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MECHANICAL

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Notes to Specifier/Designer:

Note 1: Remove the section if not applicable to the specific project to create the project specific specification. The table of contents is to be edited to reflect the sections included under the revised specification. The sections not identified by a Note 1 shall not be removed from the project specific specification. All sections removed are to be reviewed and approved by VPTC Management Partners, LLC.

Note 2: Specific sections within this specification can be edited. Review the section and create the project specific specification where text is **[bracketed and bold type]**. All sections edited are to be reviewed and approved by VPTC Management Partners, LLC.

Sections of the specification that are not identified as sections to be edited shall not be edited without the approval of the VPTC Management Partners, LLC.

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Section 15010 – Basic Mechanical Requirements

Part 1 General

1.01 Related Documents:

- A. General: The requirements of the General and Special Conditions, Bidding and Contract Requirements - Division 0 and Division 1 apply to all Work under this Section.
- B. Definition: The term Contractor shall mean the Mechanical, Plumbing, and Fire Protection Contractor or subcontractor(s) responsible for work described under Mechanical, Plumbing, and Fire Protection sections.
- C. R.F.P.: If this Document is issued separately from the General Construction Documents, then all references throughout this Division to Division 0 and Division 1 shall mean VPTC Management Partners, LLC's Request for Proposal and its related instructions to the Contractors.

1.02 Description of Work:

- A. Drawings and Specifications:
 - 1. It is the intent of this Design Criteria, Plans, and Specifications to form a guide for the complete Mechanical, Plumbing, and Fire Protection installation, tested, commissioned, and ready for operation. The successful Contractor(s) shall be responsible for the final design (design build), sizing and installation of all Mechanical, Plumbing and Fire Protection work, to provide a complete workmanlike installation. Where capacities, sizes, styles, equipment, and similar items are indicated, this Specification shall be considered minimum requirements.
 - 2. The basis for design of the building is the VPTC Management Partners, LLC Master MEP Specification (latest edition prior to the issuance of these specifications). The job specific specifications have been selected to include only those sections applicable to this particular project. In the event that changes result in the addition of work not covered by these job specific sections, the additional work will be governed by the VPTC Management Partners, LLC Master MEP Specifications.
 - 3. The Architectural, Structural, Electrical, and Mechanical Drawings and Specifications discussed herein are hereby incorporated into and become a part of the Contract Document for Work under this Division. This Contractor shall examine all related Drawings and Specifications available for his review.
 - 4. This criteria establishes the minimum acceptable quality of equipment, material, and workmanship; the Drawings are shown for concept only and are not intended to dictate design, zoning, sizing, or distribution. This Contractor shall be responsible for the actual design to provide a complete, workmanlike system and installation.
 - 5. This criterion is intended to establish design guidelines and does not detail or dictate mechanical/electrical data needed for full coordination. Prior to submitting a proposal, this Contractor shall coordinate his design requirements with the listed electrical contractors so

that loads and responsibilities are clearly understood. Lack of coordination will NOT be considered a basis or justification for adjustments in costs.

6. Innovations on the part of the Mechanical, Plumbing, and Fire Protection bidders are encouraged. The intent is to provide the Owner with a well-designed, state-of-the-art installation meeting, but not limited to, the requirements set forth in these Specifications.
 7. The Contract will not be awarded solely on the basis of price. Other important criteria, such as system zoning, economy of operation and maintenance, space requirements, flexibility, and comfort control will be evaluated.
- B. Work Included: This Work includes the furnishing of all design, coordination, labor, materials, equipment, fixtures, apparatus, and appurtenances required for complete installation of operating heating, ventilating, air conditioning, plumbing, and fire protection systems as indicated and specified, in place and ready for service.
- C. Work Described Under Other Sections: Requirements given within this Section apply to the Work of all Sections of this Division.
1. Finish painting is specified in other Divisions. Prime and protective painting of equipment is the responsibility of this Contractor, including touch-up of any paint damaged during construction.
 2. The Mechanical Contractor will be responsible for the installation of electrical or electronic temperature control and control interlock apparatus, other electrical apparatus, and wiring which is related solely to the HVAC temperature control system. Necessary conduit, wiring, boxes, and fittings, if required, shall be provided and installed as specified under Division 16. Line voltage power supply to temperature control equipment shall be the responsibility of the Electrical Contractor. Line voltage motor interlock wiring outside of the motor control center or motor starter shall be by the Electrical Contractor. The Mechanical Contractor shall coordinate all necessary power connections with the Electrical Contractor.
 3. Access doors in finished surfaces as specified under other Divisions shall be supplied and installed by this Contractor. Locations shall be as required for proper equipment access, including shutoff valves in all toilet chases. Locations shall be coordinated with the Architect prior to installation.
 4. Concrete housekeeping pads, materials, and supporting structures shall be located, dimensioned, and installed under this Division. This Contractor shall coordinate these requirements with the Structural Engineer. Provide pads under each piece of floor-mounted mechanical equipment and size so that pad extends 4" beyond each edge in Plan. Final dimensional requirements will be determined by the equipment furnished. Pads shall be a minimum of 3-1/2" high.
 5. Coordinate requirements for pits for sewage ejectors, storm water, and other pumps with the Structural Engineer. Dimensions and locations of pits shall be the responsibility of this Division.
 6. Owner-furnished equipment is furnished and installed under other Divisions. Proper HVAC and Plumbing provisions, including rough-in and final equipment connections, are included in the Work of this Division.
 7. Motors for all equipment shall be furnished and installed with the equipment furnished by this Contractor. Refer to Section 15030, "Electrical Provisions of Mechanical Work", for additional information.
 8. Motors and motor starters that are an integral part of the equipment are furnished under this Division with the driven equipment; all other motor starters, electrical power wiring and

connections are included in the Work of Division 16. Refer to Section 15030, "Electrical Provisions of Mechanical Work", for additional information.

1.03 1.03 Codes, Permits, and Standards:

A. General:

1. Install all work in accordance with all applicable codes, rules, laws, and regulations.
2. All work must meet requirements of the all applicable codes, rules, laws and regulations. This Contractor shall provide a code summary in the project specifications or drawings.
3. It is the Contractor's responsibility to obtain approvals necessary from VPTC Management Partners, LLC as well as to provide all fees necessary for permits, tests, and approval by the municipality, or any other agency, of this design and installation of the Mechanical, Plumbing, and Fire Protection systems. Any and all work necessary, whether or not shown or specified, but as required by the authorized building codes for general building, or any other code-required work not shown or specified, shall be included.
4. This Contractor shall prepare complete, professionally sealed, Plans and Specifications that shall be submitted to VPTC Management Partners, LLC for review.
5. This Contractor shall prepare complete, professionally sealed, Plans and Specifications that shall be submitted to the building officials along with the permit applications.
6. The Contractor, as a "designer/builder", shall submit proof of coverage of a professional liability insurance policy in accordance with their contract.

B. Precedence: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule. Any modifications resulting therefrom shall be made without additional cost to the Owner or VPTC Management Partners, LLC. This Contractor shall report any such modifications to VPTC Management Partners, LLC and secure their approval before proceeding.

1.04 Quality Assurance and Standards:

- A. Materials/Methods: Manufacturers, materials, and methods described in the various sections of the Specifications, and indicated on the Drawings are intended to establish a standard of quality. It is not the intention of this Criteria Specification to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. Further, it should not be assumed that the listing of a specific manufacturer as an acceptable manufacturer means that the manufacturer's standard product will meet the requirements of the project design, Specifications and space constraints.
- B. Alternative Products/Materials/Methods: Products by other reliable manufacturers, other materials, and other methods may be accepted provided they have equivalent capacity, construction, and performance. Under no circumstances shall any substitution be made without the prior written approval of VPTC Management Partners, LLC. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of VPTC Management Partners, LLC that the specified product, material or method is the only one that shall be used without prior approval. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be provided, it is the intention of VPTC Management Partners, LLC that products of manufacturers that are specified are the only products that will be acceptable

and that products of other manufacturers will not be considered for substitution without prior written approval.

1. For an alternative product/material/method to be considered, the Contractor must provide VPTC Management Partners, LLC with sufficient information to make a determination. The information should include a description of the product/material/method, drawings or sketches showing the impact on the physical constraints of the project, indications of the affect on the construction schedule and any cost implications. VPTC Management Partners, LLC will review the information with the Owner or Owner's representative and VPTC Management Partners, LLC's engineering consultant. The Contractor shall provide at least four copies of the information he wants to be considered.
- C. Alternative Equipment: Where substituted or alternative equipment is used on the project, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available, including all required Code and maintenance

clearances, and to coordinate all equipment requirements and provisions with the Mechanical (HVAC) and Plumbing Design and all other Contractors.

D. Standards: Refer to Division 1 for general administrative/procedural requirements related to compliance with applicable standards. This Work shall meet the standards set forth in the applicable portions of the following recognized standards:

1. ADC Air Diffusion Council
2. AGA American Gas Association
3. AMCA American Movement and Control Association
4. ANSI American National Standards Institute
5. ARI American Conditioning and Refrigeration Institute
6. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers
7. ASME American Society of Mechanical Engineers
8. ASPE American Society of Plumbing Engineers
9. ASSE American Society of Sanitary Engineering
10. ASTM American Society for Testing and Materials
11. AWS American Welding Society
12. AWWA American Water Works Association
13. CDA Copper Development Association
14. CE Corps of Engineers (U. S. Department of the Army)
15. CISPI Cast Iron Soil Pipe Institute
16. ETL Electric Testing Laboratory
17. FM Factory Mutual Engineering Corp.
18. FS Federal Specification (General Services Admin.)
19. IRI Industrial Risk Insurers
20. MCAA Mechanical Contractors Association of America
21. MIL Military Standardization Documents (U. S. Dept. of Defense)
22. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
23. NEC National Electrical Code (by NFPA)
24. NEMA National Electrical Manufacturers Association
25. NFPA National Fire Protection Association
26. OSHA Occupational Safety Health Administration (U. S. Department of Labor)
27. PDI Plumbing and Drainage Institute
28. SMACNA Sheet Metal & Air Conditioning Contractors' National Association
29. UL Underwriters' Laboratories, Inc.

1.05 Site Visit and Familiarization:

A. General: Become familiar with the Criteria Drawings and Specifications, examine the premises, and understand the conditions under which the Contract shall be performed, prior to submitting a bid.

- B. Site: Be informed of the site conditions, verify locations of new and existing equipment, and determine exact requirements for connections.
- C. Coordination: Tender of a proposal for this project infers that the Contractor has visited the site and has become familiar with the Drawings and site conditions and has included in his proposal, all work necessary to properly install the systems on the project.

1.06 Design Drawings, Equipment Data, and Calculations:

- A. General: Locate all items during design coordination and on-the-job measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.
- B. Location: Where locations of diffusers, grilles, and other exposed air devices, fire hose cabinets, and plumbing items are not described in the construction documents, review locations of items with the Architect and/or VPTC Management Partners, LLC prior installation. Locations shall not be determined by scaling drawings and shall not be installed unless coordinated with the trades affected. Plumbing fixtures, fire hose racks, and cabinets shall be mounted at the heights directed by VPTC Management Partners, LLC, and as required by code. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.
- C. Equipment Drawings: This Contractor shall furnish complete, easily readable material and equipment layouts and brochures, control, interlock, and riser diagrams, Shop Drawings, manufacturers' guarantees and information or samples as necessary for all equipment and material he proposes to furnish and install to VPTC Management Partners, LLC, and obtain approval prior to beginning of Work. Shop Drawings shall indicate equipment provided including indications of options. Any work started before receiving approval on any of this data will be at the Contractor's risk.
- D. Design Drawings: Provide complete drawings with all sizes, models, and equipment identification, input capacities, riser diagrams, and similar items sealed by a registered professional engineer. Equipment shall be drawn to scale and all major pieces of equipment such as heat pumps, air handling units, boilers, heat exchangers, control panels, and similar items, shall be clearly dimensioned from the nearest grid line or other clearly defined building elements. Load calculations and design data shall be furnished to VPTC Management Partners, LLC. Design drawings are to be complete prior to the start of construction of the project. Drawing content shall be such that the design is ready for construction.
- E. Drawing Submissions: All drawings and data shall be submitted in sufficient quantity so that VPTC Management Partners, LLC can keep four copies.
- F. Revisions: Any layout changes during the progress of the job shall be submitted to VPTC Management Partners, LLC for approval.

1.07 Discrepancies:

- A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.
- B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall apply to VPTC Management Partners, LLC for such further Drawings or explanations as may be necessary, allowing a reasonable time for VPTC Management Partners, LLC to supply them. The Contractor shall conform to them as a part of the Contract without additional cost to the Owner or VPTC Management Partners, LLC.
- C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to VPTC Management Partners, LLC, whose

decision shall be final and conclusive. No alleged statement by the Construction Manager will be accepted as an excuse for inferior work.

- D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Tender of a proposal conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required by the nature of the project.

1.08 Utilities:

- A. General: Utility information where shown on the Criteria Drawings has been shown based upon data obtained from the site survey and the agencies having jurisdiction and are accurate to the best of the knowledge of VPTC Management Partners, LLC.
- B. Coordination: The Contractor shall be responsible for field verification of the actual location of site utilities and shall make modifications necessary for connection to or construction around those utilities at no additional cost.

