armstrong

2.2 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with Section 8D of ANSI/ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

B. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psig.

2.3 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

B. Float Type: Brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.4 AIR SEPARATORS

A. Combination Air Separators/Strainers: Steel, tested and stamped in accordance with Section 8D of ANSI/ASME Code, for 125 psig operating pressure, with stainless steel integral strainer with 3/16 inch perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.5 STRAINERS

A. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inches to 4-inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

C. Size 5 inches and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8-inch stainless steel perforated screen.

D. Equip all strainers with 1/2-inch ball valve and hose bib for blowdown.

2.6 COMBINATION PUMP DISCHARGE VALVES (TRIPLE DUTY VALVES)

A. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.7 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled. Provide capacity as scheduled, indicated or corresponding to the required relief valve capacity of the equipment served.

2.8 BALANCE VALVES (4 Inches and Smaller)

A. Calibrated, balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.

2.9 BALANCE VALVES (greater than 4")

A. Balancing valves, where indicated in piping larger than 4 inches, shall consist of a combination of a butterfly valve for throttling and an orifice type flow meter. Where means of throttling already exists, such as combination valves at pump outlets, omit the butterfly valve.

B. Cast iron, wafer type, orifice insert flow meter for 250 psig working pressure, with read-out valves equipped with integral check valves with gasketed caps.

C. Portable meter consisting of case containing one, 3 percent accuracy pressure gage with 0 to 60 feet pressure range two, 3 percent accuracy pressure gages with 0-135 inches and 0-60 feet pressure ranges for 125 psig maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

2.10 PUMP SUCTION FITTINGS

A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

B. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Support tanks inside building from building structure in accordance with manufacturer's instructions.

C. Where large air quantities can accumulate, provide enlarged air collection standpipes.

D. Provide manual air vents at system high points, and as indicated.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide valved drain and hose connection on strainer blowdown connection.

G. Provide combination pump discharge valve on discharge side of pump.

H. Provide balancing valves on water outlet from terminal heating units.

I. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

J. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity not to exceed rating of connected equipment.

K. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.

L. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

M. Support pump suction fittings with floor mounted pipe and flange supports.

END OF SECTION 232114

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the following:
   1. Separately coupled, horizontal, in-line centrifugal pumps.
   2. Separately coupled, base-mounted, end-suction centrifugal pumps.
   3. Cartridge style, wet rotor, single stage, in-line circulator.
   4. Cartridge style, domestic hot water recirculation pump.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Provide one (1) year warranty coverage for each pump as manufactured and delivered to the site, including labor and materials, from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Furnish on-site service and maintenance of pumps including parts and labor for 1 year starting at the date of Substantial Completion. Submit service contract for approval by Owner and Engineer.

1. Ensure all pumps continue to function properly over the period.
2. Check operation on site of all pumps at the end of one year of operation and again at two years.
3. Respond to and repair failure or trouble on critical systems within 4 hours. This would include anything which could potentially cause significant occupant discomfort, property loss such as pipe freezing, or damage to equipment, or cause school not to open or close early.
4. Failure to respond within time shall be grounds for Owner to engage another firm with costs paid by Contractor.
5. Provide 1-800 or toll free access for tech support.

B. Provide complete service of pump systems, including call backs. Make minimum of two complete normal inspections of approximately 4 hours duration, in addition to normal service calls to inspect, debug and repair as required for proper operation, and submit written reports.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each type/size of pump.

PART 2 - PRODUCTS

2.1 BASE MOUNTED FLEX COUPLED PUMPS

A. Manufacturers:

1. Taco, Inc.
2. Armstrong Pumps Inc.
3. Bell & Gossett; Div. of ITT Industries.

B. Pumps shall be Taco Model FI or approved equal. The pumps shall be single stage end suction rear pull out design. The bearings and seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.

C. Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.

D. All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow servicing.

E. Pump volute shall be foot mounted. Overhung cantilevered design not allowable.

F. The pump shall be center line discharge for both positive air venting and allowance for better load distribution.

G. The pump casing inlet shall have an integrally cast anti-rotational vane.

H. The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.

I. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.

J. The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250ºF. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. Any pump used on an open system shall be furnished with a seal flush line and a Cuno / Kynar / Purocell #900 replaceable cartridge filter or separator with shut-off isolation valve installed in the seal flushing line. The filter shall have the ability to remove particles down to five microns in size. The entire pump line shall use no more than three different sizes of seals.

K. All pumps to be provided with a fully welded, rigid structural steel base. The base shall include closed ends and top openings to allow for grouting. The base shall include an integral drain pan fabricated from steel with a minimum thickness of 0.1875” and shall contain an integral ¾” drain connection.

L. The pump bearing frame shall incorporate maintenance free permanently lubricated and sealed bearings with an L10 life of 60,000 hours. Bearing frame shall be equipped with Forsheda seals to protect bearings from moisture and airborne contaminants. The entire line of pumps shall use no more than four different sizes of bearing frames.

M. The pump shall be flexibly coupled to a NEMA standard T frame motor. The coupler shall be suitable for across the line starting as well as variable speed conditions associated with variable frequency drives. The coupling shall be equal to a Woods Dura-Flex coupler. Any pump manufacturer providing a mechanically inferior coupler design, especially in variable torque applications, shall extend the warranty of the coupler for an additional two years in addition to their own standard warranty. The coupling and shafts shall be covered by a metal guard. Pump shall be aligned upon receipt at job, during installation, and after system fill by contractor.

2.2 WET ROTOR INLINE PUMPS

A. Manufacturers:

1. Taco, Inc.
2. Armstrong Pumps Inc.
3. Bell & Gossett; Div. of ITT Industries.

B. Provide wet rotor circulating pumps for chilled water and hot water heating systems with performance as scheduled or otherwise indicated on the drawings.

C. The pumps shall be of the horizontal system lubricated type, specifically designed for quiet operation. Suitable for 230 DEG F operation at 125 psig working pressure.

D. The pumps shall have a ceramic shaft supported by carbon bearings. Bearings are to be lubricated by the circulating fluid. Pump shaft shall connect to a non-metallic polypropylene impeller.

E. Pump volute shall be of cast iron design for heating systems or cast "lead free" bronze for domestic water systems. The connection style on cast iron pumps shall be flanged and on bronze body pumps should be of either sweat, flanged, or union design, as noted on schedule.

F. The motor stators shall be isolated from circulating fluid through use of stainless steel stator can. Rotor to be sheathed in stainless steel.

G. Motors shall be non-overloading at any point on the pump curve. Motors to have built in impedance protection and shall be UL and CSA listed.

H. Pump shall be of a maintenance free design and be capable of operating in variable speed (varying voltage) applications.

2.3 SEPARATELY COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Taco, Inc.
2. Armstrong Pumps Inc.
3. Bell & Gossett; Div. of ITT Industries.

B. Description: Factory assembled and tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Shaft Coupling: Molded rubber insert with interlocking spider capable of absorbing vibration.

E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

F. Capacities and Characteristics are scheduled and shown on the drawings.

2.4 CARTRIDGE STYLE, SINGLE STAGE, IN-LINE CIRCULATOR PUMP

A. Manufacturers:

1. Taco, Inc.
2. Armstrong Pumps Inc.
3. Bell & Gossett; Div. of ITT Industries.

B. Description: Taco Model 007 Cartridge Circulator, self-lubricating, designed for installation with pump and motor shafts mounted horizontally or vertically. Minimum fluid temperature of 40 F, maximum fluid temperature of 230 F. Max working pressure of 125 psi.

C. Pump Construction:

1. Casing: Cast iron
2. Stator Housing: Steel
3. Cartridge: Stainless Steel
4. Impeller: Non-metallic
5. Pump Shaft: Ceramic
6. Pump Bearings: Carbon
7. O-Ring and Gaskets: EPDM

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and resiliently mounted to pump casing. Permanent split capacitor, impedance protected. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Capacities are scheduled and shown on the drawings.

2.5 DOMESTIC HOT WATER RECIRCULATION PUMP

A. Manufacturers:

1. Taco, Inc.
2. Armstrong Pumps Inc.
3. Bell & Gossett; Div. of ITT Industries.

B. Description: Taco SmartPlus hot water recirculation, self-lubricating; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Bronze, sweat
2. Cartridge: Stainless steel.
3. Impeller: Noryl.
4. Pump Shaft: Ceramic.
5. Pump Bearings: Carbon.
6. O-Ring: EPDM

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Capacities are scheduled and shown on the drawings.

2.6 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

F. All pumps shall be fitted with a discharge multi-purpose balancing valve or other means of providing system balance, isolation, and check feature for reverse flow. The valve shall be straight or angle pattern and shall be field convertible between the two. The valve shall be ductile iron and rated for 250 psi working pressure for all jobs. The valve flanges shall be matched to suit the working pressure of the piping components on the job; with either ANSI class 125 flanges or ANSI class 250 flanges. The valve shall include the following components; non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation. Valve shall be serviceable under full system pressure. The valve shall be a Taco model MPV Plus Two multi-purpose valve or equivalent.

G. All pump suctions to be fitted with a multifunction inlet suction diffuser equal to that as manufactured by Taco, Inc. The suction diffuser body and cover plate shall be ductile iron and be rated for 250 psi for all jobs. The guide flanges shall be matched to suit the working pressure of the piping components on the job; with either ANSI class 125 flanges or ANSI class 250 flanges. The suction guide shall include the following components; full length S.S. straightening vanes, permanent S.S. strainer, disposable 16 mesh bronze start up strainer, blow down ports, and metering ports. For those pumps where an inlet guide fitting is not installed, there should be five pipe diameters of straight undisturbed flow going into the pump suction. The fitting shall be a Taco model SD inlet suction elbow or equivalent.

H. All pumps shall be fitted with one 4 ½" dial pressure gauge piped to the inlet and outlet pump flanges. The gauge is to be isolated from each flange via ¼" ball valve. This gauge is to be used to take the differential across the pump unless otherwise indicated.

I. Contractor shall install pump in accordance with the manufacturer's instructions. All base mounted pumps to be aligned upon receipt at jobsite, during installation, and after system fill. Contractor shall level and grout each pump according to the manufacturer recommendations to insure proper alignment prior to operation.

J. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.

K. Pumps shall NOT be run dry to check rotation.

L. Change start-up strainers to permanent strainer upon acceptance of the job. Provide a blowdown valve on each strainer and terminate with hose thread or extend blowdown line to nearest floor drain.

3.3 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Provide laser alignment & adjustment of pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. Provide laser alignment & adjustment.

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

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

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

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps. (Base mounted pumps only)

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 232123

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure using same refrigerant as used in the system.

B. Suction Lines for Air-Conditioning Applications: 185 psig.

C. Suction Lines for Heat-Pump Applications: 325 psig.

D. Hot-Gas and Liquid Lines: 325 psig.

1.4 RELATED WORK

A. Section 230500 – Common Work Results for HVAC

B. Section 230548- Vibration Isolation and Seismic Restraints

C. Section 230700 - Mechanical Insulation

D. Section 238126 – Variable Refrigerant Flow Mini-Split Air Conditioner System

1.5 1.5 QUALITY ASSURANCE

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

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

B. Thermostatic expansion valves.

C. Solenoid valves.

D. Hot-gas bypass valves.

E. Filter dryers.

F. Strainers.

G. Pressure-regulating valves.

H. Flow Control Valves.

I. Shop Drawings: Installing Contractor shall prepare and submit refrigerant piping shop drawing indicating the layout, specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment. Shop Drawing Scale: 1/4 inch equals 1 foot.

J. Refrigerant piping indicated on contract documents is schematic only. Installing contractor shall field verify size, actual piping layout, oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

K. Field quality-control test reports.

L. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L or ASTM B 280, Type ACR. Wrought-Copper Fittings: ASME B16.22.