1.09 Pre-Design Conference:

- A. Conference(s): Upon the award of this Contract, and prior to commencing any work, the Contractor, his Engineer, and his designated major subcontractors, shall confer with the Architect and VPTC Management Partners, LLC concerning the Work under this Contract. The conference(s) shall be at a mutually agreeable place and time.

1.10 Submittals:

- A. General: Submittals required for this project shall include, but not be limited to:
1. Shop Drawings and Product Procedure Submittals,
 2. Certifications and Test Reports,
 3. Operating and Maintenance Manuals, and
 4. Warranties (Guarantees)
 5. Refer to Division 1 for additional submittal requirements.
- B. Shop Drawings and Product Brochure Submittals: The Contractor shall submit a minimum of eight complete bound sets of Shop Drawings and complete data covering each item of equipment or material. The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment, or actual Shop Drawings. The first submittal of each item requiring a submittal must be received by VPTC Management Partners, LLC in accordance with the project schedule. VPTC Management Partners, LLC shall not be responsible for any delays or costs incurred due to excessive Shop Drawing review time where the first submittal is received more than 60 days after contract award. The Architect and VPTC Management Partners, LLC will retain four (4) copies of all Shop Drawing submittals for their files. Where full size Drawings are involved, submit two prints and one reproducible in lieu of eight sets.
1. Contractor shall prepare complete submittals that include all pertinent information about the product. A single Shop Drawing shall not contain information from more than one Specification section, but a single Specification section may be subdivided into separate submittals for items or equipment that are specified in that section. Shop Drawings shall be separately bound by complete or partial Specification section. Where a single Shop Drawing contains information from more than one Specification section, it will be marked "NOT ACCEPTED" and returned. Each Shop Drawing shall include the following items enclosed in a suitable binder, Shop Drawings that do not comply with the above requirements will be marked "NOT ACCEPTED" and returned to the Contractor:
 - a. A cover sheet with the name of the Project, and the Subcontractor making the submittal. The cover sheet shall also contain the Specification section number

applicable to the item or items submitted, the item nomenclature and description and a submittal number. HVAC, plumbing and fire protection submittals shall be numbered sequentially by Specification section with a sequence suffix (e.g. 15640-1, 15640-2, 15700-1, etc.). Resubmittals shall be numbered with the original submittal number plus an R in the sequence suffix (e.g. the resubmittals of submittal 15640-1 would be 15640-1R1, 15640-1R2).

- b. A list of variations. This page shall list all variations, including unfurnished or additional items or features between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "No Variations". Where variations affect the work of other contractors, then the contractor shall certify on this page that these variations have been fully coordinated with the affected contractors and that all expenses associated with the variations will be paid by the submitting contractor.
- c. Equipment information including manufacturer's name and designation, size, performance, and capacity data. All applicable Listings, Labels, Approvals and Standards shall be clearly indicated.
- d. Dimensional data and actual sketches as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances.
- e. Identification of each item of material or equipment matching that indicated on the Drawings.
- f. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Criteria Drawings and Specifications. Any options or special requirements shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method. Any non-applicable information shall be crossed out.
- g. Additional information as required in other sections of this Division.
- h. Certification by the Contractor that the material submitted is in accordance with the Contract Documents, signed and dated.
- i. An authorized officer of the manufacturer or testing agency shall certify reports or information requiring certification.
- j. Certified Shop Drawings showing dimensions, loading details, anchor bolt locations, and inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.
- k. Equipment and material submittals shall show sufficient data including all performance curves, sound data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances,

capacities, materials, and finishes. All equipment capacity data shall be made with ARI certified selections.

- C. Required Shop Drawing Submittals: Submit Shop Drawings including but not limited to the following items:
1. Electric Heating Cable - Refer to Section 15070
 2. Seismic Controls for Mechanical – Refer to Section 15075
 3. Electronic Variable Speed Drives - Refer to Section 15080
 4. Valves Refer to Section - 15100
 5. Mechanical Pumps - Refer to Section 15170
 6. System Insulation - Refer to Section 15250
 7. Office Building Fire Protection Systems - Refer to Section 15300
 8. Plumbing Piping Systems - Refer to Section 15400
 9. Plumbing Pumps - Refer to Section 15410
 10. Floor and Roof Drains - Refer to Section 15420
 11. Plumbing Fixtures and Trim - Refer to Section 15440
 12. Electric Water heaters - Refer to Section 15458
 13. Mechanical Piping Systems - Refer to Section 15510
 14. Air Removal and Water Expansion System - Refer to Section 15514
 15. Water Treatment System - Refer to Section 15545
 16. Hot Water Boilers - Refer to Section 15550
 17. Air Cooled Condensing Units - Refer to Section 15675
 18. Split System Fan Coil Units - Refer to Section 15680
 19. Fluid Coolers - Refer to Section 15730
 20. Electric Heating and Cooling - Refer to Section 15833
 21. Unit Heaters - Refer to Section 15834
 22. Air Turnover Units - Refer to Section 15836
 23. Fan and Ventilators - Refer to Section 15860
 24. Ductwork - Refer to Section 15891
 25. VAV and Fan-Powered Air Terminal Units - Refer to Section 15931
 26. Air Outlets and Inlets - Refer to Section 15940
 27. Building Automation System - Refer to Section 15950
- D. Shop Drawing Submittal Review: Shop Drawings will be reviewed for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown in review comments is subject to the requirements of the Contract Documents. The submitting Contractor is responsible for: dimensions that shall

be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.

1. The Shop Drawing review time in VPTC Management Partners, LLC's office will be minimum of two weeks per review, exclusive of transmittal time, and this review time shall be considered by the Contractor when scheduling his work on the project.
2. The Architect's review or approval and VPTC Management Partners, LLC's review of Shop Drawing shall not relieve the Contractor of the responsibility for errors, omissions or deviations that may be contained in the submittals. If the Contractor proceeds on the basis of undetected errors, omissions or deviations in reviewed Shop Drawings, it shall be at his sole responsibility and the review does not allow deviations from the requirements of the Contract Documents. Noting some errors, omissions, and deviations but overlooking other errors, omissions, and deviations does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawing or VPTC Management Partners, LLC's review thereof, the Contract Documents shall govern the Work and are neither waived nor superseded by the Shop Drawing review.
3. At the time equipment and materials are delivered to the job site, it shall be the responsibility of the submitting Contractor to check all equipment and materials for conformance with the Contract Documents and submittals including comments and revisions made to the submittal during the submittal process. If equipment or materials are determined by the contractor to be in non-conformance, it shall be the responsibility of the contractor to bring equipment and materials into conformance with the Contract Documents. The contractor shall also notify VPTC Management Partners, LLC of any corrections that need to be made.
4. Inadequate or incomplete Shop Drawings will not be reviewed by VPTC Management Partners, LLC and will be returned to the Contractor marked "NOT ACCEPTED" for completion and resubmittal.
5. Shop Drawings will be marked "REVIEWED", "REVIEWED WITH COMMENT", "REVISE AND RESUBMIT", or "NOT ACCEPTED" when reviewed by VPTC Management Partners, LLC. The definitions of these terms for review purposes is as follows:
 - a. **REVIEWED** - The Shop Drawing was reviewed and no deviations from the general conformance with the design concept and general compliance with the information given in the Contract Documents were noted.
 - b. **REVIEWED WITH COMMENTS** - The Shop Drawing was reviewed and found to have either minor deviations from the requirements of the Contract Documents or information missing from the submittals. A complete Shop Drawing resubmittal is not required, however, a written response to all review comments shall be submitted in the format used for a resubmittal.
 - c. **REVISE AND RESUBMIT** - The Shop Drawing was reviewed and major deviations from general conformance with the design concept and general compliance with the information given in the Contract Documents were observed as noted. The Shop Drawing shall be revised to eliminate the deviations noted and resubmitted.
 - d. **NOT ACCEPTED** - The Shop Drawing was reviewed and is not in general conformance with the design concept or in compliance with the information given in the Contract Documents, as noted. A revised Shop Drawing submittal for the specified equipment or materials shall be resubmitted.
6. Division 1 and General Conditions requirements concerning Shop Drawing submittal review are not applicable to this Division.
7. Materials and equipment which are purchased or installed prior to Shop Drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such

materials and equipment and related work which is judged unsatisfactory by VPTC Management Partners, LLC for any reason, shall be at the expense of the Contractor.

8. Shop Drawings shall be complete and checked prior to submission to VPTC Management Partners, LLC for review. The contractor shall stamp and date each section indicating review and acceptance of that shop drawing.
- E. Certifications and Test Reports: Test reports and certifications shall be provided as specified in sections 15995 Mechanical Commissioning and 15990 HVAC Operational Testing. Additional testing described elsewhere in the specifications is also required as specified.
- F. Operating and Maintenance Manuals: Submit three (3) copies of Operating and Maintenance Manuals to VPTC Management Partners, LLC. Manuals shall be bound in rigid cover, 3-ring binders with spine and cover labels and shall provide operating and maintenance information for every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 15 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins. As a minimum, the following information shall be provided as applicable:
 1. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams.
 2. Fully detailed parts lists, including all numbered parts and recommended spare parts, of each item of equipment and apparatus provided under this Division.
 3. Manufacturer's printed instructions describing operation, service, maintenance, troubleshooting, and repair of each item of equipment and apparatus.
 4. Typewritten record of tests made of materials, equipment, and systems included under this Division. Such records shall state the dates the tests were conducted, name(s) of

person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests.

5. Temperature control wiring diagrams complete with instructions outlining each sequential step in the start up and shutdown of the heating/cooling system. Include precautions and instructions for servicing each item of the system.
 6. Identifying names, name tags designations and locations for all equipment.
 7. Valve tag lists with valve number, type, color coding, location and function.
 8. Equipment and motor name plate data.
 9. Approved Shop Drawing submittals.
 10. Fabrication drawings.
 11. Equipment and device bulletins and cut sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable.
 12. Maintenance instructions clearly highlighted to show all required periodic maintenance and lubrication.
 13. Wiring diagrams.
 14. Operating instructions clearly highlighted to show proper operating procedures for all equipment.
 15. Exploded parts views and parts lists for all equipment and devices.
 16. Color-coding charts for all painted equipment and conduit.
 17. Location and listing of all spare parts and special keys and tools furnished to the Owner.
- G. Tools: Provide and deliver to VPTC Management Partners, LLC any special tools required for maintenance of systems, equipment, and apparatus installed under this Division prior to requesting final acceptance of the installation.

1.11 Project Record Documents:

- A. Site Prints: Maintain a set of clearly marked black line prints of the Contract Drawings at the job site which shall be used for recording the work details, final size, location, interrelation, and similar items of all work under this Division. This set of Drawings shall be corrected daily as the Work progresses and shall clearly indicate all changes to suit field conditions, changes made by "Field Order" or "Change Order", accurate dimensions of all buried or concealed work, precise locations of all concealed work, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall be to at least two permanent structure points.
- B. Upon completion of the work, the Contractor shall transfer all marks from the site prints to a set of reproducible record "as-built" Drawings using red pencil. The reproducible record "as-built" Drawings shall have the Design Engineer's name and seal removed or blacked out and shall be clearly marked and signed on each sheet.
- C. Review: Prior to final acceptance of the Work of this Division, the Contractor shall submit one reproducible and two black line prints of properly certified Record Drawings to the Design Engineer and VPTC Management Partners, LLC for review and shall make changes, corrections, or additions as the Design Engineer and VPTC Management Partners, LLC may require to the Record Drawings. Upon completion of review and acceptance by the VPTC

Management Partners, LLC, the Contractor shall have all data transferred to the original CAD files. “.

1.12 Coordination of Mechanical Work:

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships that must be established within the mechanical work, and in its interface with other work including structural impact, utilities and electrical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various ductwork and piping systems and equipment items and the sizes of the major interconnecting ducts and pipes, without showing exact details as to elevations, offsets, control lines, and installation details.
1. Arrange mechanical work in a neat, well organized manner with services running parallel with primary lines of the building construction. A minimum of 7-1/2” inch clear space above future or existing ceilings is to be maintained for future tenant finish work.
 2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of VPTC Management Partners, LLC. Relocations necessitated by the conditions at the site or directed by VPTC Management Partners, LLC shall be made without any additional cost to the Owner.
 3. All ducts and pipes except those in the various equipment rooms, in unfinished spaces or where specifically designated herein or on the Drawings shall be run concealed in furring, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of VPTC Management Partners, LLC and shall stop work in those areas until VPTC Management Partners, LLC directs the resumption of the work. Submit for approval a Shop Drawing for any change in piping, equipment placement, ductwork, etc.
 4. Equipment chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and

access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor.