B. Brazing Filler Metals: AWS A5.8. – Brazing is the only acceptable tube joining method for R-410 A systems.

2.2 VALVES AND SPECIALTIES

A. Service Valves: Body: Forged brass with brass cap including key end to remove core. Removable ball-type check valve with stainless-steel spring. Seat Polytetrafluoroethylene. End Connections: Copper spring. Working Pressure Rating: 500 psig.

B. Moisture/Liquid Indicators: Forged brass with replaceable clear fused glass window with indicating element protected by filter screen. Color coded to show moisture content in ppm. Indicate moisture above 60 ppm. End Connections: Socket or flare. Working Pressure Rating: 500 psig. Maximum Operating Temperature: 240 deg F.

C. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement. Maximum Pressure Loss: 2 psig. Working Pressure Rating: 500 psig. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

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

B. Atofina Chemicals, Inc.

C. DuPont Company; Fluorochemicals Div.

D. Genetron Refrigerants.

E. INEOS Fluor Americas LLC.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Steel may not be used for refrigerant piping service.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install moisture/liquid indicators in liquid line at the outlet of the condensing unit

C. Install filter dryers in liquid line outlet of the condensing unit.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or

panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install pipe sleeves at penetrations in exterior walls and floor assemblies. Insulation shall pass through penetration.

Q. Seal penetrations through exterior walls, fire and smoke barriers with firestop caulk.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

T. Seal pipe penetrations through exterior walls with weatherproof UV resistant silicone caulk.

U. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

D. Support multi-floor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Verify that compressor oil level is correct.
   2. Open compressor suction and discharge valves.
   3. Open refrigerant valves except bypass valves that are used for other purposes.
   4. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

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PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sealants and gaskets.
3. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 Performance Requirements

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 Submittals

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

1. Liners and adhesives.
2. Sealants and gaskets.

B. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Sprinklers.

C. Welding certificates.

D. Field quality-control reports.

1.5 Quality Assurance

A. Welding Qualifications: Qualify procedures and personnel according to the following:

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 Single-Wall Rectangular Ducts And Fittings

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal

Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 Sealant and Gaskets

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.3 Hangers and Supports

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 Duct Installation

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 Duct Sealing

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
3. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 Hanger and Support Installation

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size."

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 Connections

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 Field Quality Control

A. Perform tests and inspections.

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Test for leaks before applying external insulation.
3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
4. Give seven days' advance notice for testing.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 Duct Cleaning

A. Clean new duct system(s) before testing, adjusting, and balancing.

3.7 Start Up

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 Duct Schedule

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Ducts Connected to Constant-Volume Air-Handling Units:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.

2. Ducts Connected to Variable-Air-Volume Air-Handling Units:

   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 3.

B. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.

C. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm:

      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

END OF SECTION 233113

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PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
1. Manual volume dampers.
2. Flange connectors.
3. Turning vanes.
4. Flexible connectors.
5. Flexible ducts.
6. Duct accessory hardware.

B. Related Requirements:
1. Section 233423 “HVAC Power Ventilators”.
2. Section 235100 “Breechings, Chimneys, and Stacks”.

1.3 Submittals

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 Assembly Description

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 Materials

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 Manual Volume Dampers

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. McGill AirFlow LLC.
   c. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.

7. Bearings:

    a. Oil-impregnated stainless-steel sleeve.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

2.4 Flange Connectors

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

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.5 Turning Vanes

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

1. Ductmate Industries, Inc.
2. METALAIRE, Inc.
3. SEMCO Incorporated.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.6 Flexible Connectors

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.7 Flexible Ducts

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F

C. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

D. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

E. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; [polyethylene] [aluminized] vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

F. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.8 Duct Accessory Hardware

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 Installation

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install flexible connectors to connect ducts to equipment.

G. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

H. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

I. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.

J. Install duct test holes where required for testing and balancing purposes.

3.2 Field Quality Control

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Registers and grilles.

B. Related Sections:
   1. Section 233300 "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

A. Adjustable Bar Register:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. METALAIRE, Inc.
      b. Price Industries.
      c. Titus.

   2. Material: Steel.
   3. Finish: Baked enamel, color selected by Contractor.
   4. Face Blade Arrangement: Horizontal spaced 1-1/2 inches apart.
   5. Core Construction: Integral.
   6. Rear-Blade Arrangement: Horizontal 1/2 inch apart.
   7. Frame: 1-1/4 inches wide.
   8. Mounting Frame: Filter.

9. Mounting: Countersunk screw.
10. Damper Type: Adjustable opposed blade.
11. Accessories:

    a. Front-blade gang operator.
    b. Filter.

B. Adjustable Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. METALAIRE, Inc.
    b. Nailor Industries Inc.
    c. Price Industries.
    d. Titus.

2. Material: Steel.
3. Finish: [Baked enamel, white] [Baked enamel, color selected by Architect] <Insert finish>.
4. Face Blade Arrangement: [Horizontal] [Vertical] spaced [3 inches (76 mm)] [1-1/2 inches (38 mm)] [3/4 inch (19 mm)] [1/2 inch (13 mm)] apart.
5. Core Construction: [Integral] [Removable].
6. Rear-Blade Arrangement: [Horizontal] [Vertical] spaced [3/4 inch (19 mm)] [1/2 inch (13 mm)] apart.
7. Frame: [1-1/4 inches (32 mm)] [1 inch (25 mm)] wide.
8. Mounting Frame: [Filter] <Insert frame size and style>.
9. Mounting: [Countersunk screw] [Concealed] [Lay in].

C. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Nailor Industries Inc.
    b. Price Industries.
    c. Titus.

2. Material: Steel.
3. Finish: Baked enamel, color selected by Contractor.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Filter.
8. Mounting: Countersunk screw.
9. Accessory: Filter.

D. Linear Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Nailor Industries Inc.
   b. Price Industries.
   c. Titus.

2. Material: Steel.
3. Finish: Baked enamel, color selected by Contractor.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Distribution plenum.

   a. Internal insulation.
   b. Inlet damper.

6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Filter.
8. Mounting: Countersunk screw.
9. Damper Type: Adjustable opposed blade.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels,

locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

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

END OF SECTION 233713

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Venting for the removal of products of combustion for Category II, III, IV gas burning appliances.

1.2 SUBMITTALS

A. Product Data.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

1.3 REFERENCES

A. Underwriters Laboratories (UL):
   1. UL1738

B. National Fire Protection Association (NFPA):
   2. NFPA 54 - National Fuel Gas Code
   3. NFPA 211 – Standard for Chimneys, fireplaces, Vents, and Solid Fuel-Burning Appliances.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 54

B. Must install duct in accordance to manufacturer's listings and installation instructions.

C. Components coming in contact with the products of combustion shall carry the appropriate UL or cUL listing, mark or label.

1.5 WARRANTY

A. Condensing Appliance vent listed to UL1738 shall have a limited lifetime warranty to begin at the date of installation. Any portion of the vent repaired or replaced under warranty shall be warranted for the remainder of the original warranty period.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. Listed Double-Wall vent for condensing appliances, Model “FCS” as manufactured by Metal-Fab, Inc.

B. Van-Packer

C. Selkirk

2.2 LISTED VENTING FOR CONDENSING APPLIANCES

A. The condensing appliance vent shall be double-wall for use with Category II natural draft appliances and Category III or IV positive pressure appliances.

B. Maximum temperature shall not exceed 550˚ F (288˚ C).

C. Vent shall be listed for an internal static pressure of 6 inch w.g. and tested to 15 inch w.g. for diameters 6 inch - 36 inch.

D. Vent shall be constructed of AL29-4C material tested to UL1738, .015 thickness for 6 inch - 12 inch diameters, .024 thickness for 14 inch to 24 inch diameters with 1-1/2” long internal sleeve on one end with 1/2” flanges on both ends.

E. Outer casing shall be constructed of aluminized steel of .018 inch thickness for 6 inch to 12 inch diameters, .024 inch thickness for 14 inch to 24 inch diameters.

PART 3 EXECUTION

3.1 STORAGE AND CONSTRUCTION

A. Protect materials from accidental damage.

B. All supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be included.

C. Joint assembly utilizes flange & 1-1/2” long internal sleeve connection for diameters 6 inch –24 inch. P070 sealant will be used on the flange surface. Flanges are joined with a vee band secured by tightening draw bolts.

D. Where exposed to weather, the outer closure band shall be sealed to prevent moisture from entering the space between the walls.

E. Vent shall terminate in accordance with installation instructions and local codes.

F. Installation shall conform to manufacturers installation instructions.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers, trim, and accessories for generating hot water.

1.3 SUBMITTALS

A. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. Design calculations and seismic restraint details, signed and sealed by a qualified professional engineer per Section 23 05 48 “Vibration and Seismic Controls for HVAC piping and equipment”.
      a. Design Calculations: Calculate requirements for selecting seismic restraints and for designing determination of housekeeping pad sizes.
      b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at standard and IBR conditions.
   2. Minimum/maximum water flow rates.
   3. Input gas capacity and max/min inlet gas pressure.
   4. Minimum entering water temperature.
   5. Assembled unit dimensions.
   6. Weight and load distribution.
   7. Required clearances for maintenance and operation.
   8. Size and location of piping and wiring connections.
   9. Wiring Diagrams: For power, signal, and control wiring.
   10. Equipment Support Requirements.
   11. Piping roughing-in requirements.
   12. Vent & combustion air roughing-in requirements.
   13. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   14. Access requirements, including working clearances for mechanical controls and electrical equipment, and service clearances.

15. Documentation of controls including any and all interface coordination items with building wide temperature control system.

C. Operation and Maintenance Data as part of the close-out submittal: For each boiler to include in operation, and maintenance manuals.

D. Warranty: Sample of warranty.

E. Field quality-control test reports.

F. Other Informational Submittals:
1. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. Startup service reports.

1.4 QUALITY ASSURANCE

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

B. American Society of Mechanical Engineers (ASME) Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code. Provide boiler controls and safety devices in accordance with ASME CSD Section I.

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. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.

F. 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.

1.5 COORDINATION

A. Coordinate size and location of concrete bases or supports with actual equipment provided. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are the responsibility of this division.

B. Coordinate boiler venting and outside air requirements with the requirements of Section 23 51 00 “Breechings, Chimneys and Stacks”.

C. Coordinate sizes and locations of equipment supports, and penetrations with actual equipment provided.

D. Coordinate boiler controls and make accommodations required to facilitate interfacing with building wide temperature control system. Conduct temperature controls coordination meeting prior to preparation and submission of equipment product data to engineer.

1.6 WARRANTY

A. Provide warranty for complete boiler unit starting from the date of substantial completion with the following terms:

1. Entire Unit: One year for complete boiler including defects in material and workmanship.
2. Heat exchanger warranty: ten years standard, twenty years for thermal shock.
3. Burner warranty: Five years standard.

1.7 MAINTENANCE

A. Contractor to include service and maintenance of boilers by a factory-authorized service representative for period of one (1) year from Date of Substantial Completion.

B. Ensure all boilers continue to function properly over the period.

C. Respond to and repair failure or trouble on critical systems within 4 hours. This would include anything which could potentially cause significant occupant discomfort, property loss such as pipe freezing, or damage to equipment, or cause school not to open or close early.

1. Failure to respond within time shall be grounds for Owner to engage another firm with costs paid by Contractor.
2. Provide 1-800 or toll free access for tech support.

D. Provide complete service of boilers, including call backs. Make minimum of two complete normal inspections of approximately 4 hours duration, in addition to normal service calls to inspect, debug and repair as required for proper operation, and submit written reports.

1.8 DELIVERY, STORAGE AND HANDLING

A. Store boilers with factory shipping packaging in a dry location protected from the outdoor elements including extreme heat and cold.

B. Protect boilers from damage during transit, delivery, storage and during entire construction period.

C. Installing contractor is responsible for any and all damage to equipment.

D. Do not deliver equipment until interior building work is suitably complete and ready to accept the equipment without compromising any storage or protection requirements of this specification and the manufacturers warrantee.