5. Piping interference shall be handled by giving precedence to pipe lines that require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:
 - a. Building Lines,
 - b. Structural Members,
 - c. Soil and Drain Piping,
 - d. Condensate Piping,
 - e. Sprinkler Piping,
 - f. Vent Piping,
 - g. Supply Ductwork,
 - h. Exhaust Ductwork,
 - i. Chilled Water and Heating Hot Water Piping,
 - j. Domestic Water Piping, and
 - k. Electrical Conduit.
 6. Locate operating and control equipment properly to provide easy access. Arrange entire mechanical work with adequate access for operation and maintenance.
 7. Advise other trades of openings required in their work for the subsequent move in of large units of mechanical work (equipment).
 8. Coordinate all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: structural weight, voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.
 9. When submitting Shop Drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.
- B. Coordination:
1. This Contractor shall coordinate his work with other trades as required to provide the best overall systems installation. Due to the inherent interrelationship between the Mechanical and Electrical Contractor, it is imperative that all aspects of the mechanical work be coordinated with the Electrical Contractor prior to bid.
 2. This contractor shall coordinate his work with the sub-contractors performing his scope of work. This includes coordinating the equipment suppliers and the sub-contractors to ensure technical support and information is available as needed to complete his scope of work.
 3. In case of conflict, VPTC Management Partners, LLC shall decide the proper location or arrangement, and any costs in revision or relocating equipment or material shall be at the expense of the Contractor responsible for the work.
 4. Prepare complete design documents and coordination drawings (Shop Drawings) showing the actual physical dimensions (at accurate scale) required for the installation of mechanical and electrical equipment fitted within the allotted spaces. Prepare and submit

coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.

1.13 Materials and Workmanship:

- A. General: Materials and equipment shall be new, of best grade and quality, and standard products of reputable manufacturer's regularly engaged in the production of such materials and equipment.
- B. Workmanship: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.
- C. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

1.14 Space Requirements:

- A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearances for adjustments, repair, or replacement.
- B. Clearance: Allow adequate space for clearance in accordance with requirements of the code and local inspection department. In addition, all equipment shall be installed where the equipment can be maintained per the manufacturer's recommendations.
- C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.
- D. Responsibility: Since space requirements and equipment arrangement vary for each manufacturer, the responsibility for access and proper fit rests with the Contractor.
- E. Review: Final arrangements of equipment to be installed shall be subject to the review of VPTC Management Partners, LLC.

1.15 Safety Regulations:

- A. All mechanical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the mechanical work shall be provided by and operated by the Mechanical contractor.

1.16 Delivery, Storage, and Handling of Materials:

- A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.
- B. Scope: Work under this Division shall include, but not limited to:
 - 1. Shipping from point of manufacture to job site,
 - 2. Storage on site with proper protection as required,
 - 3. Hoisting and scaffolding of materials and equipment included in this Division, and
 - 4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.
- C. Coordination: All large pieces of apparatus which are to be installed in the building and which are too large to permit access through doorways, stairways or shafts shall be brought to the

job by the Contractor and shall be placed in the spaces before enclosing structure is completed. All apparatus shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering where required for protection.

1.17 Cutting and Patching:

- A. General: Coordinate penetrations and place equipment in time to avoid cutting new construction.
- B. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from VPTC Management Partners, LLC. Patching shall create a surface that is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.
- C. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

1.18 Noise and Vibration:

- A. General: Warrant the heating, ventilating, air conditioning systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended levels shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected at no cost to VPTC Management Partners, LLC.
- B. Noise level criteria shall comply with the levels outlined in the ASHRAE Fundamentals Handbook, Chapter 7.
- C. Special attention should be paid to the areas directly adjacent to mechanical rooms and directly below rooftop mechanical equipment. Necessary vibration isolators, duct silencers, and other design provisions shall be included as required to meet the criteria outlined above. Coordinate with architect and other trades if special architectural construction or structural isolation is required. Ductwork shall be sized and designed to avoid objectionable noise, especially in medium pressure duct systems.
- D. Verification: Should a question arise of whether noise and vibration in a particular space or piece of equipment meet the above criteria, the Contractor shall be responsible for providing the services of an approved vibration or acoustic consultant to verify criteria compliance.

1.19 Cleaning, Adjusting, and Start-up:

- A. Start-up Services: Where required to validate manufacturers warranty or otherwise specified in these specifications or construction documents, provide a factory-authorized representative for testing and start-up of equipment and systems for any individual item of heating, ventilating, air conditioning and plumbing equipment and instruction of Owner's operating personnel. Provide to VPTC Management Partners, LLC a copy of the start-up report generated by the factory-authorized representative and/or provide the manufacturer's start-up checklist completed by the installing contractor. In the event that the checklist is not available then in order to certify that these services have been performed include a properly executed invoice for these services or a letter from the manufacturer stating that the equipment and or system has been started per their recommendations.
- B. Lubrication: Provide means for lubricating all bearings and other machine parts. Where applicable, extend a lubrication tube with suitable fitting to an accessible location and suitably

identify it where lubrication fittings are concealed or inaccessible. Lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.

C. Air Filters:

1. Air filters shall be installed on all equipment so equipped prior to initial start-up.
2. New air filters shall be installed on all equipment so equipped prior to final turnover.
3. Where equipment is used for temporary heating or cooling, temporary filter media shall be provided and installed and removed by the mechanical contractor.
4. Upon project completion provide one spare set of all filter sizes for Owner stock.

D. Testing, Adjusting, and Balance: Refer to Section 15990, "HVAC Operational Testing, Adjusting, and Balancing", for requirements.

E. Clean-up: Each Contractor shall clean away from the job site all debris, surplus material, and similar items, resulting from his work or operations, leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, ductwork, fixtures, and similar items, leaving the installation in a first class condition.

1.20 Final Review:

A. General: Upon completion of the Work, perform a final test of the entire system.

1. The system shall be operating properly with all water and air volumes balanced and all temperature controls adjusted.
2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications or the Drawings shall be accomplished without delay in order to secure final acceptance of the Work.
3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the time allotted for completion of the Contract. Retests shall be conducted as directed and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.
4. Certificates, including certificates of occupancy from local authorities and documents required herein, shall be completely in order and presented to VPTC Management Partners, LLC at least one week prior to the review.

B. System Performance Demonstration: All installing contractors are required to demonstrate to the owner, the operation of all systems installed. Refer to specification section 15995

Mechanical Commissioning for additional information and the Commissioning requirements for each system.

1. Qualified Person: Individuals knowledgeable of the systems and persons approved by VPTC Management Partners, LLC, shall be present at this final inspection to demonstrate the system and prove the performance of the equipment.

1.21 Owner Instruction:

- A. General: This Contractor and appropriate factory-trained representatives shall instruct the Owner's representative in the proper operation and maintenance of all systems and equipment and shall explain all warranties.
- B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by VPTC Management Partners, LLC.
- C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- D. Other Requirements: Refer to other Division 15 Sections for additional Operator Training requirements.

1.22 Contractor Warranties and Guarantees:

- A. General: Contractor shall guarantee and provide warrantee for all material and equipment installed by him against defects in workmanship and material for a period of 12 months after the date of substantial completion. The contractor shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. Equipment: All equipment bearing a manufacturer's guarantee and warrantee, such as motors, compressors, condensers, heat exchangers, water heaters, blowers, controls, and similar items, shall be construed to have an extended guarantee and warrantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.
- C. Start-up: The Mechanical Contractor shall provide instructions and equipment starting service on new equipment for one complete year after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

END OF 15010 – BASIC MECHANICAL REQUIREMENTS
Section 15030 – Electrical Provisions of Mechanical Work

Part 1 - General

- 1.01 Related Documents:
- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.
- 1.02 Description of Work:
- A. Work Included: Furnish and install all motors required for equipment furnished under this Division. All motors shall be factory installed on equipment whenever possible. Motor

controllers will, in general, be furnished and installed under Division 16 except for motor controllers which are integrally mounted on equipment or which are specifically specified under this Division.

1. In general, all motorized or electrically operated equipment will be set in place by the furnishing Contractor with all integrally mounted starters, controls and disconnect switches installed.
2. Where integral starters and motor controls are not provided with equipment and are not furnished by another contractor, Division 16 shall furnish, install and connect all starters and disconnect switches required per code and proper operation of that equipment. This contractor shall coordinate these requirements with Division 16.
3. All interconnecting wiring, conduit and connections between motors and starters and related control devices shall be the responsibility of the Division furnishing the control device.
4. Division 16 shall furnish miscellaneous 120 volt control power as required for systems and equipment furnished by other Divisions. This control power shall be furnished by Division 16 for all systems and equipment and where shown on the Drawings or approved shop drawings by the Division furnishing the system or equipment.
5. All starters and controllers for non-120 volt equipment and motors shall be furnished with control power transformers and control power circuits will not be required.
6. Equipment and devices shall comply with applicable standards of NEMA and must be UL listed or approved by a code accepted agency. Assemblies, not just components, must be UL listed, where required by code. All work shall comply with the National Electrical Code.

1.03 Quality Assurance:

A. Manufacturers: Provide products produced by one of the following:

1. Baldor
2. Century/Gould
3. General Electric
4. Louis Allis
5. Reliance
6. Siemens-Allis
7. US Motors
8. Westinghouse
9. Lincoln

1.04 Submittals:

A. Shop drawing submittals shall include, but not be limited to, the following information:

1. Manufacturer's name and cut sheets
2. Motor type
3. Horsepower
4. Voltage/Phase/Hertz
5. RPM
6. Service factor
7. Insulation class
8. NEC code number

9. Motor efficiency and testing method

Part 2 - Products

2.01 Electric Motors:

- A. General: Motor voltages shall be as follows, unless noted or specified otherwise:
 - 1. 1 hp and larger - 460 volts, 3-phase, 60 Hz,
 - 2. Smaller than 1 hp - 120 volts, 1-phase, 60 Hz, and

- B. Motors: All motors shall be started across-the-line, unless 30 hp or greater. Motors of 30 hp or greater shall be started via a Wye-Delta, closed transition configuration. All motors shall have copper windings. Motors shall be selected with low starting current and shall be designed for continuous duty to attain the running torque and pull-in torque required to suit the load. Motors for indoor-protected use shall be open drip-proof (ODP) construction, unless noted or specified otherwise. All motors exposed to the weather or contaminated environments shall be of the totally-enclosed fan-cooled (TEFC) or totally-enclosed air over (TEAO) type. All motors shall be single speed (1750 rpm), unless otherwise noted or specified. Two-speed motors shall be two-speed, one-winding (2S-1W) or two-speed (1750/1200 rpm), two-winding (2S-2W), unless otherwise noted or specified. All motors used with wye-delta reduced voltage starting shall be wound with taps for wye-delta reduced voltage starting. Refer to other Sections herein and the Electrical Drawings for two-speed motors and motors with reduced voltage starting.

- C. Frequency Inverter Motors: All motors which will be controlled by a frequency inverter for variable speed operation shall be selected in coordination with the frequency inverter requirements and shall be certified for this duty.

- C. Service Factor: All open motors shall be 1.15 service factor and all enclosed motors shall be 1.0 service factor, unless specified otherwise. All motors shall be rated for continuous duty. All motors shall be selected at design conditions without exceeding nameplate data assuming a 1.0 service factor.

- D. Bearings: Motors shall have either sealed ball bearings or field lubricated type ball bearings. Field lubricated ball bearings shall be drilled for grease fittings and have fittings installed. Where motors are installed inside equipment, extended grease fittings shall be provided.

- E. Balancing: Motors shall be statically and dynamically balanced and tested at the factory prior to shipment and shall be selected for quiet operation.

- F. Insulation: Open single phase motors shall have Class A or Class B insulation, open 3 phase motors shall have Class B insulation and all enclosed motors shall have Class F insulation.

- G. Single Phase Motors: All single phase motors shall be capacitor start or permanent split capacitor type selected to suit the load served. Single phase motors 1/4 hp and smaller shall have internal thermal protection.

- H. End Bells: All open motors 10 hp and smaller shall have cast aluminum end bells with steel frames. All open motors 15 hp and larger and all enclosed motors shall have cast iron housings.

- I. Rotation: The Mechanical Contractor shall be responsible to verify that the rotation of all 120 volt, single phase motors for mechanical equipment is in the correct direction prior to installation. The Electrical Contractor shall be responsible for correct rotation of all three-phase motors.
- J. Nameplates: A motor nameplate shall be securely affixed to each motor and shall clearly indicate the electrical data, horsepower, rpm, frequency, NEC code number, motor efficiency, class of insulation, winding material, and service factor.
- K. Energy Efficient Motors: Energy efficient motors shall be provided for motors which run "continuously" such as primary and secondary loop pump motors, cooling tower fan motors, outside air fan motors, toilet exhaust fan motors, and garage exhaust fan motors. Motor efficiency shall be based upon dynamometer testing per IEEE 112-E Test Standard, Method B, as set forth by NEMA MG 1-12.53a standard for efficiency testing and motor shall be labeled in accordance with NEMA MG1-12.53b. Motors shall be Baldor Super-E motors or an approved equal. Motors shall have a minimum efficiency as follows:

<u>Horsepower</u>	<u>Efficiency</u>
5 - 20 H.P.	92%
25 - 40 H.P.	94%
50 H.P. and larger	95%

- L. Additional Requirements: All motors shall comply with applicable NEMA standards and shall be UL listed. Refer to the various equipment Sections of this Division for additional motor requirements.