PART 2 - PRODUCTS

2.1 CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by:
   1. Camus - DynaForce

B. Substitutions for Cause: Submit requests for substitution in writing immediately on discovery of need for change.
   1. Manufacturers: Subject to compliance with requirements, the following substitutions may be considered:
      a. Viessmann
      b. Benchmark - Aerco
   2. Conditions: Engineer will consider Contractor's request for substitution when all of the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution has a significant advantage in delivery time or price.
      b. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      c. Substitution request is fully documented and properly submitted.
      d. Requested substitution will not adversely affect Contractor's construction schedule.
      e. Requested substitution has received necessary approvals of authorities having jurisdiction.
      f. Requested substitution is compatible with other portions of the Work.
      g. Requested substitution has been coordinated with other portions of the Work.
      h. Requested substitution provides specified warranty.

C. Substitutions for Convenience: Not allowed.

D. Factory Testing: The complete boiler shall be factory fire tested by the manufacturer and a copy of the fire test report shall be supplied with the unit.

E. Heat Exchangers: Heat exchangers shall be constructed in accordance with Section IV of the ASME code.

F. Contractor shall provide a high-performance, modulating, compact natural gas condensing boiler capable of achieving ultra-high efficiency levels at thermal and electrical performance as scheduled or otherwise indicated on the drawings.

G. Each boiler shall be capable of modulating down to 20% of the input to ensures that when the demand for heat is low the efficiency is maintained.

H. The boiler shall meet the requirements of ANSI Z21.13, and CSA 4.9. The heating boiler shall be vented as a Category II or IV condensing appliance.

I. Each boiler shall be capable of handling a minimum return water temperature of 40 deg F without any concern of thermal shock or damage to the heat exchanger. Boiler design shall be such that the thermal efficiency increases as the boiler firing rate decreases.

J. Combustion Chamber: The combustion chamber shall be all welded stainless steel construction with an all welded vertical cylindrical stainless steel counter-flow design consisting of an upper burner section for primary heat transfer and a lower section for extracting latent heat from flue gases. Stainless steel access heat exchanger wraps shall be provided for ease of service and inspection of the external heat exchanger and an easily removable radial fired knitted fiber stainless steel burner to access the internal combustion chamber for inspection, service, and cleaning. A window view port shall be provided for visual inspection of the boiler combustion during firing. The boiler will be equipped with a non-sparking blower for venting the products of combustion

K. Heat Exchanger: The stainless steel heat exchanger shall be inspected and tested to ASME Section IV requirements and shall bear the seal of approval. The stainless steel heat exchanger shall be a 12 pass primary secondary design with a maximum working pressure of 160 psig. The heat exchanger shall be of 439 grade stainless steel welded construction with a vertical cylindrical counter-flow water tube design complete with integral 439 grade stainless steel finned heat transfer tubes and waterways. The heat exchanger design shall be capable of 40 deg F constant system return temperatures and have a fully condensing primary and secondary heat exchanger complete with condensate trap and drains.

L. Gas Train: Provide CSD-1 gas train consisting of a pressure regulating electro-hydraulic proportional air/gas main gas actuator providing a slow opening, fast closing shutoff valve and proportional 1:1 air/gas ratio control, a fast closing safety shutoff gas pressure regulator with 1 PSI allowable static pressure, a low gas pressure switch and a high gas pressure switch. A factory pre-set combination metering valve and orifice shall be provided for setting combustion parameters and operate with a 5:1 turndown ratio. Boiler shall be capable of operating at an inlet Natural Gas pressure of 7" WC (min) and deliver heat capacities as scheduled.

M. Burner/Combustion: The combustion chamber shall be of the sealed combustion type. The combustion air fan shall draw gas under negative pressure and mix it with air to generate a fine tuned air gas mixture which is delivered under positive pressure to the radial knitted stainless steel burner. Combustion modulation is established by either a pulse width modulation signal or by a variable frequency drive. The burner shall be a 100% stainless steel vertical mounted radial fired type with stainless knitted metal fiber construction. The burner shall combust a precise amount of premixed combustion air and gas to provide equal distribution of heat for heat transfer throughout the entire heat exchanger. Combustion products shall be exhausted under minimum back pressure. Combustion shall operate with a 5:1 turn down ratio while sustaining combustion characteristics throughout the entire modulating range. Operation of up to 99% thermal efficiency and shall be certified for Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.

N. Firing Mode: The burner combustion shall operate as proportional modulating with a 5:1 turndown ratio with a minimum 20% firing rate. Multiple boiler “Cascade” firing algorithms shall be available for proportional modulation. Light off shall be at no more than 50% input to assure rumble free soft start. Combustion shall be suitable for natural gas operation.

O. Ignition Module: The ignition module shall employ a direct igniter with 3 tries for ignition followed by lockout. Trial for ignition shall proceed with 15 seconds between retrials. Ignition control shall include times for prepurge, pre-ignition, ignition, and post purge.

P. External Jacket and Fasteners: The external jacket shall be of 430 stainless steel mirror finish panels and a powder paint coated access top cover assembled utilizing interference fit locks and minimal non-strip self tap screws for ease of removal and access to the heat exchanger and combustion air/gas control.

Q. Boiler shall be extremely quiet in operation and be provided with thermal and acoustic insulation.

R. Controls: Each boiler shall be provided with integral digital controller ensuring optimal condensing performance. Each Boiler shall be linked together (cascade system) and shall work jointly to match building heating load. Each individual boiler shall operate when the heating demand is high enough for an additional boiler in the cascade system to fire. The cascade system shall adapts to changed in heating demand due to seasonal temperature changes by allowing heat output to be precisely matched to heating demand.

S. Boiler shall come complete with operating controls and shall include a SOLA electronic proportional integrated combination ignition limit/operator control accurate to 10 deg F having a 4-20 mA output signal suitable for control of a variable frequency motor drive or a pulse width modulation signal output for modulating fan speeds. Controls shall be lead lag “Cascade” ready for control of up to eight boilers and shall include outdoor temperature reset.

T. Control Options: Control shall be supplied with a mounted touch screen mid level display which shall also provide for control system configuration and set up, readouts of boiler target,

differential and inlet/outlet temperatures as well as accumulated runtime, enunciator diagnostics, and firing rates. Optional "System" control display shall provide full diagnostics including real time data logging and support for up to eight (8) boilers in "Cascade" sequencing application, MODBUS ready. The complete control package shall be mounted on the front panel with a hinged door for easy access to all control modules. The boiler safety control string shall be furnished with controls for low gas pressure, optional high gas pressure, fan air proving, blocked flue, water pressure, high limit, stack limit and flow switch. A flow switch shall be provided loose. Additional control safeties shall include flue gas stack temperature, flame rectification, fan speed, and soft high limit.

U. Each boiler shall include adjustable operating temperature limit, adjustable manual reset safety high temperature limit, master switch, air flow switch, water flow switch, manual reset low water cutoff, combination pressure/temperature gauge, control system fuse, high temp switches for stack and inner cabinet, and single-point electrical hook-up with integral control circuit. The trim shall include an ASME pressure relief valve.

V. Each boiler shall be completely factory assembled, packaged and fire-tested, requiring only connection to the water circulating system, fuel, electric utilities and flue gas vent. Factory fire-test results and complete operating and maintenance instructions are to be furnished with the unit.

W. Boiler shall be installed and connected to an approved AL29-4C stainless steel venting system and components for draining condensate. Boiler shall be designed to operate under sealed combustion characteristics. Integral fan shall provide the means for pulling air and products of combustion across the heat exchanger, through the boiler flues and exhausting the flue gases into the vent system.

X. Boiler manufacturer shall provide BACnet interface for each boiler.

2.2 CONDENSATE NEUTRALIZING UNITS

A. When available contractor shall provide factory condensate neutralization kit (furnished by boiler manufacturer) for each boiler. Contractor shall install in accordance with manufacturer's recommendations and code.

B. If not available from equipment manufacturer contractor shall provide condensate neutralization units as separate units meeting code requirements. Provide condensate neutralization units for each boiler drain and all drains serving breeching, chimneys and stacks.

C. The condensate tubes shall be designed to raise the PH level 10–1,000 times more towards the neutral point of the PH being discharged by the boiler or furnace and be pre-filled with media such as limestone.

D. The neutralizer tube or tubes shall be as manufactured by JMM Boiler Works and sized as indicated below:

Model No.	MBH (input)	GPH	Dia. (in)
JM-2	200	2	2-3/4
JM-6	600	6	4
JM-10	1,000	10	4
JM-20	2,000	20	5
JM-30	3,000	30	5
JM-40	4,000	40	7-3/16
JM-50	5,000	50	7-3/16

E. The installing contractor shall supply all boilers/furnaces and vent condensate drains with "P-traps" and unions before the neutralizing tubes.

F. All piping for the first 2 ft from boiler or stack drain including "P-Trap" shall be stainless steel tube thereafter drain piping may be PVC. Plastic tubing is not an acceptable alternative and shall not be used at all.

G. The boiler and flue condensate drains shall not be combined into one neutralizer. All piping shall be per manufacturer's piping diagrams and directions. All neutralizing tubes shall be secured to the floor or wall so as not to be exposed to damage or within a normal walkway. The contactor shall fill all "P-traps" and neutralizing tubes with tap water before the firing of any boiler.

H. The contractor shall inform the owner of any maintenance or scheduled recharge of the tube's limestone aggregate as described in the manufacturer's manual.

2.3 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.

C. Burner and Hydrostatic Test: Factory shall perform hydrostatic test of boiler prior to shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for boiler supports, anchor bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Install boilers level using factory support frame or base.

B. Provide seismic snubber angles and housekeeping pad for floor mounted boilers.

C. Provide rubber bushings and seismic anchors for wall mounted boilers.

D. Install gas-fired boilers according to state and local codes.

E. Assemble and install all boiler trim, piping, controls furnished by boiler manufacturer.

F. Install electrical devices and controls furnished with boiler, but not specified to be factory mounted, including field wiring.

G. Follow boiler manufacturer's installation requirements including, but not limited to, the following:
   1. Flush the system with clean water.
   2. Isolate the boiler, fill the system with fresh water and a boiler cleaner, and run for 30 minutes to 1 hour. Under no circumstances may boiler cleaner be pumped through the boiler. Use only products approved by boiler manufacturer.
   3. Thoroughly flush the system with fresh water. Ensure all zones and loops are flushed. Empty out sediment traps.
   4. Fill the system with fresh water and the proper amount of inhibitor.
   5. Verify the pH is within the proper range as recommended by the boiler manufacturer.
   6. Add additional inhibitor if pH is not within the proper range.
   7. Contractor shall notify Owner to check pH annually as part of demonstration. Contractor shall include this in O&M manuals also.
   8. Use untreated water only to fill the system.
   9. Never introduce non-approved boiler treatment or similar additives.

H. Flow Rate: Do not exceed the maximum permissible flow rate through the boiler. Excessive flow can cause erosion damage to the heat exchanger.

I. Dielectric Isolation: Install Dielectric Unions at the boiler supply line and return nearest the boiler or the low loss header.

J. Cleaning Requirements: Before connecting the boiler to a new or existing heating system, clean and flush the system thoroughly. Ensure the system is free of sediment, flux and any residual boiler water additives.

K. Do not mix different manufacturer's products of cleaners or inhibitors. Consult boiler manufacturer's representative for recommendations.

3.3 CONNECTIONS

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

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

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

D. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to nearest floor drain.

F. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

G. Connect breeching to full size of boiler outlet. Comply with requirements of specifications, boiler manufacturer and breeching manufacturer requirements.