2.02 Motor Controllers:

- A. General: All motor starters, controllers, and disconnect switches shall conform to requirements of Division 16 and additional requirements specified elsewhere in this Division or noted on the Drawings.
- B. Control and Interlock Wiring:
 1. Except as otherwise specified, the Mechanical Contractor shall provide low (or line where used as an alternate) voltage control and control interlock wiring required by the direct digital control system. Line voltage power wiring to master units of temperature control equipment shall be by the Electrical Contractor.
 2. Controls, control wiring, alarm contacts, and motorized dampers not required for the operation of the motor will be provided by the Mechanical Contractor.
 3. The Mechanical Contractor shall provide all thermostats required for equipment supplied under Division 15.
 4. Control of motorized louvers and interlocks with temperature control devices shall be provided by the Mechanical Contractor.
 5. The Electrical Contractor will provide power wiring to electric baseboard heaters and/or electric cabinet unit heaters.

Part 3 - Execution

3.01 General:

- A. Motors shall be leveled, set in true angular and concentric alignment with driven equipment, and bolted firmly to motor base, if not mounted on equipment. Motors factory-mounted on equipment shall be checked for alignment to driven equipment and mounting bolts shall be checked to ensure bolts are tightly fastened.
- B. Coordination: The Mechanical Contractor shall have the responsibility to provide adequate rough-in information to the Electrical Contractor. Any costs resulting from inadequate coordination, such as patching and refinishing of walls, shall be divided between the Electrical and Mechanical Contractors.
- C. Start-up: All motors installed shall have the amperage and voltage tested and recorded by the contractor responsible for start-up.

END OF SECTION 15030

Section 15041 – Interior Finish Office Design Parameters

Part 2 General

1.01 Related Documents:

- A. The conditions of the contract and applicable requirements of Division 1, and Section 15010, “Basic Mechanical Requirements”, govern this section.

1.02 Definition(s):

- A. Net Rentable Area-sqft. (NRSF): Shall mean the result of subtracting from the gross area of the floor, the area of the major vertical penetrations on that same floor. No deductions shall be made for columns and projections necessary to the building. Spaces outside the exterior walls, such as balconies, terraces, or corridors, are excluded. The building net rentable area shall equal the sum of all net rentable areas from each floor.
- B. Major Vertical Penetrations: Shall mean stairs, elevators shafts, flues, pipe shafts, vertical ducts, and their enclosing walls. Atria and light wells above the finished floor are included in this definition. Not included, are vertical penetrations built for the private use of a tenant. Structural columns, openings for vertical electric cable or telephone distribution, and openings for plumbing lines are not considered major vertical penetrations.
- C. Gross Building Area-sqft.(GSF): Shall mean the total constructed area of the building, excluding parking areas and loading docks (or portions of the same) outside the building line.
- D. Common Area Building Zone: The common area building zone is defined as the area common to all tenants. This area includes but is not limited to restrooms, janitor’s closets, electrical rooms, telecommunication closets, mechanical rooms, corridors, atrium and lobbies.
- E. Perimeter Building Zone: The perimeter building zone is defined as the area measured under the length of the perimeter of the building and 15 feet from the exterior column line.
- F. Interior Building Zone: The interior building zone is defined as the total net rentable square feet less the common area square feet and less the perimeter building zone square feet.

1.03 Description of Work:

- A. Work Included: The Work includes, but is not limited to, design and installation of the following systems, equipment, and services:
 - 1. Air Cooled Split Air Conditioning Systems:]
 - a. Provide and connect all ductwork, diffusers, insulation and controls to the existing air-cooled split air conditioning system. This scope of work shall include but not be limited

to the design and installation of the, ductwork, insulation, filters, vibration isolation, fire dampers, grilles, registers, ceiling outlets, acoustic treatment of ducts, sound attenuating equipment (lined elbows and transfer ducts), controls and condensate drains.

- b. Where required to maintain design conditions and or specific tenant requirements, not covered under the initial shell building construction, relocate split systems to maintain required conditions. Provide new split systems where necessary to maintain conditions when existing equipment is not adequate to serve tenant load conditions.
- c. The installation of a new split system or relocation of existing shall include the connection of all associated ductwork, mechanical piping, insulation, vibration isolation, fire dampers, filters, grilles, registers, thermostat, and interface with existing temperature controls necessary to provide a fully functional split system.
- d. Split systems shall be installed above common area spaces, within the tenant space they serve. Split systems shall not be located above conference rooms, executive office space and/or other areas considered sensitive to noise.
- e. Building Common Areas: **[Where not provided in the base building construction]**
 - 1) Provide split systems for building common areas such as restrooms, atrium, elevator lobbies, service corridors, telecommunication closets, and the main building lobbies.
 - 2) The split system for public spaces shall consist of one split direct expansion air conditioning system per zone. Common area zone sizes can exceed the 1500 interior zone maximum. The split system unit cannot exceed 4 tons in sizes.
 - 3) Thermostat locations for units serving common areas are to be coordinated with VPTC Management Partners, LLC and the Architect. Thermostats are not to be installed in main entrance lobbies.
 - 4) Where split systems are installed to serve electric rooms or telecommunication closets, the thermostat is to be located within these rooms.
- f. Split System Zone Sizing:
 - 1) Provide one split system per perimeter net rentable building zone. A single perimeter zone shall be limited to a maximum of 800 square feet. No single perimeter building zone shall require more than 3 tons of cooling equipment capacity to maintain design conditions. The net rentable area (sq ft) shall be used in determining zone sizes.
 - 2) Provide one split system per interior net rentable building zone. A single interior zone shall be limited to a maximum of 1,500 square feet. No interior building zone shall require more than 3 tons of cooling equipment capacity to maintain design conditions. The net rentable area (sq ft) shall be used in determining zone sizes.
 - 3) The combined perimeter and interior zone size average for the total net rentable building sq ft shall not exceed 1000 sq ft.
 - 4) The interior and exterior zones shall not be served by the same split system. The Interior and exterior zones that have different functions (for example, a conference room and open office area) shall not be served by the same split ac system.
- g. The split direct expansion unit sizes shall be based on the peak load air conditioning and heating requirements of each zone with a minimum air circulation of 0.70 CFM per square foot of conditioned space. Each split direct expansion unit shall have an

electric, or electronic thermostat located in its respective zone to control temperature. Provide the thermostat and 40' of control wire coiled at the indoor unit.

- h. The locations of the condensing unit for the split systems are to be coordinated with VPTC Management Partners, LLC.
 - i. Refrigerant lines are to be installed in accordance with manufacturer's requirements and in a manner that will not cause premature failure of the compressor.
 - j. Each split system shall have an electronic thermostat located in its respective zone to control temperature. The thermostat shall be located in the space in an area that will best measure the actual room temperature. Coordinate with office furniture layout plan to locate thermostat in best location. Thermostats located near heat generating equipment, producing inaccurate results will need to be relocated by the installing contractor.
 - k. Where the ceiling space is utilized as a return air plenum, provide transfer ducts, fire dampers and or additional ductwork to ensure design airflow back to the unit.
 - l. Where required for excessive noise transmitted from ductwork and or split systems, sound attenuation shall be installed to maintain sound levels acceptable per ASHRAE Standards.
 - m. Building Pressure Control:
 - 1) The base building system air balance should be verified to ensure proper building positive pressure. This contractor shall request base building drawings and test and balance data to verify base building system balance. VPTC Management Partners, LLC shall be notified of any deficiency.
 - 2) All new split systems shall be provided with code required outside air and shall utilize the same concept for introduction of outside air as the base building systems. Verify the capacity of the base building outside air system prior to adding new systems. VPTC Management Partners, LLC shall be notified of any deficiency in system capacity.
 - 3) Any tenant system which results in addition of outside air or exhaust shall be integrated such that proper building positive pressure is maintained. Required base building system control or modification shall be included in the tenant design.
 - 4) Submit a summary of any addition or modification to the building air balance to VPTC Management Partners, LLC for review and approval.
2. Packaged Roof Mounted Air Cooled Variable Air Volume Air Conditioning Systems:
- a. Provide and connect all ductwork, diffusers, insulation and controls to existing terminal boxes including but not limited to hard duct branch lines, flexible ductwork, supply and return linear and square diffusers/grilles, thermostat and building controls.
 - b. Verify base building roof top equipment can maintain design conditions to the new and existing tenants, if additional building loads are added. Provide additional capacity when the base building rooftop systems cannot support additional building loads added as a result of the interior finish up-fit.
 - c. Where required to maintain design conditions and or specific tenant requirements, not covered under initial construction, relocate terminal boxes to maintain required conditions. Locate boxes outside of perimeter offices for servicing and provide a designated box for each conference room or corner office. Provide new air terminal boxes with or without heat where necessary to maintain conditions when existing equipment is not adequate to serve tenant load conditions.
 - d. The installation of a new terminal box (VAV with heat or without heat) or relocation of existing shall include the connection of all associated ductwork, insulation, vibration

isolation, fire dampers, filters, grilles, registers, thermostat, and interface with existing temperature controls necessary to provide a fully functional terminal box. Terminal box installation or relocation shall match the base building standard for installation and materials.

- e. Fan powered terminal boxes shall be installed above common area spaces, within the tenant space they serve. Fan powered terminal boxes shall not be located above conference rooms, executive office space and/or other areas considered sensitive to noise.
- f. Fan powered terminal boxes installed in the building are to be relocated during interior finish, when they are located in conference rooms or executive office space. The relocated equipment shall be installed above common area spaces.
- g. Fan powered terminal boxes or VAV terminal boxes shall be installed to allow for manufacturer required maintenance access. Do not install any terminal box over a hard ceiling without the installation of adequately sized access panels.
- h. Where required for excessive noise transmitted via ductwork and or equipment, sound attenuation shall be installed to maintain sound levels acceptable per ASHRAE Standards.
- i. Where existing ventilation fan or ductwork system is not adequate to provide code required ventilation air, provide necessary equipment, ductwork, transfer grilles, balancing dampers and fire dampers to existing system to provide evenly distributed code required ventilation air.
- j. Where the ceiling space is utilized as a return air plenum, provide transfer ducts, fire dampers and or additional ductwork to ensure design airflow back to the unit.
- k. The air terminal unit sizes shall be based on the peak load air conditioning and heating requirements of each zone with a minimum air circulation of 0.7 CFM per net rentable square foot of conditioned space.
- l. Each air terminal units shall have an electronic thermostat located in its respective zone to control temperature. The thermostat shall be located in the space in an area that will best measure the actual room temperature. Coordinate the thermostat location with the office furniture and equipment layout plan to locate thermostat in best location. Thermostats located near heat generating equipment, producing inaccurate results will need to be relocated by the installing contractor.
- m. **Common Areas: [Where not provided in the base building construction]**
 - 1) Provide air terminal units for building common areas such as restrooms, atrium, elevator lobbies, service corridors, telecommunication closets, and the main building lobbies.
 - 2) The basic system includes one air terminal unit per zone. A single zone for the common area can exceed 1500 square feet. The terminal unit serving the common areas shall not exceed 4 tons in cooling capacity.
 - 3) Where main entry lobbies, computer rooms, equipment rooms, elevator equipment rooms, electric rooms, and retail spaces are separated from typical office floors by

multiple garage parking levels, the contractor may provide DX split system equipment for these remote areas in lieu of air terminal units.

- 4) Thermostat locations for units serving common areas are to be coordinated with VPTC Management Partners, LLC and the Architect. Thermostats are not to be installed in main entrance lobbies.
 - 5) Where air terminal units are installed to serve electric rooms or telecommunication closets, the thermostat is to be located within these rooms.
- n. Air Terminal Unit Zone Sizing:
- 1) Provide one fan powered air terminal unit with electric re-heat per perimeter zone. A single perimeter zone shall be limited to a maximum of 800 square feet. No single perimeter building zone shall require more than 2,000 CFM cooling equipment capacity to maintain design conditions. The net rentable area (sq ft) shall be used in determining zone sizes.
 - 2) Provide one air terminal unit per interior zone. A single interior zone shall be limited to a maximum of 1,500 square feet. No single interior building zone shall require more than 2,000 CFM equipment capacity to maintain design conditions. The net rentable area (sq ft) shall be used in determining zone sizes.
 - 3) The combined perimeter and interior zone size average for the total net rentable building s area shall not exceed 1000 sq ft.
 - 4) Terminal unit sizes shall not exceed 2500 CFM.
 - 5) In tenant spaces with open office floor plans the interior zones of the VAV system can be larger than the 1500 sq ft maximum zone size. However, zone sizes cannot differ from the sizes noted above, without the review and approval of VPTC Management Partners, LLC. In all cases, the terminal box used to serve the larger zones cannot exceed 2500 CFM of equipment capacity.
 - 6) The interior and exterior zones shall not be served by the same air terminal units. Interior and exterior zones that have different functions (for example, a conference room and open office area) shall not be served by the same air terminal unit.
- o. Building Pressure Control:
- 1) The base building system air balance should be verified to ensure proper building positive pressure. This contractor shall request base building drawings and test and balance data to verify base building system balance. VPTC Management Partners, LLC shall be notified of any deficiency. Building pressure shall not exceed 0.035".
 - 2) All new terminal boxes shall be provided with an outside air to supply air ratio based on the base building rooftop unit system set-up. Additional outside air shall

be provided as required. An increase in the rooftop outside air ratio shall only be allowed if approved by VPTC Management Partners, LLC.

- 3) Any tenant system which results in addition of outside air or exhaust shall be integrated such that proper building positive pressure is maintained. Required base building system control or modification shall be included in the tenant design.
- 4) Submit a summary of any addition or modification to the building air balance to VPTC Management Partners, LLC for review and approval.