H. Power wiring shall be by Division 26.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports. Installing Contractor shall provide the services of a factory-trained service representative to provide the factory startup, initial boiler lightoff and one (1) year of follow-up service. This requirement shall not be waived, nor shall the responsibility for the Service Contract be assumed by any other party.

B. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

C. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply. Provide analysis equipment required to determine performance.

D. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

E. Document test results in a report and submit to Engineer and Owner for review and comment.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 235216

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Heating and ventilating air-handling units.

1.3 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Shop Drawings: Showing duct and connection details for each air-handling unit.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Comply with NFPA 70.

F. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

G. Units shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.7 1.06 Warranty

A. Manufacturer shall provide a limited “parts only” warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

1.8 COORDINATION

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

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. AAON.
   2. Carrier
   3. Trane; American Standard Inc.

B. Substitute equipment may be considered for approval that includes at a minimum:
   1. ECM driven direct drive backward curved plenum supply fans
   2. Double wall cabinet construction
   3. Insulation with a minimum R-value of 6.25
   4. Hinged access doors with lockable handles
   5. Designed, engineered, and manufactured in the United States of America
   6. All other provisions of the specifications must be satisfactorily addressed
   7.

A. General Description

1. Indoor air handling units shall include filters, supply fans, hot water coil, mixing box, and unit controls.

2. Unit shall have a draw-through supply fan configuration and discharge air horizontally.

3. Unit shall be factory assembled and tested including leak testing of the hot water coil, and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.

4. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

5. Unit components shall be labeled, including pipe stub outs, electrical and controls components.

6. Installation, Operation and Maintenance manual shall be supplied within the unit.

7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.

8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

B. Construction

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

2. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.

3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.

4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

5. Access to filters, heating coil, supply fans, and electrical and controls components shall be through hinged access doors.

6. Access doors shall be flush mounted to cabinetry. Coil access door and supply fan access door shall include quarter-turn lockable handles. Supply fan access door shall include removable pin hinges.

C. Electrical

1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.

2. Unit shall be provided with standard power block for connecting power to the unit.

3. Unit shall include a factory installed 24V control circuit transformer.

4. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

D. Supply Fans

1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.

2. Blower and motor assembly shall be dynamically balanced.

3. Blower and motor assembly shall be isolated with neoprene gasket.

4. Motor shall be a high efficiency electronically commutated motor (ECM).

5. Air handling unit and matching condensing unit shall be capable of operation as an R-410A split system air conditioner.

E. Heating Coil

1. Hot Water Heating Coil

a. Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.

b. Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

c. Coil shall have quarter serpentine circuitry, 2 row and 12 fins per inch.

d. Coil shall have left hand external piping connections. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing and be factory sealed on both the interior and exterior of the unit casing, to minimize air leakage.

e. Control valves shall be field supplied and field installed.

f. Coils shall be located in the preheat position upstream of the cooling coil.

F. Filters

1. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the cooling coil.

2. Unit shall include a clogged filter switch.

G. Mixing Box

1. Unit shall contain a mixing box with left return air opening and front outside air opening.

2. Return air opening shall contain an adjustable, motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven. Dampers shall be fixed position controlled by a fully modulating actuator.

3. Outside air opening shall contain an adjustable, motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven. Dampers shall be fixed position controlled by a fully modulating actuator.

H. Controls

1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.

2. Factory Installed and Factory Provided Controller

   a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.

   b. Controller shall be capable of stand-alone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.

   c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

   d. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.

   e. Make Up Air Controller

      1. Unit shall modulate cooling with constant airflow to meet ventilation outside air loads. Cooling capacity shall modulate based on supply air temperature.

      2. Hot gas bypass shall be required on the lead refrigeration circuits of systems without variable capacity compressors.

      3. Unit shall modulate heating with constant airflow to meet ventilation outside air loads. Heating capacity shall modulate based on supply air temperature.

   f. Unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, set point adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network. [Watt Master Orion Controls System]

3. Standard Terminal Block

   a. Unit shall be provided with a terminal block for field installation of controls.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
8. Comb coil fins for parallel orientation.
9. Verify that proper thermal-overload protection is installed for electric coils.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.

The Y-Series system shall consist of PUHY outdoor unit, multiple indoor units, and M-NET DDC (Direct Digital Controls). The sum of connected capacity of all indoor air handlers shall range from 50% to 130% of outdoor rated capacity.

1.3 COORDINATION

A. Coordinate size, location, and connection details with equipment supports, and roof penetrations.

B. Coordinate layout and installation units and support system components with other construction elements including existing conditions.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Materials
   1. Furnish one spare filter for each unit. Provide new filter prior to turning over to Owner.

1.6 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.7 DELIVERY, STORAGE AND HANDLING

A. Store units with factory shipping packaging in a location protected from damage and or extreme conditions such as heat, cold and moisture.

B. Protect units from damage during transit, delivery, storage and during entire construction period.

C. Installing contractor is responsible for any and all damage to equipment.

D. Do not deliver equipment until work is suitably complete, and project site is ready to accept the equipment without compromising any storage or protection requirements of this specification and the manufacturers warrantee.

E. Consult and follow manufacturer’s requirements for delivery, storage and handling requirements.

1.8 MAINTENANCE SERVICE

A. Furnish on-site service and maintenance of split AC units including parts and labor for 1 year starting at the date of substantial completion. Submit service contract for approval by owner and engineer.
   1. Ensure all split AC units continue to function properly over the period.

2. Check operation on site of all split AC units at the end of one year of operation and again at two years.
3. Respond to and repair failure or trouble on critical systems within 4 hours. This would include anything which could potentially cause occupant discomfort, property loss, damage to equipment, or cause building to be shut down.
   Failure to respond within time shall be grounds for Owner to engage another firm with costs paid by Contractor.
4. Provide 1-800 or toll free access for tech support.

B. Provide complete service of all units, including call backs. Make minimum of two complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, debug and repair as required for proper operation, and submit written reports.

1.9 WARRANTY

A. The CITY MULTI units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.

B. Manufacturer shall have a minimum of thirty-three (33) years of HVAC experience in the U.S. market.

C. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

D. The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Mitsubishi Electronics America, Inc.; HVAC Division.
   2. Trane.
   3. Dakin (U.S.A.) Corp.

2.2 CONTROLS, GENERAL

A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

B. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.

C. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

D. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.

E. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.

F. System shall be capable of email generation for remote alarm annunciation.

G. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi Electric controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi Electric Controls Applications Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours.

2.3 S-SERIES OUTDOOR UNIT

A. General:

The Y-Series PUHY outdoor unit shall be specifically used with CITY MULTI VRF components. The PUHY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped, wired and run tested at the factory.

1. The model nomenclature and unit requirements are shown below. All units requiring a factory supplied twinning kit shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

Outdoor Unit Model Nomenclature		
208/230 Volt		Twinning Kit
Model Number	Units	
PUHY-P72TLMU	(1) PUHY-P72TLMU	None
PUHY-P96TLMU	(1) PUHY-P96TLMU	None
PUHY-P120TLMU	(1) PUHY-P120TLMU	None
PUHY-P144TLMU	(1) PUHY-P144TLMU	None
PUHY-P144TSLMU	(2) PUHY-P72TLMU	CMY-ER100CBK
PUHY-P168TLMU	(1) PUHY-P168TLMU	None
PUHY-P168TSLMU	(1) PUHY-P96TLMU (1) PUHY-P72TLMU	CMY-ER200CBK
PUHY-P192TSLMU	(1) PUHY-P72TLMU (1) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P216TSLMU	(1) PUHY-P96TLMU (1) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P240TSLMU	(2) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P264TSLMU	(2) PUHY-P72TLMU (1) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P288TSLMU	(1) PUHY-P72TLMU (1) PUHY-P96TLMU (1) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P312TSLMU	(1) PUHY-P72TLMU (2) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P336TSLMU	(1) PUHY-P96TLMU (2) PUHY-P120TLMU	CMY-ER200CBK
PUHY-P360TSLMU	(3) PUHY-P120TLMU	CMY-ER200CBK

2. Outdoor unit shall have a sound rating no higher than 62 dB(A) individually or 65 dB(A) twinned. Units shall have a sound rating no higher than 51 dB(A) individually or 55 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected,

any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

3. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.

4. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.

5. Both refrigerant lines from the outdoor unit to indoor units shall be insulated.

6. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.

7. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection.

8. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet (294 feet optional) and have a total refrigerant tubing length of 3280 feet. The greatest length is not to exceed 541 feet between the outdoor unit and the indoor units without the need for line size changes or traps.

9. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature or cooling mode down to 23°F ambient temperature, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

10. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

11. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend “no or reduced heating” periods shall not be allowed.

B. Unit Cabinet:

12. The casing(s) shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models (–BS models).

C. Fan:

13. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan.

14. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. The fan shall be factory set for operation under 0 in.

WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

15. The fan motor shall be mounted for quiet operation.

16. The fan shall be provided with a raised guard to prevent contact with moving parts.

17. The outdoor unit shall have vertical discharge airflow.

D. Refrigerant

18. R410A refrigerant shall be required for PUHY-T/Y(S)LMU outdoor unit systems.

19. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

E. Coil:

20. The outdoor Hexicoil™ heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction.

21. The coil fins shall have a factory applied corrosion resistant blue-fin finish.

22. A stainless steel pipe connects the aluminum coil to copper piping.

23. The coil shall be protected with an integral metal guard.

24. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

25. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

F. Compressor:

26. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.

27. A crankcase heater(s) shall be factory mounted on the compressor(s).

28. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 15%-3% of rated capacity, depending upon unit size

29. The compressor shall be equipped with an internal thermal overload.

30. The compressor shall be mounted to avoid the transmission of vibration.

G. Electrical:

31. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.

32. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).

33. The outdoor unit shall be controlled by integral microprocessors.

34. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.4 PKFY (WALL MOUNTED) INDOOR UNIT

A. General: The PKFY shall be a wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. The PKFY shall be used with the S-Series outdoor unit. The PKFY shall support individual control using M-NET DDC controllers.

B. Indoor Unit

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. All casings, regardless of model size, shall have the same white finish
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
3. There shall be a separate back plate which secures the unit firmly to the wall.

D. Fan:

1. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).

4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

E. Filter:
1. Return air shall be filtered by means of an easily removable, washable filter.

F. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. Both refrigerant lines to the PKFY indoor units shall be insulated.

G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

H. Controls:
1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 4 of this guide specification for details on controllers and other control options.
2. The unit shall be able to control external backup heat.
3. The unit shall have a factory built in receiver for wireless remote control
4. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
5. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
6. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
7. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
8. Indoor unit shall be set to sense space temperature at the wall mounted controller.
9. Install a Diamond DPLS1 drain pan level swith in the drain pan of the indoor unit. Connect to control board to shut down indoor unit when excess level is sensed.

Part 4 – Controls

4.01 Overview

A. General:

The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

4.02 Electrical Characteristics

A. General:

The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

B. Wiring:

1. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

2. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.

3. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.

4. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

5. The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.

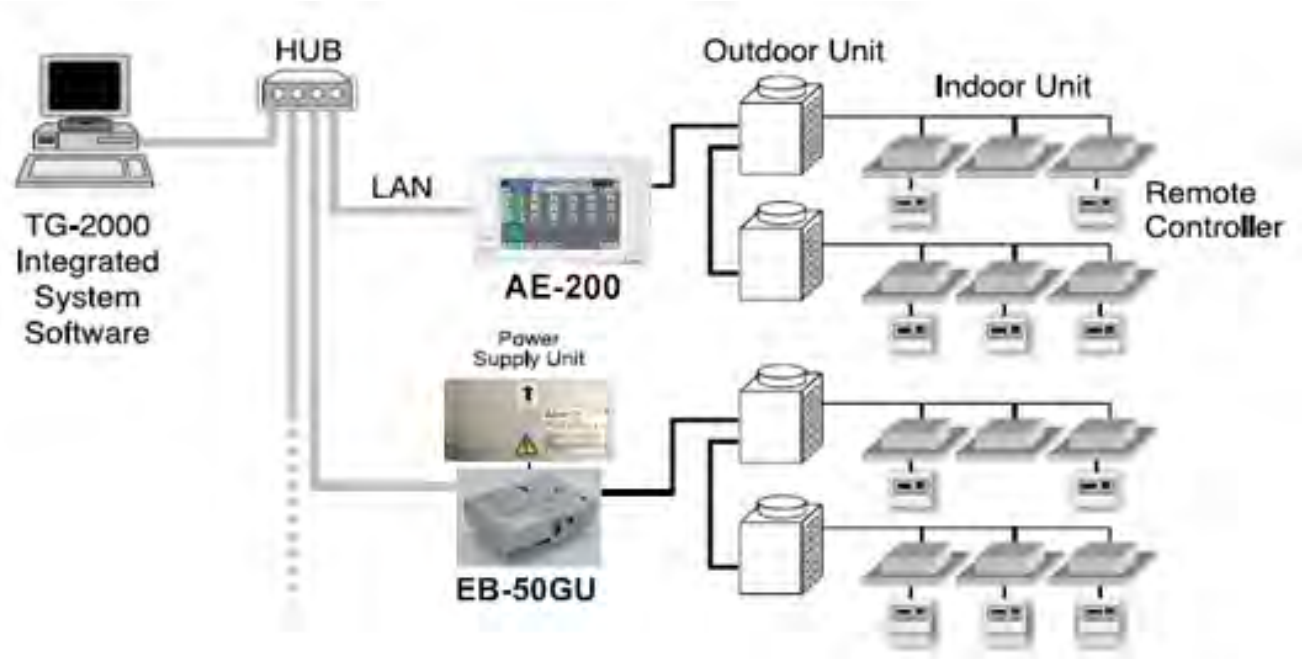
C. Wiring type:

1. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.

2. Network wiring shall be CAT-5 with RJ-45 connection.

4.03 CITY MULTI Controls Network

The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



CMCN System Configuration

A. CMCN: Remote Controllers Backlit Simple MA Remote Controller (PAC-YT53CRAU)

The Backlit Simple MA Remote Controller (PAC-YT53CRAU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3” x 5” and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from

the Backlit Simple MA. The Backlit Simple MA Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality/error.

The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers (PAR-FL32MA-E / PAR-FA32MA-E) or with other Backlit Simple MA Remote Controllers (PAC-YT53CRAU), with up to two remote controllers per group.

The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

PAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	**Description**	**Operation**	**Display**
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1

PAC-YT53CRAU (Backlit Simple MA Remote Controller)			
Item	**Description**	**Operation**	**Display**
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display “test run”).	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

4.04 Centralized Controller (Web-enabled)

A. AE-200 Centralized Controller

The AE-200A Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three (3) AE-50A expansion controllers. The AE-200A Centralized Controller shall be approximately 11-5/32” x 7-55/64” x 2-17/32” in size and shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the AE-200A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations con-

sisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

AE-200 (Centralized Controller)			
Item	**Description**	**Operation**	**Display**
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *1. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group

AE-200 (Centralized Controller)			
Item	**Description**	**Operation**	**Display**
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Set-back Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3. Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4. When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC

AE-200 (Centralized Controller)			
Item	**Description**	**Operation**	**Display**
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.	N/A	Collective
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: “Batch start/stop”, “Batch emergency stop” By pulse: “batch start/stop”, “Enable/disable remote controller” Output: “start/stop”, “error/Normal” *5. Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

All AE-200A Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three AE-50A expansion controllers for display of up to two hundred (200) indoor units on the main AE-200A interface.

The AE-200A Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.

Standard software functions shall be available so that the building manager can securely log into each AE-200A via the PC’s web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available but are not included. The Tenant Billing function shall require TG-2000 Integrated System software in conjunction with the Centralized Controllers.

B. AE-50A Expansion Controller

The AE-50A Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the AE-200A Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the AE-200A. Up to three (3) AE-50A expansion controllers can be connected to the AE-200A via a local IP network (and their IP addresses assigned on the AE-200A) to the AE-200A to allow for up to two hundred .(200) indoor units to be monitored and controlled from the AE-200A interface.

The AE-50A expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the AE-200A and configured to display their units on the main controller, the individual indoor units connected to the AE-50A can still be monitored and controlled from the interface of the AE-50. The last command entered will take precedence, whether at the wall controller, the AE-50A or the AE-200A Centralized Controller.

HVAC Guide Specifications

Execution

Part 1- Installation

A. General:
Rig and install in full accordance with manufacturer's requirements, project drawings, and contract documents. Refer to the manufacturer's installation manual for full requirements.

B. Location:
Locate indoor and outdoor units as indicated on drawings. Provide service clearance per manufacturer's installation manual. Adjust and level outdoor units on support structure.

For climates that experience snowfall, mount the outdoor unit a minimum of 12" above the average snowfall line. In climates where this height requirement proves unfeasible, the outdoor units may be installed at the average snowfall line provided regular snow removal in the area surrounding the units keeps the snow line below the bottom of the units.

C. Components / Piping:
Installing contractor shall provide and install all accessories and piping for a fully operational system. Refer to manufacturer's installation manual for full instructions.

Traps, filter driers, and sight glasses are NOT to be installed on the refrigerant piping or condensate lines.

Standard ACR fittings rated for use with R410A are to be used for all connections. Proprietary manufacturer-specific appurtenances are not allowed.

Refrigerant pipe for CITY MULTI shall be made of phosphorus deoxidized copper, and has two types.

A. ACR "Annealed": Soft copper pipe, can be easily bent with human's hand.
B. ACR "Drawn Temper": Hard copper pipe (Straight pipe), being stronger than Type-O pipe of the same radical thickness.

The maximum operation pressure of R410A air conditioner is 4.30 MPa [623psi] . The refrigerant piping should ensure the safety under the maximum operation pressure. Refer to recommend piping specifications in Mitsubishi Electric's engineering manual. Pipes of radical thickness 0.7mm or less shall not be used.

Flare connection should follow dimensions provided in manufacturer's installation manuals.

D. Insulation:
Refrigerant lines, as well as any valves, shall be insulated end to end with ½" closed-cell pipe insulation for piping up to 1"in diameter, or ¾" for piping 1-1/8" and larger, with a thermal conductivity no greater than 0.27 BTU-in/hr sq.ft ^{o}F. If state or local codes require insulation other than that specified above, the greater insulation shall be used.

E. Electrical:
Installing contractor shall coordinate electrical requirements and connections for all power feeds with electrical contractor. Refer to Division 26 (Master Format 2004) or Division Section 16 (Master Format 1995) for additional information.

F. Third Party Controls:
Installing contractor shall coordinate all BAS/BMS control requirements and connections with controls contractor.

PART 1 – VRF Project Supervision

1.01 General

A. VRF Manufacturer shall provide on-site *Project Supervision* as outlined in this specification section, providing: onsite technical review of installed VRF systems, review of activities related to the installation of the VRF system, VRF system components and associated controls.

B. All *Project Supervision* field activities shall be completed by an employee of the VRF manufacturer whose primary job responsibilities are to provide direct technical support of their product; sales staff or in-house support staff are not permitted to complete this scope of work.

C. A factory certified representative may assist the VRF manufacturer's personnel in the completion of certain elements of work contained within this specification. Activities completed by a Factory Certified Representative shall be supervised onsite by the VRF manufacturer. Certified representatives shall not be used in lieu of the manufacturer's personnel.

D. The installing contractor shall assist the VRF manufacturer, in their completion of the system review and have available onsite a technician with appropriate diagnostic tools, materials and equipment, as required, for the duration of the inspection process. The technician assisting the VRF manufacturer shall be fully licensed and insured to complete necessary duties as directed by the VRF manufacturer.

E. The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended and successfully completed a minimum 3- day VRF Service & Installation course at an approved training facility. A copy of this certificate shall be presented to the VRF manufacturer prior to the commencement of installation activity.

F. VRF manufacturer shall provide [**4**] onsite visits during the course of the project's completion. Additional site visits, if requested, shall require approval by the owner's representative and will be billed accordingly.

G. Onsite visits shall be conducted at installation milestones noted below. The installing contractor is responsible to coordinate each visit at the appropriate milestone, giving the VRF manufacturer a minimum 2-week notice prior to each visit.

    a. Project milestones

i. Project Kick Off meeting
ii. Site Visit at 25% project completion
iii. Site Visit at 50% project completion
iv. Final Inspection prior to Commissioning of the VRF System

1.02 Project Kick-Off

A. A project kick off meeting will be conducted with the installing contractor and appropriate parties with the sole purpose to review the installation of VRF systems being installed.
B. Kick off meeting shall consisting of a single **[4]** hour meeting with the installing contractor. This meeting shall be completed at the project site and be executed at the beginning stages of the installation of VRF systems.
    a. Items to be reviewed during the Project kick-off meeting are:
        i. Presentation of Best Practices & Installation Requirements specific to the VRF system(s) being installed under this scope of work.
        ii. Review of the project's mechanical design drawings related to the VRF systems being installed. Documents to be provided by the mechanical contractor.
        iii. Review of VRF Manufacturers design selection software and system design schematic drawings for the system being installed Documents to be provided by the mechanical contractor.
        iv. Discuss project activity related to the installation of VRF system components
        v. Establish clear path of communication and project support. Mechanical contractor shall designate an onsite point of contact for all field coordination activities.

C. The installing contractor shall obtain from the Engineer/Designer of the VRF system a copy of the most current electronic design file used in the design and engineering process of the VRF system being installed. This electronic design file shall have been completed on the VRF Manufacturers software and is the mechanical contractor's responsibility to provide the most current as-built version of this file during the course of the projects installation.

D. The installing contractor shall provide the VRF manufacturer, for their use, a complete set of HVAC mechanical plans prior to the Kick off meeting. The mechanical contractor is responsible to updates these plans during the course of the project.

1.03 Site Visit

A. Each site visit shall consist of a single visit, not exceeding an [**8**] hour period. All visits shall occur during regular business hours of 8:30AM-4PM, Monday thru Friday.

B. Activates to be completed during each Site-Visit are as follows:
    a. Meet with designated representative from the VRF installation contractor to discuss field activities and provide technical support related to the VRF systems.
    b. Review installed VRF systems for compliance with manufacturer's installation, service and engineering specifications.
    c. Assist the contractor in updating the VRF Design software for as-built purposes and for calculating the appropriate refrigerant charge.
    d. Provide a field report identifying any installation issues requiring attention. Report shall provide detailed information containing:
        i. Issue reference number
        ii. Priority Level of issue
        iii. Equipment M# & Reference TAG#
        iv. Status of issue
        v. Description of issue being identified
        vi. Recommendation for corrective action
        vii. Follow-up requirements, if required

1.04 Project Close Out Documents

A. Documents completed during the project Supervision process shall be compiled and presented to the owner's representative at the completion of field activities.

B. Close out documentation shall include
    a. Project Supervision report outlining activities completed under this scope of work
    b. As-built VRF design file depicting Model numbers and BTU capacity ratings of equipment installed, refrigerant pipe size & connection lengths between each system component, calculated refrigerant charge.
    c. Issue report

1.05 Professional Solutions Contact information

A. Contact your regions Mitsubishi Electric Professional Solutions Manager for information and pricing related to services required under this projects scope of work.