3. Toilet Exhaust:

- a. A toilet room exhaust air at each restroom shall be exhausted through sheet metal ductwork using exhaust fans located at the discharge of the duct. Maximum fan capacity per riser shall be 30,000 CFM.
- b. Toilet room exhaust shall be based on a minimum of 2 CFM per square foot of toilet room and in accordance with local code, whichever is greater. The exhaust should always maintain toilet rooms at a negative pressure in relation to the adjacent spaces.

4. Automatic Temperature Controls: [Applicable if the base building control system is a direct digital control system]

- a. All new or existing heating or cooling equipment installed, relocated or otherwise modified under the tenant finish scope of work shall be connected/reconnected to fully communicate with the base building temperature control system.
- b. The programming and graphics for the added heating and cooling equipment shall be added to the base building DDC system. Graphics and programming methods shall be consistent with the existing system.

5. Communication Rooms/Telephone Rooms: **[Where not provided in base building.]**

The main telephone/equipment room shall have a VAV box or split system for room conditioning. Communication and telephone rooms on the tenant floors shall be cooled but do not require dedicated equipment unless it is known that heat generating equipment

will be concentrated in the space. VAV boxes serving tenant spaces shall not serve these rooms.

6. Plumbing: All interior finish plumbing systems shall be designed and installed, consistent with the materials and methods described within 15250, 15400, 15410, 15420, 15440
7. Fire Protection:
 - a. All portions of building sprinkler design and construction shall meet NFPA requirements.
 - b. Refer to specification section 15300 and 15041 for additional design requirements for fire protection.

1.04 Design Conditions:

- A. General: Components of the heating and air conditioning systems shall be designed and selected according to the following design conditions:
 1. Outdoor Conditions:
 - a. Summer: 2005 ASHRAE .4% Design Criteria
 - b. Winter: 2005 ASHRAE 99.6% Design Criteria
 - c. For convenience, reference attached ASHRAE weather data for major metropolitan areas common to VPTC Management Partners, LLC. Reference the 2005 ASHRAE Fundamentals for locations not included.
 2. Indoor Conditions:
 - a. The following indoor conditions shall be maintained within all occupied spaces.
 - b. Summer: 74°F DB @ 60% RH (by system design without reheat)
 - c. Winter: 72°F DB (no humidity control) (without credit for internal gains or solar contribution) (humidification not required)
 - 1) Indoor conditions must be maintained within less than 1.5 °F mean deviation from temperature specified.
 - 2) The relative humidity requirement is a maximum condition and is not to be exceeded.
 - d. Elevator Machine Room: Actual requirements by the elevator equipment supplier shall establish this requirement.
 - e. Mechanical/Telephone/Electrical Spaces: Ventilate or condition to maintain space temperatures within the manufacturer's recommended limits. Electrical equipment and

material ratings must be coordinated with the space conditions. Coordination with the Electrical Contractor is the responsibility of this Contractor.

- f. Main Lobby: Provide positive pressure in the lobby to minimize infiltration.
3. Lighting:
 - a. Office Areas 1.5 Watts/NRSF Fluorescent (All Areas) +0.5 Watts/NRSF Incandescent (For Exterior Offices)
 - b. Retail Shops 5 Watts/NRSF Total
 - c. Restaurants 5 Watts/NRSF Total
 - d. Public Lobbies 5 Watts/NRSF Total
 4. Equipment Heat Load:
 - a. Office Areas 2.0 Watt/NRSF
 - b. Retail 1.5 Watts/NRSF
 - c. Restaurants Seating 1 Watt/NRSF
 - d. Lobbies 0.5 Watts/NRSF
 - e. Kitchen Per Kitchen Design
 5. Occupancy (Use for calculating cooling load):
 - a. Office Areas 100 NRSF/person
 - b. Retail 40 NRSF/person
 - c. Restaurant 15 NRSF/person
 - d. Lobbies 33 NRSF/person
 - e. Kitchen 100 NRSF/person
 6. Outside Air Ventilation: Provide outside air at the rates specified in ASHRAE 62.1-2004. At a minimum size equipment to accommodate normal office area functions based on the

net rentable (NRSF) footage of the building. Air handling equipment shall be selected in the mid-range of its' maximum capacity.

7. Minimum Air Circulation:
 - a. All Occupied Spaces 0.70 CFM/NRSF
 - b. At a minimum supply registers are to be provided per every 210 sq ft. of usable space. Return grilles shall be provided per every 225 sq ft. of usable space.
8. Air Load Factors for HVAC Systems:
 - a. Duct heat gain * (Approximately 2% of unit capacity)
 - b. Fan motor * (Approximately 2%)
 - c. Duct leakage 5% (Downstream of heat pumps)
 - d. Contingency ** (Established at 5% for each heat pump)
 - e. Convert actual losses or loads to BTU/HR.
9. Window, Wall, and Roof Factors: Refer to the Architectural Drawings for area definitions, glass types, and roof details. Verify the shading coefficients of each glass type and U values of each wall, roof and floor with VPTC Management Partners, LLC.
10. Refer to specification section 15010.1.19 for Noise and Vibration design criteria.

Part 3 Products

Not applicable.

Part 4 Execution

3.01 System Layout:

- A. Good engineering practices shall be followed as outlined by professional organizations covering each area of work.
- B. Unitary equipment shall be sized and selected based on peak load conditions for the area which it serves.
- C. Unitary equipment (terminal units, zone dampers, roof top equipment) serving tenant spaces shall be sized, selected, and located to allow for separation of "like condition" spaces.
 1. Allow for 12'-0" exterior zone around the perimeter of the building.
 - a. Unitary equipment located above ceiling space intended to serve perimeter zones shall be placed at 15'-0" off the exterior column line.
 2. Dissimilar perimeter zones shall be separated by individual units. For example, (1) for North zone, (1) for South zone, etc.
- D. Supply air flow rates to the spaces shall be determined based on the sensible load in the space and the calculated supply air temperature and supply air flow rate shall be maintained by the unit.
- E. Noise levels must be taken into consideration in the placement of mechanical systems. Noise level requirements are specified in section 15010. Where noise criteria conditions cannot be

met by standard installation, additional sound attenuation measures must be incorporated into the design of the mechanical system to maintain specified conditions.

- F. Where structurally possible, roof top equipment with air cooled condensing units shall be orientated with the fins on the condensers, facing the eastern exposure. This shall be done to minimize damage to the fins and coils from incoming storms.

END OF SECTION 15041

Section 15070 – Electric Heating Cable

Part 5 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 "Basic Electrical Requirements", govern this Section.

1.02 Description of Work:

- A. General: The extent of electric heating cable work is as indicated by the requirements of this Section and as specified elsewhere in these Specifications. In general, electric heating cable shall be furnished and installed by the Mechanical and Plumbing Contractors in accordance with this Specification. Coordinate power wiring requirements for electric heating cable with the Electrical Contractor.
- B. Applications: Pipe heat tracing applications required for this project include, but are not limited to, the following:
 - 1. Provide pipe freeze protection heat tracing for all sanitary and storm piping, hydronic piping, domestic hot and cold water piping, and for sump pump and sewage ejector

discharge piping which is exposed to outdoor temperatures. Heat tracing on wet fire protection systems is allowed only if acceptable to the local Fire Marshall.

- C. Types: The type of electric heating cable required for the project is self-limiting parallel resistance heat tracing cable.

1.03 Quality Assurance:

- A. Manufacturers: Provide products produced by one of the following:
1. Chromalox Precision Heat and Control
 2. ESG Electrical Group
 - a. Easy Heat
 - b. Nelson Heat Trace
 3. Raychem, Division of Tyco Thermal Controls
 4. Thermon Manufacturing Company
- B. UL Standards: Electric heating cable shall conform to all applicable standards and shall be UL-labeled.

Part 6 Products

2.01 Materials and Components:

- A. Parallel Resistance Heat Tracing Cable: Provide parallel resistance heat tracing cable in the ratings required with non conductive thermoplastic material jacket as required.
- B. Electric Heating Cable Thermostat: Provide raintight NEMA 4 enclosure electric heating cable thermostat with temperature range from 0 to 90°F, single or double-pole, single-throw switch with heavy-duty 600 volt ac, 20 ampere contacts and as instructed by the cable manufacturer.
- C. Electric Heating Cable Accessories: Provide electric heating cable accessories, including heat transfer foil, stainless steel banding strips and fiberglass tape as instructed by the manufacturer for each particular application.

Part 7 Execution

3.01 Installation:

- A. General: Install electric heating cable in accordance with the manufacturer's written instructions, the applicable portions of the NEC and recognized industry practices to ensure that products serve the intended functions.
- B. Installation: Install electric heating cable where shown. The tracing system shall be designed to maintain a 40°F water temperature within the traced pipe, with an ambient temperature of 0°F.
- C. Thermostats: Install thermostat sensing bulb on opposite side of pipe from electric heating cable to provide pipe heat sensing control.
- D. Coordination: Coordinate installation of electric heating cable with piping, fittings, valves and insulation.
- E. Insulation: Pipe insulation over heating tape and cable is specified in Section 15250.
- F. Power Circuit: Connect electric heating cables only to circuits protected by ground fault circuit interrupters providing 30 ma equipment protection.

3.02 Testing:

- A. General: Test heating tape and cable to demonstrate proper operation. Repair or replace malfunctioning or damaged tape and cable. Retest to demonstrate proper operation.

END OF SECTION 15070

Section 15080 — Electronic Variable Speed Drives

Part 1 - General

1.02 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.03 Description of Work:

- A. Included: Furnish and mount all electronic variable speed drives (VSD) ready for wiring as required for equipment furnished under this division. All line voltage wiring shall be done by the Division 16 Contractor.
- B. The technical requirements of this section shall also apply to variable speed drives provided as part of factory packaged equipment.
- C. Types: The types of electronic variable speed drives required for the project include, but are not limited to variable frequency motor speed controllers.

1.04 Standards:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the latest applicable standards of IEC, UL, ANSI, and NEMA.
- B. VSD design and construction shall comply with all applicable provisions of the National Electric Code.
- C. Each VSD shall comply with Part 15, Subpart J of FCC rules for Class A computing devices in the range of 7 to 30 MHz for conduction. FCC label of compliance shall be displayed on the VSD.

1.05 Quality Assurance:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Eaton Cutler-Hammer
 - 2. Square D
 - 3. Toshiba
 - 4. Yaskawa
- B. Factory Testing: To ensure quality, each VSD shall be subjected to the following factory tests:
 - 1. The integrated circuits shall undergo a 120-hour "burn-in" to test reliability. During the "burn-in" the temperature shall be cycled between 0 and 70°C.
 - 2. The completed unit shall undergo a fully loaded 24-hour "burn-in" while serving a varying induction motor load. Test load shall vary between 50% and 100% of rated HP capacity and shall include a minimum of 12 hours at rated HP.
 - 3. The unit shall be subject to a series of in-plant quality controlled inspections before approval for shipment from manufacturer's facilities.

1.06 Submittals:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of individual speed controllers with construction, dimensions, weights, ratings, voltage, poles, options, and all associated accessories clearly indicated.

2. Wiring diagrams for the drive power, bypass, and control sections.
3. A detailed description of drive operation and adjustable parameters.
4. A detailed description of factory testing.
5. Additional information as required in Section 15010.

1.07 Product Delivery, Storage and Handling:

- A. Store speed controllers in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle speed controllers carefully to avoid damage to material components, enclosure and finish.

Part 2 - Production

2.02 Electronic Variable Speed Drives:

- A. General: Provide electronic variable speed drives for control of standard or high-efficiency NEMA Design B induction motors as required for equipment
- B. Operation: Each variable speed drive shall convert available utility power to adjustable voltage/frequency, 3-phase, ac power for stepless motor control from 25 to 110% of motor 60 Hz speed.
 1. The variable speed drive (VSD) shall produce an adjustable ac voltage/frequency output for complete motor speed control. Speed control shall be stepless throughout the range under a variable torque load on a continuous basis. The VSD shall be automatically controlled by an external control signal.
 2. The VSD maximum output current rating shall be greater than or equal to the motor nameplate full load. The input power factor of the controller shall be 0.95 or greater under all speed and load conditions and the unit shall be rated for 100% operation at full rated current, voltage and frequency.
 3. The VSD shall contain a fused input power disconnect or circuit breaker with door interlock.
 4. A dedicated line filter shall be provided at the input of the VSD to limit EMI from interference with vital electrical equipment if required for FCC compliance as specified in Paragraph 2.09/C/3.
- C. Components: Each controller shall include, but not be limited to an input rectifier, constant voltage dc link, filter, sine-weighted pulse width modulation inverter and accessory sections with each section modularized for ease of troubleshooting. Controller shall be protected with I²T fuses or circuit breakers per the manufacturer's design and specification. All components shall be factory mounted and wired on a dead-front, grounded, free-standing or wall-mounted minimum NEMA 1 enclosure arranged for top or bottom conduit entry. The free-standing enclosure shall be suitable for mounting on a steel platform or on a concrete housekeeping pad.
 1. The controller enclosure shall be provided with the manufacturer's illustrated operating instructions and parts list mounted inside the enclosure door, manual speed control potentiometer or electronic manual control, three position mode selector switch (manual-

off-auto), "power on" light, diagnostic/frequency display, auxiliary relays, and contacts for interlock and control wiring.