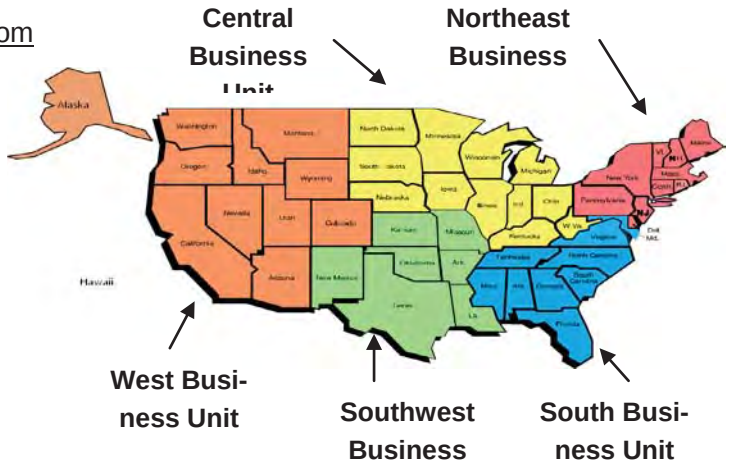
Northeast Business Unit
psgne@hvac.mea.com

South Business Unit
psgs@hvac.mea.com

Southwest Business Unit
psgsw@hvac.mea.com

Central Business Unit
psgc@hvac.mea.com

West Business Unit
psgw@hvac.mea.com



Part 2 - VRF System Commissioning

2.01 General

A. The VRF Manufacturer shall oversee and assist the installing contractor with the start up and commissioning of VRF equipment as outlined below. This process will be completed in two phases. Phase one shall cover the Pre-Start-Up inspection process, Phase two will cover the Physical Start-Up & Commissioning of Equipment.

B. All *VRF System Commissioning* activities shall be completed by an employee of the VRF manufacturer whose primary job responsibilities are to provide start up and commissioning of their products; sales staff or in-house support staffs are not permitted to complete this scope of work.

C. A factory certified representative may assist the VRF manufacturer's personnel in the completion of certain elements of work contained within this specification. Activities completed by a Factory Certified Representative shall be supervised onsite by the VRF manufacturer. Certified representatives shall not be used in lieu of the manufacturer's personnel.

D. The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended a minimum 3- day VRF Service & Installation course at an approved training center. A copy of this certificate shall be presented as part of the VRF equipment submittal process

E. The installing contractor shall assist the VRF manufacturer in their completion of the system review and have available a technician with appropriate diagnostic tools, materials and equipment, as required, for the duration of the inspection process. The technician shall be fully licensed and insured to complete necessary duties as directed under the supervision of the VRF manufacturer.

F. Upon completion of the Equipment Start-Up & VRF Commissioning process, the VRF manufacturer shall provide a formal report outlining the status of the system, in electronic format only. Contained within this report shall be copies of all field inspection reports, required action items and status, Manufacturers design software As-Built, equipment model & serial numbers.

G. Completion of the Equipment Start-Up and VRF Commissioning process shall verify that the VRF system has been installed per the Engineer's design intent and complies with the VRF manufacturers engineering and installation specifications related to their equipment.

H. Compliance with federal, state and local codes as well as other authorities having jurisdictions are not part of this process and are the responsibility of the installing contractor.

I. Contact your regions Mitsubishi Electric Professional Solutions Manager for information and pricing related to services required under this projects scope of work.

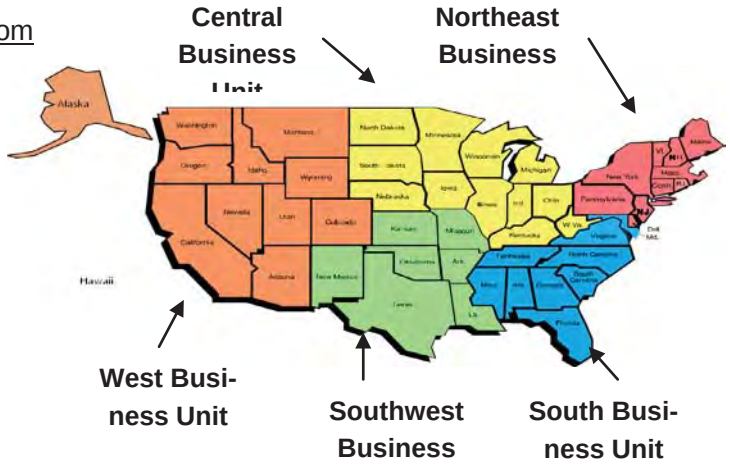
Northeast Business Unit
psgne@hvac.mea.com

South Business Unit
psgs@hvac.mea.com

Southwest Business Unit
psgsw@hvac.mea.com

Central Business Unit
psgc@hvac.mea.com

West Business Unit
psgw@hvac.mea.com



2.02 Pre Start-Up Inspection

A. Contractor shall employ the services of the VRF manufacturer to provide a comprehensive field review of the completed VRF system installation, prior to the physical start up and operation of equipment. Upon satisfaction that the system meets the VRF manufacturer's installation requirements and specifications, the contractor shall be allowed to proceed with the physical start up and operation of equipment.

B. Prior to the pre-start-up inspection, all systems components shall be in a final state of readiness having been fully installed and awaiting inspection.

C. The installing contractor shall provide the VRF manufacturer a copy of the electronic design file used in the design and engineering process of the system being inspected. This electronic design file shall have been completed on software approved by the specified VRF manufacturer and shall have been updated to reflect as-built conditions.

D. The installing contractor shall have prepared the refrigeration piping systems per equipment installation and service manuals. All refrigerant piping systems, upon

completion of assembly, shall have been pressurized to a minimum 600 PSI, using dry nitrogen, and held for an uninterrupted 24HR period, with acceptable change due to atmospheric conditions.

a. A record of the pressure check process shall be recorded and tagged at the outdoor unit. The tag shall contain the following information: date & time of pressure check start, fill pressure, outdoor temperature at start & stop, date & time of pressure check completion, and the person's full name & company information completing the pressure check.

b. The installing contractor shall engage the General Contractor as a witness of the pressure check process, confirming that all steps and procedures related to the pressure check where properly followed and that the system held the holding pressure of 600PSI for a period of 24hr hours, with acceptable change due to atmospheric conditions. Witness information, including full name, company name, title, phone number and signature shall be recorded on same pressure tag used by installing contractor.

E. Upon completion of the 600 PSI pressure check, the system shall be evacuated to a level of 500 microns, where it will be held for a period of 1HR with no deflection. The installing contractor shall utilize the triple evacuation method per the equipment install and service manuals.

a. Evacuation start & stop dates, times, and persons involved shall be recorded and tagged at the outdoor equipment.

b. Installing contractor shall digitally capture a photo of the micron gauge reading, at the conclusion of the 1hr holding period, for each system and provide a copy to the VRF manufacturer. Each photo shall contain a tag providing the outdoor units Serial number.

F. Upon the completion of the 500-micron hold, the calculated additional refrigerant charge can be added. The calculated refrigerant charge shall have been calculated using the VRF manufacturers design software.

a. Total refrigerant charge of the system shall be recorded and displayed at the outdoor unit by permanent means.

G. A review of the equipment settings shall be completed, with recommendations provided to improve system performance, if applicable. Physical changes of system settings will be completed by the contractor. Electronic recording of final DIP switches shall be provided as part of the commissioning report.

H. A comprehensive review and visual inspection shall be completed for each piece of equipment following a detailed check list, specific to the equipment being re-

viewed. A copy of the inspection report shall be provided as part of the manufacturers close out documentation. Any deficiencies found during the inspection process shall be brought to the attention of the installing contractor for corrective action. Any system components that are not accessible for proper inspection shall be noted as such.

I. Indoor Equipment report shall contain
- o Model & Serial Number
- o Equipment location
- o Equipment Tag/Identification number
- o Network Address & Port Assignment
- o Digital recording of equipment settings
- o Mounting/support method
- o Seismic restraints used
- o Proper service clearance provided
- o Wiring and connection points are correct
- o High voltage reading(s) within acceptable range
- o Low voltage reading(s) within acceptable range
- o Type of Remote Controller used and its location
- o Occupied space temperature sensing location
- o Air temperature readings within acceptable range
- o Condensate pump interlock method
- o Fan E.S.P. setting
- o Air Filter condition
- o Height differential setting in heat mode
- o Noise level acceptable
- o Refrigerant pipe connected and insulated properly
- o Condensate pipe connected and insulated properly
- o Condition of connected ductwork
- o Fresh air connected
- o Humidifier connected and checked
- o Review of air balance report complete
- o Other interlocked systems, i.e. baseboard heat, booster fan etc.

2.03 Physical Start-Up & Commissioning of Equipment

A. Upon proper equipment start up by the contractor, following the manufacturers guidelines and specifications, an employee of the VRF manufacturer shall complete a review of the system performance and complete the following tasks:

B. Check and confirm all communication addressing of system components.

C. Check and confirm each indoor unit, individually, is properly piped and wired by commanding the indoor unit on, in either heat or cool mode and verifying proper response.

    a. This process shall be digitally recorded and included as part of the close out documentation.

D. Electronically record a minimum of one-hour of operational data per refrigeration system.

E. Electronically record selector switch positions on all indoor and outdoor equipment.

F. The VRF manufacturer shall retain the electronically recorded data, collected during the start-up and equipment commissioning process, at a designated location within the US for future reference.

2.04 Close-Out Information

A. The VRF manufacturer shall issue a System Performance report at the completion of all fieldwork. Contained within this report shall be an overview of the system performance, recommendations, field reports, all electronic data, and as-built design file.

Part 3 - Owner Training and Technical Support

3.01 GENERAL

A. The VRF manufacturer shall provide the owner's representative a minimum []-hour VRF Operation and Maintenance training class covering systems installed under this scope of work.

B. Training program is to be provided at the time of owner occupancy.

C. Owner shall provide a suitable location, onsite, to conduct the VRF Operation and Maintenance class.

D. Training material shall be provided to participants in electronic format.

E. Contact your region's Mitsubishi Electric Professional Solutions Manager for information and pricing related to services required under this projects scope of work.

END OF SECTION 238127

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydronic convectors.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details and dimensions of custom-fabricated enclosures.
4. Indicate location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which convectors will be attached.
2. Method of attaching convectors to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HOT-WATER CONVECTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Engineered Air.
2. Rosemex.
3. Slant/Fin Corporation.
4. Sterling Hydronics; a Mestek company.
5. Trane Inc.

B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-iron headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig.
1. See Drawings for capacity.

C. Front and Top Panel: Minimum 0.0528-inch-thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.

D. Wall-Mounted Back and End Panels: Minimum 0.0428-inch-thick steel.

E. Floor-Mounted Pedestals: Conceal conduit for power and control wiring at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel.

F. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

G. Insulation: 1/2-inch-thick, fibrous glass on inside of the back of the enclosure.

H. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

I. Damper: Knob-operated internal damper.

J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Enclosure Style: Flat top.

1. Front Inlet Grille: Punched louver; painted to match enclosure.
2. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

a. Mill-finish aluminum.
b. Anodized finish, color as selected by Architect from manufacturer's standard colors.

c. Painted to match enclosure.

3. Front Outlet Grille: Punched louver; painted to match enclosure.
4. Front Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

a. Mill-finish aluminum.
b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
c. Painted to match enclosure.

5. See Drawings for enclosure dimensions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive convectors for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of convector.

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

3.2 INSTALLATION

A. Install convectors level and plumb.

B. Install valves within reach of access door provided in enclosure.

C. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

D. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232114 “Hydronic Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water convectors and components to piping according to Section 232113 "Hydronic Piping" and Section 232114 “Hydronic Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Section 230900 "Instrumentation and Control for HVAC."

D. Install piping adjacent to convectors to allow service and maintenance.

E. Connect wiring according to Section 260519 "Power Conductors."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start convectors to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Convectors will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 82 33

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Berko; Marley Engineered Products.
2. Chromalox, Inc.
3. Indeeco.
4. Markel Products Company; TPI Corporation.
5. Marley Engineered Products.
6. Ouellet Canada Inc.
7. QMark; Marley Engineered Products.
8. Trane Inc.

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

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

2.3 CABINET

A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with

stainless-steel hardware, and limit controls for high-temperature protection.Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Controls: Unit-mounted thermostat.