D. Features: VSD features shall include, but not be limited to, the following:

1. Input Power: **[208] [480]** volts ac $\pm 10\%$, 60 Hz, ± 1.8 Hz. Input power factor shall be 0.95 or greater from full motor speed to zero speed for any motor load.
2. Output Power: Three phase, 0-**[480] [208]** volts, 2-60 Hz.
3. Ambient Temperatures: Operating: 0°C to 40°C (32°F to 104°F). Storage: -20°C to 60°C (-4°F to 140°F).
4. Frequency Stability: Output frequency will be held to $\pm 0.1\%$ of maximum frequency regardless of load, $\pm 10\%$ input voltage change or temperature changes within the ambient specification.
5. Disconnect: Locking type input disconnect switch with external operating handle.
6. Bypass: Manual bypass that isolates the drive from the circuit and allows motor operation at full across-the-line speed. Bypass shall include motor contactor, drive isolation contactors, motor overload protection, fused control power transformer and front panel mounted bypass controls.
7. Input Filter: Input line filter capable of protecting the electronics against transient voltage spikes or notches.
8. Current Limit: To limit output current to 110% of that of the drive rating. The current limit shall be designed to function automatically to prevent overcurrent trip due to momentary overload conditions, allowing the drive to continue operation.
9. Instantaneous Overcurrent Trip: To safely limit the output current in under 50 microseconds due to short circuit or severe overload conditions.
10. Undervoltage Trip: To protect the drive due to non-momentary power or phase loss. The undervoltage trip will activate automatically when line voltage drops 15% below rated input voltage.
11. Overvoltage Trip: To protect the drive due to voltage levels in excess of its rating. The overvoltage trip will activate automatically when the inverter bus in the controller exceeds 950 volts dc.
12. Ground Fault Protection: Fuseless electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.
13. Overload Protection: Electronic output overload protection shall be provided to eliminate the use of bimetallic overloads. The drive shall not be phase sequence sensitive. The overload protection shall also protect the motor when it is operated at full speed in the bypass mode.
14. Overtemperature Trip: To protect the drive from elevated temperatures in excess of its rating. An indicating light which begins flashing with 10°C of the trip point will be provided to alert the operator to the increasing temperature condition. When the overtemperature trip point is reached, this light will be continuously illuminated.
15. Automatic Reset/Restart: The drive shall be equipped such that a trip condition resulting from overcurrent, undervoltage, overvoltage or overtemperature shall be automatically reset, and the drive shall automatically restart upon removal, or correction of the causative condition. The number of reset/restart attempts for undervoltage, overvoltage, overtemperature and overcurrent shall be limited to five. If, in five attempts, a reset/restart is not successful, the drive shall shut down safely, requiring a manual restart. If, within five

attempts, a successful reset/restart occurs, the Auto Reset/ Restart circuit will reset the attempts counted to zero after approximately 10 minutes of continuous operation.

16. Power Interruption: In the event that an input or output power contactor is opened or closed while the drive is activated, no damage to the drive shall result.
17. Short Circuit Protection: In the event of a phase-to-phase short circuit the drive shall be designed to shut down safely without component failure.
18. Sustained Power Loss: In the event of a sustained power loss, the drive shall be designed to shut down safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation.
19. Momentary Power Loss: In the event of a momentary power loss, the drive shall be designed to ride-through a power interruption up to five cycles and shut down safely without component failure. Upon a more extended momentary power loss, the system shall be designed to automatically return to normal operation upon return of power.
20. Stand Alone Operation: To facilitate start-up troubleshooting, the drive shall be designed to operate without a motor or any other equipment connected to the drive output.
21. Start/Stop Control: The drive may be started or stopped by any one of the following:
 - a. A contact closure rated 50 ma, 115 volt ac minimum.
 - b. Use of a motor starter or contactor in the input power line.
 - c. The speed control signal dropping below or rising above minimum.
 - d. An external 115 volt ac signal.
 - e. Operation of momentary start/stop switch or pushbuttons. The drive shall include built-in holding contacts for this purpose.
22. Speed Control: The drive will adjust the output frequency in proportion to a [0-10 volt dc analog] [4-20 ma dc analog] input.
23. Minimum and Maximum Speed Control: Adjustable minimum and maximum speed potentiometers for all speed signals. Minimum range shall be 0-80%, field set at 40%. Maximum range shall be 100-0%, field set at 100%.
24. Signal Gain and Offset: Adjustable signal gain (1:1 to 10:1 range) and offset (0-50% of input signal for all speed signals).
25. Inverted Signal: Inverted speed signal selector switch to invert the response to input speed signal.
26. Automatic Reversing: Reversing terminals to automatically reverse the rotation of the motor(s) shall be available for customer use if so desired. When a contact closure is made across these terminals, the motor shall decelerate from its operating speed to zero at the

preset deceleration rate. Upon reaching zero, it shall reverse direction and accelerate to the set speed at the present acceleration rate.

27. Adjustable Accel/Decel: Independently adjustable acceleration and deceleration time potentiometers from 30-300 seconds, field set at 90 seconds.
28. Control Isolation: Low voltage logic and 115 volt control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.
29. Control Adjustments: All control adjustments shall be made without the necessity of an extender board or specialized meters, and from front accessible controls.
30. Diagnostics: A diagnostic fault detection center shall be integral to each VSD, providing an indication of the following fault conditions:
 - a. External fault.
 - b. Processor line fault.
 - c. Low ac line voltage.
 - d. High ac line voltage.
 - e. Current overload.
 - f. High dc bus voltage.
 - g. VSD output fault.
31. Status Indication: Status indication of conditions described in Items 1 through 5 shall be provided. An SPDT contact for remote indication of Items 2 through 5 shall be provided. Additionally, status to show "Power On", "Zero Speed", and "Drive Enabled" shall be

provided. All status indication shall be self-contained in the front panel of the unit and shall be duplicated for ease of troubleshooting on the inside of the unit.

32. Indicating Lights:

- a. Power On: Lights any time input power is applied to the drive.
- b. Zero Speed: Illuminates whenever the drive is at zero frequency.
- c. Enabled: Lights to indicate that the drive has a start command.
- d. Over Temperature: Begins flashing when the internal temperature of the drive is within 10°C of overheating. Upon reaching the overtemperature trip point, the light is continuously illuminated.
- e. Current Limit: Indicates that the Accel, Decel or Run Limit circuit is in operation.
- f. Undervoltage: Indicates that an undervoltage trip has occurred.
- g. Overvoltage: Indicates that an overvoltage trip has occurred.
- h. Overcurrent: Indicates that the current rating of the drive has been exceeded and the overcurrent trip circuit has been activated.

33. External Alarm Contacts: A single pole, double throw contact rated 115 volt ac, 28 volt dc, 1 amp resistive, shall be available for external monitoring. Contact will change state when any trip condition has occurred.

34. Speed Reference Signal: A 0 to 5 volt dc signal shall be provided for customer use. This 0 to 5 volt dc signal shall vary in direct proportion to the drive speed.

35. User Interface: The VSD shall have the following door mounted user interface devices:

- a. "Power On" light.
- b. Hand/Off/Auto (or equivalent) selector switch.
- c. Manual speed potentiometer.
- d. Digital Readout Frequency Meter/Diagnostic Display.

36. Cooling: The VSD shall be convection-cooled. Units requiring fan cooling are not acceptable. The unit shall have high temperature protection.

37. Control Power: A 115 volt ac, control power shall be available for customer use whenever drive input power is applied.

38. External Safeties: Fire alarm interface, safety and temperature control interlock terminals with door mounted "external fault" light.

39. Open Communication: The VFD shall be equipped with a factory installed open communications such as Modbus. The open communication will allow the DDC system to both push commands to the drive and pull information from the drive unit. All control points

shall be available to the DDC system and the unit shall be completely configurable without the use of proprietary software.

E. System Operation:

1. Selector switch in the "off" position - the controller run circuit will be open and the system will not operate.
2. Selector switch in the "manual" position - the speeds of the motor will be controlled by the manual speed potentiometer.
3. Selector switch in the "auto" position - operation will be via the external control input signal with the output speed proportional to the input signal.

Part 3 - Execution

3.03 Installation of Electronic Variable Speed Drives:

- A. General: Install electronic variable speed drives where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
- B. Supports: Provide all electronic variable speed drives with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Drives shall not be supported by conduit alone. Where drives are mounted on equipment served, the drive shall

not inhibit removal of any service panels or interfere with any required access areas. All drives shall be installed plumb and aligned in the plane of the wall in/on which they are installed.

- C. Coordination: The Division 15 Contractor shall coordinate electronic variable speed drive selection and installation including, but not limited to, the following:
1. Coordinate power wiring to electronic variable speed drives and served motors with the Division 16 Contractor.
 2. Coordinate selection of variable speed drives and served motors to insure compatibility.
 3. Coordinate variable speed drive control interface with controls and sequence of operation specified in Section 15950, "Direct Digital Control Systems".

3.04 Start-up/Testing:

- A. Pre-energization Check: The Division 16 Contractor shall check electronic variable speed drive power wiring for continuity of circuits and for short circuits.
- B. Start-up Services: A representative of the variable speed drive manufacturer shall provide start-up services for each drive including, but not limited to, the following:
1. Check out of drive control and power wiring.
 2. Start-up drive and demonstrate proper manual, automatic, and bypass operation.
 3. Adjust variable speed drive overload protection and other adjustable parameters to suit project requirements.
- C. Motor/Controller Coordination Documentation: Provide motor/controller coordination documents including, but not limited to, the following information in the operation and maintenance manuals.
1. Motor size in horsepower.
 2. Motor full load amps.
 3. Motor efficiency.
 4. Motor service factor.
 5. Size and manufacturer's catalog number of electronic variable speed drives.
 6. Setting of electronic variable speed drive overload protection and other adjustable parameters.
- D. Motor Rotation: Verify that motor rotation is correct as connected. Where rotation must be changed, the Division 16 Contractor shall reconnect phase conductors to motor leads at motor junction box.

3.05 Training:

- A. General: A representative of the variable speed drive manufacturers shall provide for and present to the Owner, at no cost, a training and troubleshooting course at the owner's location. This course shall be comprised of 4 hours of instructions complete with visual aids, documentation, circuit diagrams, and hands-on training. This course is not to be construed as a sales meeting, but rather as a school to familiarize the owner with the care, troubleshooting,

and servicing of the variable speed drives. The manufacturer's representative shall provide a list of recommended spare parts.

3.06 Identification:

- A. Refer to Section 15190 for nameplate requirements for all electronic variable speed drives.
- B. Each electronic variable speed drive shall have an internal wiring diagram on the inside of the drive cover and shall be labeled inside the cover to indicate the type, ampacity and horsepower rating of the unit.

END OF SECTION 15080

Section 15100 – Valves

Part 8 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide valves as specified and indicated.

[EDIT THE FOLLOWING SECTIONS TO SUIT PROJECT]

1.03 Quality Assurance:

- A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable, subject to compliance with the requirements of these Specifications.

1. General Valves:
 - a. Crane Company
 - b. Grinnell
 - c. Jenkins Bros. Valves
 - d. Kennedy Valve
 - e. Nibco
 - f. Stockham Valves and Fittings
 - g. Walworth Company
2. Ball Valves:
 - a. Apollo
 - b. Jamesbury Corporation
 - c. Jenkins Bros. Valves
 - d. Nibco
 - e. Stockham Valves and Fittings
3. Backflow Preventers:
 - a. Febco Sales, Inc.
 - b. Watts Regulator Company
 - c. Zurn Industries, Inc.; Wilkens-Regulator Division
4. Refrigerant Valves:
 - a. Henry Valve Company
 - b. Mueller Brass Company
 - c. Sporlan Valve Company
 - d. Superior Valve Company
5. Check Valves:
 - a. Clow Valve Company

- b. Crane Company
 - c. Gruvlok
 - d. Jenkins Bros. Valves
 - e. Milwaukee
 - f. Muesco, Inc.
 - g. Nibco
 - h. Stockham
 - i. Victaulic
6. Butterfly Valves:
- a. Apollo
 - b. Centerline
 - c. Demco
 - d. Grinnell
 - e. Gruvlok
 - f. Jamesbury Corporation
 - g. Jenkins Bros. Valves
 - h. Keystone
 - i. Nibco
 - j. Stockham Valves and Fittings
 - k. Victaulic

Part 9 Products

2.01 Materials:

- A. General: All valves shall be similar to numbers listed. All similar type and size valves shall be products of one manufacturer.
- B. Refrigerant Valves: Valves manufactured specifically for use in refrigerant systems shall be used in such systems.
- C. Butterfly Valves: All butterfly valves shall be full tapped and threaded lug type, manufacturer certified for bubble-tight, dead end shut off from either direction at design working pressure and temperature. Valves 2-1/2 through 5" in size shall have lever type operators. Valves 6" and larger shall have enclosed, self-locking worm gear type operators, waterproof, and factory-lubricated. Gear segment shall be manganese bronze or ductile iron with a steel or ductile iron worm and oil impregnated bronze bushings or worm shaft. Operator shall have built-in adjustable mechanical stops and position indicators. Valves used for balancing shall be certified suitable for continuous throttling service. Butterfly valves shall not be used on steam or high temperature hot water systems.
- D. Ball Valves: Valves shall be furnished with blowout-proof stems. Valves used for chilled water service shall be insulated as specified for the pipe in which the valve is installed. All ball valves shall be full-line size to prevent flow restriction through the ball.
- E. Gate Valves: All bronze gate valves shall have packing boxes with adequate depth to allow space for sufficient amounts of stem packing. Malleable iron handwheels and gland followers

shall be furnished on all bronze gate valves. All gate valves shall have non-asbestos stem packing suitable for pressure and service. OS&Y and IBBM gate valves shall be furnished with a stem lubrication fitting on all sizes. All gate valves shall be designed to permit repacking while the valve is in line.

2.02 Valves:

A. Valves for service at or less than 150 PSIG:

1. Block (Stop) Valves: Ball valves 2" and smaller shall be red brass, cast bronze, or yellow forged bronze with brass, stainless steel, or bronze ball and stem, 150 psig nonshock WOG at 200°F, equal to Jenkins Fig. No. 900T. Valves 2-1/2" and larger shall be butterfly type, 200 psig nonshock WOG at 200°F, ANSI Class 150 with ductile iron lug body. The replaceable resilient elastomer seat shall be Buna N or EPDM. The disc shall be silicon or aluminum bronze and shaft shall be No. 316 or No. 416 stainless steel. Secondary O-ring seals shall be provided at the top and bottom of the upper and lower shafts to guarantee zero leakage to the shaft, equal to Jenkins Fig. No. 232EL/EG or No. 632E.
2. Balancing Valves: Valves shall comply with the general requirements specified for block valves. Valves used for balancing shall have adjustable memory stops or position indicators. Valves 2" and smaller shall be equal to Jenkins Fig. No. 900TE. Valves 2-1/2" and larger shall be equal to Jenkins Fig. No. 232EL.
3. Gate Valves: As a general rule, gate valves shall not be used for sizes 2-1/2" and smaller. If necessary, with prior approval from the Construction Manager, valves 2-1/2" and smaller shall be equal to Jenkins Fig. No. 47-U, 200 psig WOG bronze body with screwed bonnet and ends. Valves 3" and larger shall be equal to Jenkins Fig. No. 651-A, 200 psig WOG.
4. Globe Valves: Valves 2" and smaller shall be equal to Jenkins Fig. No. 546-P, bronze body, bronze rising stem, screw-in bonnet, renewable seat, and screwed or solder ends. Valves 2-1/2" and larger shall be Jenkins Fig. No. 613, 200 psig WOG, outside screw and yoke (OS&Y), iron body, bronze-trimmed, renewable seat, Pressure Class 125, with ANSI B16.1 flanged ends.

B. Valves for Service Over 150 PSIG:

1. Block Stop Valves: Ball valves 2" and smaller shall be red brass cast bronze or yellow forged bronze with brass, stainless steel, or bronze ball and stem, 300 psig nonshock WOG at 200°F with Teflon packing and gaskets, equal to Jenkins Fig. No. 900T. Valves 2-1/2" and larger shall be 300 psig nonshock WOG, with Class 300 ANSI B16.5 flanges, full tapped and threaded cast steel lug body. Valves shall have 300 pounds body drilling and shall be suitable for service indicated on the Plans. Disc shall be cast steel and the shaft shall be No. 416 stainless steel. Secondary O-ring or gland seals at the top and bottom of the upper and lower shafts shall guarantee zero leakage to the shaft. Seals and backing rings shall be TFE or Viton. Seal retainer rings shall be No. 316 stainless steel, Dezurik No. 645.
2. Balancing Valves: Valves shall comply with the general requirements specified for block valves. Valves used for balancing shall have adjustable memory stops or position indicators.
3. Gate Valves: As a general rule, gate valves shall not be used for sizes 2-1/2" and smaller. If necessary, with prior approval from the Construction Manager, valves 2-1/2" and smaller shall be equal to Jenkins Fig. No. 270-U, 300 pounds WOG, bronze body, rising stem, with screwed bonnet and screwed ends. Valves 3" through 12" shall be equal to Jenkins Fig. No. 204, 500 pounds WOG, OS&Y valves with Class 250 ANSI B16.1 flanged ends, cast iron body and bronze trim.
4. Globe Valves: Valves 2" and smaller shall be equal to Jenkins Fig. No. 556-P, 400 pounds WOG, bronze body and trim, rising stem, union bonnet, renewable seat, and screwed ends.

Valves 2 1/2" through 8" shall be equal to Jenkins Fig. No. 923, 500 pounds WOG, iron body, bronze trim rising stem, OS&Y Class 250 ANSI B16.1 flanged ends.

- C. Check Valves: Chilled, hot, condenser, and domestic water pipes 2-1/2" and larger shall be, spring-loaded, quiet type. Valve nonshock pressure temperature rating shall be as specified for piping in which it is installed. Valve shall be full-threaded, lug body, or flanged body. Valves 2" and smaller shall be equal to Jenkins Fig. No. 92A. Threaded valves installed at pump discharge shall have its shaft perpendicular to the pump shaft. Valves located in pumped sewage pipes and in storm pipes shall be equal to Crane No. 383 outside weight, 200 pounds WOG, iron body, bronze trimmed, with swing check design.
- D. Valves for Water Make Up Connections: Valves 2" and smaller shall be equal to Jenkins Fig. No. 900T. Valves 2-1/2" and larger shall be equal to Jenkins Fig. No. 632B or No. 632E, butterfly valve operator furnished per Paragraph 2.01/C.
- E. Relief Valve: Temperature and pressure, self-closing, lever operated with thermo-bulb extension, 3/4", ANSI B2.1 taper thread male inlet connection, 210°F (98.8°C) and 125 psig setting, ANSI Z1.22, equal to Watts Regulator Company Type No. 40XL.
- F. Combination Pressure Reducing and Relief Valve for Make Up Water: Bell and Gossett Model Number 3, dual unit.
- G. Reduced Pressure Backflow Preventer: Backflow preventer shall be equal to Watts Regulator No. 909 Series, 2-1/2" and larger shall be provided with dual "Y" pattern spring-loaded check valves and independent relief valve located between checks. Backflow preventers shall be

rated for pressure up to 150 psig working pressure at 140°F (60°C) and sized according to the maximum design flow.

- H. Domestic Water Pressure Reducing Valves: Watts Regulator 223S or Clayton 90G-01. Pressure and flow schedule as indicated on the Drawings.

Part 10 Execution

3.01 Installation:

- A. General: Except as otherwise indicated, comply with the following requirements.
- B. Ball Valves: Provide ball valves on branch service runout to each piece of terminal equipment, at each coil, and elsewhere as shown on the Drawings.
- C. Valve Stems: Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.
- D. Chain Operators: In central plant and in fan or mechanical rooms where chilled water and condenser water valves are installed over 8' above floor, provide chain operators.
- E. Swing Check Valves: Swing check valves shall be installed in horizontal piping only.
- F. Unions and Companion Flanges: Provide unions or companion flanges where required to facilitate dismantling of valves and equipment.
- G. Access Doors and Panels: Verify the location and quantity of access doors or panels required to provide full valve access.
- H. Backflow Preventer: All relief assemblies off of backflow prevention devices shall be piped to the nearest floor drain.
- I. Relief Valve: All relief valves including factory installed relief valves on boilers and domestic water heaters shall be piped to the nearest floor drain.

END OF SECTION 15100

Section 15135 - Meters and Gauges

Part 11 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide meters, gauges, taps, and accessories as specified and indicated.

Part 12 Products

2.01 Gauges and Thermometers:

- A. Pressure Gauges: Gauges shall be Ashcroft, Ernst Gage, Marsh Instrument, Miljoco, Trerice, Weksler, Moeller, or Weiss with 4-1/2" dial face, cast aluminum case, stainless steel movement with Grade A phosphor bronze bourdon tube, Plexiglas dial cover and micrometer type calibration adjustment screw. Accuracy shall be 1/2% of full scale. Provide a gauge cock and

pulsation dampener in pressure tube to gauge. Use liquid filled gauges, using duplex style (pressure & vacuum), where required. Graduation shall be one pound or less.

- B. Thermometers: Thermometers shall be Terice, Weksler, Miljoco, Moeller, or Weiss solar-operated electronic type with high-impact ABS plastic case, minimum 3-1/2" union stem and complete with separable brass or stainless steel socket well. Thermometers shall be straight, incline or recline, selected and installed as best suited for ease in reading
- C. Range and Graduations: Gauges and thermometers shall be selected to give range and graduations best suited for quantities to be measured. Generally, gauges and thermometers shall be selected so that normal operating pressures and temperatures are neither more than 2/3 nor less than 1/2 of the range, scale division shall be 2°F or less. Typical ranges shall be:
 - 1. Heating Hot Water: 30 - 240 °F with 2 °F scale divisions.
 - 2. Chilled Water: 0 - 100 °F with 1 °F scale divisions.
 - 3. Condenser Water: 30-130°F with 1°F scale divisions.
 - 4. Domestic Hot Water (Dial Type): 30 - 240 °F with 2 °F scale divisions.
 - 5. Water: 0 - 100 psi with 1 pound scale divisions.
- D. Thermometer Wells: Thermometer wells shall be located so that the sensing bulb will give a true and correct reading. Thermometer wells shall be installed so as not to cause undue restriction in small piping. Where wells are located in pipe lines 1-1/2" and smaller, provide a section of pipe of such diameter that the net area of the pipe line will not be reduced by the thermometer well. Wells shall be filled with thermal grease and complete with caps and chains.

2.02 Pressure and Temperature Taps:

- A. Location: Provide pressure and temperature taps as required for start-up, balancing, and trouble shooting.
- B. Taps: Taps shall be 1/2" solid brass fittings which will receive either a pressure or temperature probe, with valve core of Nordel, and fitted with a color coded cap and gasket. Taps shall be "Pete's Plug" (Peterson Engineering Company, PO Box 217, Richardson, Texas 75080, 214/235-8393) or "Sisco P/T Plugs", (Sisco, PO Box 197, Riverton, N. J. 09077, 609/829-8686) No. 710, rated at 275°F and 1000 psig.
- C. Instruments: Furnish two each, No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes and four each 5" stem pocket thermometers: Two "Pete's Plug" or "Sisco

P/T Plug" No. 601 with 25 to 125°F range for condenser water and two "Pete's Plug" No. 603 with zero to 220°F range for heating water.

2.03 Gauge Cocks:

- A. Locations: Gauge cocks to be used for test gauges shall be provided in the entering and leaving piping to equipment, coil, coil control valve, orifice metering flange, and at other locations required for balancing and start-up.
- B. Manufacturer: Gauge cocks shall be brass lever handle type equal to Crane No. 88 needle valves, or approved equal.

Part 13 Examination

3.01 Installation:

- A. General: Install meters and gauges in accordance with the manufacturer's written instructions and in locations indicated. Position meters and gauges so that they are easy to read standing on the floor and accessible for inspection and maintenance.
- B. Thermometers and gauges shall be selected so that normal operating conditions is located the middle of the gauge range.
- C. Pressure Gauge Locations: A gauge shall be installed in the following locations:
 - 1. To indicate the suction and discharge pressures of each pump
 - a. A single gauge valved to read either inlet or outlet pressure shall be acceptable at pumps so long as the low and high of the normal operating pressure do not fall outside of the upper or lower ½ of the range.
 - 2. At incoming city water pressure
 - 3. Downstream of domestic booster pump
 - 4. Downstream of each pressure reducing valve
 - 5. At each fire system riser
 - 6. Dry system air pressure
 - 7. At inlet and outlet of each plate type heat exchanger
 - a. A single gauge valve to read either inlet or outlet pressure shall be acceptable at hat exchanger so long as the low and high of the normal operating pressure do not fall outside of the upper or lower ½ of the range.
 - 8. At the inlet and outlet of each strainer/filter including at air separators and pump suction diffusers.
 - 9. Elsewhere as indicated or required for proper balancing and maintenance of the system.
- D. Thermometer Location: A thermometer shall be installed in the following locations:
 - 1. In each supply and return main located at the central plant
 - 2. At inlet and outlet of each boiler, chiller, or cooling tower
 - 3. At the connections to each air handling unit coil
 - 4. At inlet and outlet of each heat exchanger
 - 5. Adjacent to each immersion controller
 - 6. Elsewhere as required for proper balancing and maintenance of the system

END OF SECTION 15135

Section 15140 –Hangers, Supports, and Anchors

Part 14 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.
- B. Reference applicable project piping system specifications for additional support requirements.

1.02 Description of Work:

- A. Work Included: Provide hangers, supports, and required appurtenances as specified and indicated.