B. Electrical Connection: Factory wire motors and controls for a single field connection.

2.7 CAPACITIES AND CHARACTERISTICS

1. See Drawings for capacities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 39

PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Provide basic electrical system components including raceway, wire and cable, pull and junction boxes, outlet boxes, wiring devices, motor starters, disconnect switches, overcurrent protective devices, electrical equipment not furnished as an integral part of manufactured equipment, and all incidental devices and accessories necessary for a complete and operational system as indicated on the Drawings and as specified.

1.3 Permits And Fees

A. Provide all necessary notices, obtain all permits, file all required plans, obtain all necessary approvals of governmental departments and utilities having jurisdiction over the electrical work and obtain all required certificates and inspections.

1.4 Codes, Regulations And Standards

A. Electrical equipment and materials shall be approved by the Underwriters' Laboratories, Inc. or other national, well known testing laboratory as evidenced by listing or labeling.
   1. All equipment items or parts thereof shall bear the manufacturer's nameplate, which shall give all pertinent information for the particular item.
      a. Distributor's or contractor's nameplates will not be acceptable.

B. Discrepancies. Provide the more stringent requirement in case of discrepancies among the Contract Documents, Code requirements and industry standards. Also, include item or arrangement of better quality, greater quantity or higher cost in Contract price.
   1. Notify Engineer in writing of identified discrepancies.

C. Design Drawings: Drawings are diagrammatic in nature. Locations of electrical equipment and accessories are not intended to show every offset and fitting, nor every structural difficulty that may be encountered during the installation of the Work.
   1. Where necessary and after approval from the Engineer, revise alignment of work and equipment from that shown on Drawings without additional cost to the Owner.
      a. Identify revised locations on Record Drawings.

1.5 Definitions

A. The following terms are used in this Division and are defined as follows:
1. "Provide": To furnish and install, ready for safe and regular operation the item, material or service under discussion.
2. "Furnish": To purchase, acquire and deliver to the site, complete with related accessories.
3. "Install": To erect, mount and connect completely, by acceptable methods.
4. "Concealed": Embedded in masonry or other construction; or installed in furred spaces, trenches or crawl spaces; or installed within double partitions or hung ceilings; or in enclosures.
5. "Exposed": Visible to building occupants, excluding mechanical room and utility tunnel locations.
6. "Equal": Of weight, size, design, capacity and efficiency to meet requirements specified and shown, and of acceptable manufacture, as determined in the opinion of the Engineer.
7. "Acceptable": Acceptable, as determined in the opinion of the Engineer.
8. "Named" Product: Manufacturer's name for product, as recorded in published documents of latest issue as of date of Contract Documents. Obtain Engineer's permission before using products of later or earlier model.

1.6 Submittals - General

A. Identify the following:
1. Accessories and special/non-standard features and materials to be provided.
2. List of accessories which are required for a proper installation but are NOT part of the submittal.
a. In the latter case, identify the Section(s) under which the accessories are being provided.

B. Format: Include the following information on each submittal. Failure to comply will result in submittal rejection.
1. Specification Section and Paragraph under which equipment is specified.
2. Equipment or fixture identification corresponding to that used in Contract Documents.
3. Descriptive data necessary to verify compliance with Contract Documents.

C. Operation and Maintenance Manuals Format
1. Arrange manuals in the following format:
a. Tab A - Description of Electrical System and Component Parts, including function, normal operating characteristics and limiting conditions, performance curves, engineering data and tests, and complete nomenclature and manufacturer's number for replaceable parts.

b. Tab B - Operating Procedures, including start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown and emergency instructions; summer and winter operating instructions; and any special operating instructions.
c. Tab C - Sequence of Operation and Control Diagrams, corrected to show as-built conditions.
d. Tab D - Copies of approved shop drawings, charts and diagrams.
e. Tab E - Maintenance Procedures, including routine operations, guide to trouble-shooting; disassembly, repair and reassembly; alignment, adjusting and checking; servicing and lubrication schedule, and list of lubricants; manufacturer's installation and maintenance bulletins and related information.
f. Tab F - Parts List, including illustrations, assembly drawings and diagrams required for maintenance, predicted life of parts subject to wear, and recommendations for stocking spare parts.
g. Tab G - Names, addresses and telephone numbers of manufacturer's representative and Service Company.
h. Tab H - Other data, if required under pertinent Sections of these Specifications.

D. Review Process: Upon completion of submittal review, Action Submittals will be returned, marked with one of following notations: Furnish as Submitted, Furnish as Corrected, Revise and Resubmit, Rejected, or Submit Specified Item.
1. Provide only materials and products noted as "Furnish as Submitted" or "Furnish as Corrected".

1.7 INFORMATIONAL SUBMITTALS

A. List of Proposed Manufacturers: Submit prior to product and shop drawing submittals.

B. Copies of notification letters, permits, certificates, and inspection reports.

C. Manufacturers Guarantee: Furnish standard manufacturers' guarantees for work. Such guarantees shall be in addition to, and not in lieu of, other liabilities under the law or by other provisions of the Contract Documents.

1.8 Action Submittals

A. Product Data:
1. Manufacturer's specifications including materials of construction, metal gage, thickness and finish.
2. Performance data, ratings, operating characteristics and operating limits.
3. Electrical ratings and characteristics.
4. Certifications requested, including UL label or listing.

B. Certification: Certify that system elements are of sufficient capacity to meet the specified performance requirements as set forth in Contract Documents.

C. Shop Drawings
   1. Certified dimensional drawings including clearances required for maintenance or access.
   2. Wiring and control diagrams, where applicable.

D. The selection and intention to use a product specified by name shall NOT excuse the need for timely submission of shop drawings for that product.

E. Submission of shop drawings of unnamed manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

F. Samples
   1. Submit samples as requested by Engineer/Owner.
   2. Clearly identify samples that are submitted in lieu of shop drawings. Submit a minimum of two samples.
      a. Only one sample will be returned. Keep the accepted sample at the job site office.

1.9 Closeout Submittals

A. Record Drawings
   1. Maintain and keep on site at all times, one complete set of blackline prints for Electrical and Communication work. Promptly and accurately record changes, revisions and additions in a clear and neat format.
   2. Indicate daily progress on Record Drawings by coloring in the various lines, fixtures, apparatus and associated appurtenances as they are erected.
   3. Approval of requisition for payment of work installed will NOT be given unless supported by the Record Drawings.
   4. At the conclusion of work, deliver Record Drawings to Owner.

B. Operation and Maintenance Manuals
   1. Submit Operation and Maintenance manuals for each system or piece of equipment, at least 4 weeks prior to request for acceptance of same. Upon acceptance, furnish four copies of each manual to Engineer for transmittal to Owner.

C. Video of Equipment Instruction Procedures. Pertaining to the operation or programming of equipment. Submit to Owner.

D. Letter of Guarantee.

E. Extended equipment warranty.

1.10 Quality Assurance

A. Only the best of workmanship in accordance with present standards and generally accepted construction practices will be acceptable. Any work which the workmanship is judged by the Engineer to be below the present standards or generally accepted construction practices shall be replaced with properly done work at the Contractor's expense.

1.11 Warranty

A. Warranty materials, equipment and labor against defects for a period of one year from date of Substantial Completion. Repair or replace areas, materials and other systems damaged as a result of defects.
   1. Replace defective items requiring excessive servicing during warranty period at no additional cost to the Owner.
   2. Provide maintenance and emergency service including labor and materials during the warranty period at no additional cost to Owner. Perform service and replace affected components within reasonable time period.

PART 2 - PRODUCTS

2.1 General

A. Materials for the Work are specified in the appropriate Specification Sections and may also be specified on the Drawings.

2.2 Product Selection

A. Contractor's options for selecting products are limited by Contract Document requirements and governing regulations and are NOT controlled by industry traditions or procedures experienced by Contractor on previous construction projects. Required procedures include, but are NOT necessarily limited to, following various methods of specifying:
   1. "Or Equal": Where named products are accompanied by the term "or equal" or words of similar effect, provide one of named products or propose substitute product according to "SUBSTITUTIONS" Article.
   2. Standards, Codes and Regulations: Where specification requires only compliance with a standard, code or regulation, Contractor may select any product which complies with requirements of that standard, code or regulation.
   3. Performance Requirements: Provide products which comply with specific performances indicated and which are recommended by manufacturer (in published product literature or by individual certification) for application intended. Overall performance of product is implied where product is specified with only certain specific performance requirements.

B. Inclusion by name, of more than one manufacturer or fabricator, does NOT necessarily imply acceptability of standard products of those named. All manufacturers, named or proposed, shall conform, with modification as necessary, to criteria established by Contract Documents for performance, efficiency, materials and special accessories.

2.3 Substitutions

A. Substitution request from Contractors may be submitted only after the award of Contract. Requests shall be in writing on Contractor's letterhead and shall include:
   1. Contractor's statement to the effect that proposed substitution will result in overall work equal to or better than, work originally intended.
   2. Contractor's detailed comparison of significant qualities between specified item and proposed substitution.
   3. Statement of effect on construction time, coordination with other affected work, and cost information or proposal.

B. Substitution requests from contractors will only be considered if:
   1. Extensive revisions to Contract Documents are NOT required;
   2. Changes are in keeping with general intent of Contract Documents;
   3. Requests are submitted in a timely and proper manner, fully documented; and
   4. One or more of following conditions is satisfied; all as judged by Engineer:
      a. Where request is directly related to the "or equal" clause or words of similar effect in Contract Documents.
      b. Where specified product, material or method can NOT be provided within Contract Time; but NOT as a result of Contractor's failure to pursue the work promptly to coordinate various activities properly.
      c. Where specified product, material or method can NOT be provided in manner which is compatible with other materials of the work and where Contractor certifies that proposed substitution is compatible.
      d. Where specified product, material or method can NOT be properly coordinated with other materials of the work and where Contractor certifies that proposed substitution can be properly coordinated.
      e. Where specified product, material or method can NOT be warranted as required and where Contractor certifies that proposed substitution can be so warranted.
      f. Where specified product, material or method can NOT be used without adversely affecting Owner's insurance coverage on completed work and where Contractor certifies that proposed substitution can be so used.
      g. Where specified product, material or method will encounter other substantial non-compliances which are NOT possible to otherwise overcome except by using proposed substitution.
      h. Where specified product, material or method can NOT receive required approval by governing authority and proposed substitution can be so approved.

i. Where a substantial advantage is offered to the Owner; in terms of cost, time, energy conservation or other valuable considerations; after deducting offsetting responsibilities that this Contractor may be required to bear, including additional compensation to Engineer for any redesign or evaluation services, increased cost of other work by other contractors, and similar considerations.

C. The burden is upon the Contractor, supplier and manufacturer to satisfy to the Engineer that:
1. The proposed substitute is equal to, or superior to, the item specified.
2. The intent of the Contract Documents, including required performance, capacity, efficiency, quality, durability, safety, function, appearance, space clearances and delivery date, will be equaled or bettered.

D. Changes in work of other trades, such as structural supports, which are required as a result of substitution and the associated costs for such changes, shall be the complete responsibility of the Contractor proposing the substitution. There shall be NO additional expense to the Owner.

PART 3 - EXECUTION

3.1 Installation

A. Install work as close as possible to layouts shown on Contract Drawings. Modify work as necessary to:
1. Provide maximum possible headroom and space clearances.
2. Provide ready access to all parts of the work, for inspection, operation, safe maintenance and repair, and code conformance.
3. Coordinate and arrange work to avoid conflicts with work of other trades. Satisfactory space conditions shall be shown on coordination drawing submittals.

B. Where space appears inadequate, consult Engineer before proceeding with installation.

C. Finished work shall present a neat coordinated appearance.

3.2 Inspection Of work

A. Do not cover or enclose work until it has been inspected, tested, and approved by the Owner's Representative and by authorities having jurisdiction.

B. When requested, uncover and expose work that has not been completely inspected, tested and approved. Repair and restore surfaces and enclosures at no additional cost to Owner.

3.3 Field Quality Control

A. Instruct the Owner or the Owner's Representative in the operation, adjustment, and maintenance of electrical equipment. The procedures of any instructions pertaining to the operation and/or programming of equipment shall be videotaped and two copies turned over to the Owner.

B. Obtain services of manufacturer's representatives of major equipment during erection or construction of their respective equipment to insure proper installation of same. Failure to have such checks made by manufacturers shall place full responsibility for proper installation on contractor who shall make any corrections or remedy all defects at no additional cost to Owner. If required by the Engineer, a letter shall be provided from each manufacturer certifying that manufacturer's requirements are met.

C. Test and adjust each system and equipment for which he is responsible during the progress of the work, as required by the Engineer, and shall thoroughly test the same under working conditions at the completion of the work.

D. Coordinate activities related to the electrical work.

3.4 Cleaning

A. Remove debris at the close of each workday from work areas and adjacent occupied areas. Maintain adjacent areas in a safe and useable condition.

END OF SECTION 250505

PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

1.3 Definitions

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 Submittals

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 Quality Assurance

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. 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.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 Conductors And Cables

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. American Insulated Wire Corp.; a Leviton Company.
   2. General Cable Corporation.
   3. Senator Wire & Cable Company.
   4. Southwire Company.
   5. Approved Manufacturer

B. Copper Conductors: Comply with NEMA WC 70. Minimum size for power and lighting shall be No. 12. Minimum size for low voltage control shall be No. 16.

C. Conductor Insulation: Comply with NEMA WC 70 for Types **THHN-THWN**.

D. Multi-conductor Cable: Comply with NEMA WC 70 for **metal-clad cable, Type MC**with separate internal ground wire.

2.2 Connectors And Splices

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. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.
   6. Approved Manufacturer

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 Sleeves For Cables

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

PART 3 - EXECUTION

3.1 Conductor Material Applications

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 Conductor Insulation And Multiconductor Cable Applications And Wiring Methods

A. Final connections to equipment shall be made with copper insulated conductors installed in liquid tight flexible raceway. Minimum size ¾”.

3.3 Installation of Conductors And Cables

A. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

B. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

C. There shall be no splices in any conductors except where circuits are branched and located in accessible junction or outlet box.

D. Unless otherwise noted, each conduit raceway shall contain only those conductors constituting a single feeder circuit.

E. Branch circuit home runs shall not share a common neutral. Neutral conductors shall be of same size as phase conductors unless specifically noted otherwise.

F. All feeder and branch circuits shall have a full size separate grounding conductor installed in the conduit.

G. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

H. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 Connections

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

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. All connections and pigtail splices for wires #14-#10 shall be made with insulated type "Y", "R", or "B" spring connectors or compression splices. Conductor sizes #8 and larger shall be made with compression connectors.

D. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.5 Sleeve Installation For Electrical Penetrations

A. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

B. Cut sleeves to length for mounting flush with both wall surfaces.

C. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.

D. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint.

E. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations

3.6 Field Quality Control

A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

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(FOR DUPLEX PRINTING PURPOSES)

PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.

1.3 Definitions

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 Performance Requirements

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

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

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 Submittals

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.

1.6 Quality Assurance

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 Support, Anchorage, And Attachment Components

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. 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:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
      h. Approved Equal.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
         5) Approved Equal.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      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) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
         6) Approved Equal.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 Fabricated Metal Equipment Support Assemblies

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 Application

A. Arrange conduit supports to prevent distortion of alignment by wire pulling operations.

B. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 Support Installation

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and anchorage of recessed mounted equipment and components: Use sheet metal channel to bridge studs above and below equipment and components recessed in hollow partitions.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
   6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
   9. Install surface-mounted electrical items with minimum of four anchors.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 Installation Of Fabricated Metal Supports

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 Painting

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

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

END OF SECTION 260529

PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 Definitions

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 Submittals

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details and attachments to other work.
   1. Custom enclosures and cabinets.

C. Qualification Data: For professional engineer and testing agency.

D. Source quality-control test reports.

1.5 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.

PART 2 - PRODUCTS

2.1 Metal Conduit And Tubing

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. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. Manhattan/CDT/Cole-Flex.
   7. Maverick Tube Corporation.
   8. O-Z Gedney; a unit of General Signal.
   9. Wheatland Tube Company.
   10. Approved Equal

B. Aluminum Rigid Conduit: ANSI C80.5.

C. EMT: ANSI C80.3.

D. FMC: Aluminum.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Fittings for EMT: Steel or die-cast, set-screw type.

2.2 Metal Wireways

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. Cooper B-Line, Inc.
   2. Hoffman.

3. Square D; Schneider Electric.
4. Approved Equal

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.3 Boxes, Enclosures, And Cabinets

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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
13. Approved Equal

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 Raceway Application

A. See wiring methods indicated on drawings for raceway applications.

B. Minimum Raceway Size: 3/4-inch trade size.

C. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

D. Do not install aluminum conduits in contact with concrete.

3.2 Installation Of Raceways

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems." Arrange conduit supports to prevent distortion of alignment by wire pulling operations.

E. Arrange conduit to maintain headroom and present a neat appearance.

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Conceal raceway within finished walls, ceilings, and floors, unless otherwise indicated.

H. Exposed conduit and conduit above accessible ceilings shall be run parallel with or at right angles to the walls of the building and adjacent piping.

I. All metal conduit, enclosures and raceways for conductors shall be mechanically joined together to form a continuous electrical continuity and bond. Provide grounding bushings on all conduits 1-1/4 inches and larger.

J. Conduits shall be in full lengths wherever possible and all ends shall be cut square, reamed and burred.

K. Bring conduit to the shoulder of fittings and couplings and fasten securely.

L. Use conduit bodies to make sharp changes in direction.

M. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inches in size.

N. The installation of conduit or tubing which has been crushed or deformed shall be prohibited.

O. All conduits shall be plugged with approved discs during construction and be dry and clean before pulling wires.

P. Install conduit to prevent low spots which might accumulate water during or after installation. Where unavoidable, provide junction box with drain fitting at conduit low point.

Q. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

R. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

3.3 Identification

A. Apply identification to electrical raceway and boxes as specified in Division 26 “Identification for Electrical Systems”.

3.4 Protection

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Equipment identification labels.

1.3 Submittals

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 Quality Assurance

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 Coordination

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those

required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 Power Raceway Identification Materials

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 Armored And Metal-Clad Cable Identification Materials

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 Power And Control Cable Identification Materials

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 Conductor Identification Materials

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.5 Warning Labels And Signs

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

2.6 Equipment Identification Labels

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.7 Cable Ties

A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

PART 3 - EXECUTION

3.1 Installation

A. Verify identity of each item before installing identification products.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.2 Identification Schedule

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20 A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot (10-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Power.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.

F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.

END OF SECTION 260553

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PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
   1. Lighting and appliance branch-circuit panelboards.

1.3 Definitions

A. SVR: Suppressed voltage rating.

1.4 Submittals

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 Quality Assurance

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.6 Delivery, Storage, And Handling

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.7 Project Conditions

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and

humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.8 Coordination

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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

1.9 Warranty

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: **Five** years from date of Substantial Completion.

1.10 Extra Materials

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: **Two** spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 General Requirements For Panelboards

A. Enclosures: Flush- or surface-mounted cabinets as indicated on drawings.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, **Type 1**.
   2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   3. Finishes:
      a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Galvanized steel.
      c. Retain first subparagraph below for installations in humid tropical environments.
      d. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
   4. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

D. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

E. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 Lighting And Appliance Branch-Circuit Panelboards

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Approved equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as indicated on drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.3 Disconnecting And Overcurrent Protective Devices

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Approved equal.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers Less Than 250 amps: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
   2. Electronic trip circuit breakers 250 amps and larger with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

PART 3 - EXECUTION

3.1 Examination

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 Installation

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

C. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

D. Install filler plates in unused spaces.

E. Comply with NECA 1.

3.3 Identification

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 Field Quality Control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 Adjusting

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

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PART 1 - GENERAL

1.1 Related Documents

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

1.2 Summary

A. Section Includes:
   1. Nonfusible switches.
   2. Enclosures.

1.3 Definitions

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 Submittals

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

1.5 Quality Assurance

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NFPA 70.

1.6 Project Conditions

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2010 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

1.7 Coordination

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 Nonfusible Switches

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
   5. Approved Equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 Enclosures

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 Examination

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 Installation

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with NECA 1.

3.3 Identification

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 Field Quality Control

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

E. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 Adjusting

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Chain-link fences.
   2. Gates: swing.

B. Related Sections:
   1. Section 033053 "Miscellaneous Cast-in-Place Concrete" for cast-in-place concrete equipment bases/pads for gate operators and controls and post footings.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE 7-02.
   1. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
      a. Wind Loads: See current version of Connecticut Building Code.
      b. Exposure Category: C.
      c. Fence Height: 8 feet.
      d. Material Group: IA, ASTM F 1043, Schedule 40 steel pipe.

C. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
   1. Fence and gate posts, rails, and fittings.

2. Chain-link fabric, reinforcements, and attachments.
3. Gates and hardware.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Product Certificates: For each type of chain-link fence and gate from manufacturer.

C. Product Test Reports: For framing strength according to ASTM F 1043.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which [**manufacturer**] [**Installer**] agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Faulty operation of gate operators and controls.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
   1. Fabric Height: As indicated on Drawings.
   2. Steel Wire Fabric: Wire with a diameter of 0.148 inch.
      a. Mesh Size: 2 inches.
      b. Polymer-Coated Fabric: ASTM F 668, Class 1 over **zinc**-coated steel wire.
         1) Color: As selected by Engineer from manufacturer's full range, complying with ASTM F 934.
      c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043[**or ASTM F 1083**] based on the following:
   1. Fence Height: As indicated on Drawings.
   2. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe Group II-L, roll-formed steel C-section shapes.
      a. Line Post: 2.375 inches in diameter.
      b. End, Corner and Pull Post: 2.375 inches.
   3. Horizontal Framework Members: [**Intermediate**] [**top**] [**and**] [**bottom**] rails complying with ASTM F 1043.
      a. Top Rail: 1.66 inches in diameter.
   4. Brace Rails: Comply with ASTM F 1043.
   5. Polymer coating over metallic coating.
      a. Color: As selected by Engineer from manufacturer's full range, complying with ASTM F 934.

2.3 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:

B. Polymer-Coated Steel Wire: 0.177-inch-diameter, tension wire complying with ASTM F 1664, Class 1 over zinc-coated steel wire.
   1. Color: As selected by Engineer from manufacturer's full range, complying with ASTM F 934.

2.4 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gates.
   1. Gate Leaf Width: As indicated.
   2. Gate Fabric Height: As indicated.

B. Pipe and Tubing:
   1. Gate Posts: Round tubular steel.
   2. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Assembled with corner fittings.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame as indicated to attach barbed wire assemblies.

E. Hardware:
   1. Hinges: 180-degree outward swing.
   2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
   3. Lock: Manufacturer's standard.
   4. Closer: Manufacturer's standard.

2.5 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
   1. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 100 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
   1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts [**in concrete**] [**with mechanical anchors**] [**by mechanically driving into soil**] at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Exposed Concrete: Extend 3 inches above grade; shape and smooth to shed water.
      b. Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

C. Line Posts: Space line posts uniformly per design.

D. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
   1. Locate horizontal braces at mid-height of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

E. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
   1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

F. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

G. Intermediate and Bottom Rails: Install and secure to posts with fittings.

H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
   1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

3.5 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Owner will engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Engineer promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.6 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, and limit switches.
   1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware and other moving parts.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

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