1.03 Quality Assurance:

- A. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.
- B. Acceptable Manufacturers: The manufacturer specific model numbers listed herein establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of this Specification:
 - 1. Anvil Corporation (formerly ITT Grinnel Corporation)
 - 2. Carpenter and Patterson, Inc.
 - 3. Central Iron Manufacturing Company
 - 4. Cooper B-line, Inc.
 - 5. Elcen Metal Products Co.
 - 6. Fee and Mason Mfg. Co.
 - 7. F & S Manufacturing Company.
 - 8. Michigan Hanger
 - 9. Persing & Co.
 - 10. PHD Manufacturing
 - 11. Powerstrut
 - 12. Thomas & Betts Superstrut

Part 15 Products

2.01 Pipe Hangers and Supports:

- A. General: Comply with local codes and standards for pipe and equipment support and anchorage.
- B. Materials: Pipe supports shall be of material that will prevent electrolytic action. Exterior pipe supports and supporting materials shall be galvanized finished with zinc-coated fasteners. Use a galvanizing repair finish of not less than 94 percent zinc dust by weight for regalvanizing exterior welds of ferrous metals.
- C. Inserts: Provide Grinnell No. 282 inserts for concrete construction.
- D. Piping in Single Runs: Provide Fee and Mason Fig. 239 or Grinnell No. 260 clevis hanger.

- E. Piping in Multiple Parallel Runs: Provide Grinnell No. 45 or No. 50 with Grinnell No. 137 U-bolt pipe clamps or structural channels or angles with U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Select and size members for weights to be carried and span dimensions between supports.
- F. Hanger Rod: Provide hanger rods of required length at appropriate to handle piping loads and structure movements.
- G. Riser Clamps: Provide Fee and Mason Figure 241 riser clamps. Riser clamps for copper tube shall be copper-plated.
- H. Saddles and Shields:
 - 1. Saddles for Horizontal Insulated Piping Without Vapor Barrier: At each hanger or support on horizontal runs, provide Grinnell No. 160 or Fee and Mason Figure 171, 1710, 1712, or 172 saddles, as applicable. Shields as described below may be used instead of the saddles. Where dissimilar materials are used, provide dielectric separation. Carry insulation over the hanger and seal where hanger is sized for pipe.
 - 2. Shields for Horizontal Insulated Water Piping With Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed 6 PCF density fiberglass or rigid calcium silicate, with jacket of adjacent insulation brought across unbroken, supported on semicircular 16 gauge shields. Shields for pipe 4" and smaller shall be 12" long; shields for pipe 5 to 8" shall be 18" long; and shields for larger pipe shall be 24" long.
- I. Piping on Roof: Roof mounted pipe supports are discouraged. If roof supports are necessary, installation methods must be approved by VPTC Management Partners, LLC and the Roofing Contractor.

2.02 Roof Supports:

- A. Large (over 6-inch diameter) gas piping or cooling water line supports:
 - 1. Shall be prefabricated system with bases to accommodate uni-strut tube frame as required to support number and size of piping to be supported.
 - a. C-Port CB-Series support with hanger accessory components, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 6-H with clevis hangers, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PSE with clevis hangers, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- B. Medium (3-inch to 6-inch diameters) gas line or conduit line supports:
 - 1. Gas line supports shall be prefabricated system with base to accommodate threaded rods and roller support:
 - a. C-Port CE-Series support with roller accessory components, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 5-RAH or 5-RAH-12 with roller, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PPH-RB18 with roller, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
 - 2. Conduit line supports shall be prefabricated system with base to accommodate threaded rods and channel/strut support as required by number and size of lines:
 - a. C-Port CE-Series support by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 16-Base Strut P, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.

- c. Model PP10 with Channel, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- C. Small (less than 3-inch diameter) gas line pipe supports:
 - 1. Shall be prefabricated system with base to accommodate threaded rods and roller support:
 - a. C-Port CR-Series support, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 3-RAH or 3-RAH-12, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PP10 with Roller, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
 - 2. Shall be prefabricated system with base to accommodate threaded rods and channel/strut support with clevis hanger(s):
 - a. C-Port CE-Series support with hanger accessory components, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 2.5 SB-H, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PP10 with Channel & Hanger, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- D. Duct supports:
 - 1. Shall be prefabricated system with bases to accommodate uni-strut tube frame as required to support exact ductwork sizes and equipment to be installed.
 - a. C-Port CS-Series support, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model No. 8-DS, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PPH-D, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.

Part 16 Execution

3.01 Installation:

- A. Independent Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards.
- B. Provisions for Movement:
 - 1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
 - 2. Load Distribution: Install hangers and supports to evenly distribute weight and so piping live and dead loading and stresses from movement will not be transmitted to any pipe or connected piece of equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations. Piping shall be fully supported from hangers and supports prior to connection to equipment and/or flanges.
 - 3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.
- C. Insulated Piping: Comply with the following installation requirements:
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold, chilled, or heating water piping, install coated protective shields. For pipe 8" and over, install rigid calcium silicate insulation between saddles and pipe.
 3. Where insulation without vapor barrier is indicated, install protection saddles, or use hangers as indicated in Paragraph 2.01/G.1.
- D. Spacing: Hangers and supports shall be installed as required by the following table. Local code requirements shall override. Refer to MSS Standard SP-69 for applications not listed:

HANGER SPACING BY PIPING MATERIAL

<u>Nominal Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Minimum Rod Size</u>
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Schedule 40 Steel

≤1"	7'	1/4"
1-1/4"-1-1/2"	9'	3/8"
2"	10'	3/8"
2-1/2"	11'	3/8"
3"	12'	3/8"
4"	14'	1/2"
5-6"	17'	1/2"
8"	19'	5/8"
10"	20'	3/4"
12"	23'	7/8"
14"	25'	1"

Copper Tubing

≤3/4"	5'	1/4"
1"	6'	1/4"
1-1/4"-2"	8'	3/8"
2-1/2"	9'	3/8"
3"	10'	3/8"
4"	12'	1/2"

Lead and Oakum Cast Iron

All sizes	Maximum 5', except 10' spacing where 10' lengths of pipe are installed, located within 18" of joint.	1/2"
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Compression and Hubless Cast Iron

All sizes	Up to 4' section length - at every other joint; >4' pipe lengths -on each side of coupling, located within 18" of joint.	1/2"
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Schedule 40 PVC and ABS

≤2"	4'	1/4"
3-8"	4'	3/8"
≥10"	4'	1/2"

- E. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 10'.
 2. Steel pipe shall be supported at the base and at not less than every other story level, but in no case at intervals greater than 25'.
 3. Copper tube shall be supported at each story level, but in no case at intervals greater than 10'.
 4. Plastic pipe shall be supported at mid point between floors and at ceiling to prevent movement, but in no case at intervals greater than 8'.
- F. Guides: Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.
- G. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.
1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturers written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.

2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
- H. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.
- I. Hangers: Refer to Section 15240, "Vibration Isolation", for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.

END OF SECTION 15140

Section 15170 – Mechanical Pumps

Part 17 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide pumps as specified and indicated.
- B. Work of Other Sections:
1. Refer to Division 16 for electrical connection work required in conjunction with pump motors (not work of this Section), controllers, and alarms.
 2. Refer to Section 15240, "Vibration Isolation", for materials required for isolation of pumps.
 3. Refer to Section 15250, "System Insulation", for piping and equipment thermal insulation work required in conjunction with pumps.
 4. Refer to Section 15510, "Mechanical Piping Systems", for flexible piping connections at pumps.

1.03 Quality Assurance:

- A. Manufacturers: Provide products by one of the following:
1. Armstrong Pumps, Inc.
 2. Aurora Pump Company
 3. Bell and Gossett, ITT Division,
 4. Marshall Engineered Products Company
 5. Peerless Pump Company
 6. TACO Incorporated
 7. Wienman Pumps
- B. Electrical Standards: Provide electric motors and products which have been listed and labeled by Underwriters' Laboratories, Inc. (UL) and comply with National Electrical Manufacturers' Association (NEMA) standards.
- C. Certification, Pump Performance: Provide pumps whose performance, under specified conditions, is certified by the manufacturer.

Part 18 Products

[EDIT THE FOLLOWING SECTIONS TO SUIT PROJECT]

2.01 [Chilled, Condenser and Heating Hot Water Pumps:]

A. [Horizontal Split Case Pumps:]

1. **General:** Horizontal split case pumps, where used, shall have the capacities required for the application. Pump performance shall be shown on curves of pressure versus flow. Operating point shall be at a minimum efficiency of 75% and impeller diameter shall not materially exceed 85% of the maximum size that the casing will accept. Pump discharge velocities shall not exceed 12' per second for chilled water and heating water service. Total dynamic head shall be a maximum at no-flow and decrease from no-flow to design flow. Shut-off head shall be more than 110% of design head but less than 140% of design head. Pumps shall have hydraulically and dynamically balanced impellers. Pumps shall be free of flashing and cavitation at all flow rates from 25 to 125% of design flow under the suction conditions of the pump installation. The percent of maximum diameter shall be noted on the Shop Drawing submittal.
2. **Features:** Pumps shall have 300 psig minimum casings, enclosed double suction impellers, SAE 1045 steel shafts for packing gland pumps, stainless steel shafts for mechanical steel pumps, cast iron casing wearing rings, bronze impeller wearing rings, cast iron deflectors, stainless steel impeller key, coated fiber parting gasket, steel casing studs and bolts, and internal drilled passages to lantern rings. Mechanical seals shall be used on all chilled and heating water pumps. Packing gland seals, used on condenser water pumps, shall consist of five rings of graphite asbestos packing, bronze split glands, bronze lantern rings, brass gland clips, stainless swing bolts and nuts, and 500 Brinnell hardness stainless steel sleeves. A manually operated petcock shall be installed on the vent tapping on the top of the casing. Removal of the upper half of the pump casing shall allow removal of the rotating element without disconnecting the suction and discharge piping. Pump shall be provided with 125 lb flanged suction and discharge connections.
3. **Performance:** Pumps having motors larger than 10 HP shall be capacity tested after final assembly. Provide for each pump, a certified shop performance test curve indicating capacity, head, horsepower, and efficiency at flow rates from shutoff to 125% of design flow. When the pumps are shipped from the factory, the manufacturer shall transmit three copies of a certified letter stating that the pumps have been dynamically balanced, pressure tested, and capacity tested. The certified shop performance test curves shall accompany the certified letter. No pump shall be installed before its test data has been reviewed by the Design Engineer and VPTC Management Partners, LLC.
4. **Seals:** The mechanical seals shall be as manufactured by John Crane Company, Environamic Inc., Chesterton, or Durometallic Inc. and shall be suitable for the service specified:
 - a. Seals for stuffing box working pressures 150 psig and below shall be equal to John Crane Company Type 1 or Type 2.
 - b. Seals for stuffing box working pressures greater than 150 psig shall be equal to John Crane Company Type 1B.
 - c. After the pumps are in operation for 90 days, the Contractor shall check the seals and replace any that are defective.
5. **Bearings:** Pumps shall have grease-lubricated ball bearings, grease fittings, and relief plugs. Bearings shall have a minimum B-10 life of 40,000 hours minimum life below 200 psig suction pressure and 20,000 hours for suction pressures above 200 psig. Bearings shall be removable without removing the rotating element or dismantling the pump.
6. **Base:** Base shall have cast iron or fabricated steel drip lip bases, coupling guard, provisions for grouting, anchor bolts, and collection of all seal leakage. The base shall

have machined surfaces for the motor and pump mounting surfaces. Motor mounting shall permit horizontal adjustment. A threaded outlet of 3/4" minimum size shall be provided in the base at the pump end for field piping of drainage to drain. The base shall be of sufficient strength to prevent vibration, warping, or misalignment of the pump and motor when installed without grouting. The base shall be rigidly bolted to the concrete base. After final alignment, all pumps 25 HP and over shall have the pump and motor doweled to the base. In addition, the minimum requirements of the fabricated structural steel base shall be as follows:

- a. Pumps with 20 HP and smaller motors shall have steel bases adequately stiffened as required to prevent "oil-canning".
- b. Pumps with 25 HP and larger motors shall have bases constructed of structural shapes and formed steel section. The main structural member and formed steel sections shall have a depth of at least 1/2 the overall length of the base, but not less than 4". Standard or factory bases that do not meet this requirement shall be certified by the pump manufacturer to be constructed with sufficient strength to prevent vibration, warping, and misalignment of the pumps. The base shall be filled with concrete or grout after installation on the isolation base. Concrete and grout shall be provided by this Contractor.

1) Grout-less bases by ITT Bell & Gossett may be installed on pumps with 25 HP and larger motors with prior approval from VPTC Management Partners, LLC.

7. Couplings: Pumps shall have couplings using tapered split hubs and resilient torque transmitting members, not requiring shrink fit or press fit to pump or motor shaft. Align shafts of motors and pumps within recommended tolerances by the manufacturer, and in the presence of the manufacturer's representative. Provide a certified report for each pump
 8. Motors: Pumps shall have drip-proof motors suitable for electrical service with a service factor of 1.15 and a rated temperature rise of 104°F (40°C). Motors and pumps shall be factory-mounted and aligned on bases. Motors shall not overload when operation is from 0 to 125% of design flow on the pump characteristic curve.
- B. [End Suction Base-mounted Pumps:]
1. General: End suction, vertical split case, base-mounted pumps, where used, shall have the capacities required by the application. Pump performance shall be shown on curves of pressure versus flow. Operating point shall be at a minimum efficiency of 70% and impeller diameters shall not materially exceed 85% of the maximum size the pump casing will accept. Where pump curve has a "hump", operating point shall fall below the head at the shutoff point. Impellers shall be enclosed and shall be hydraulically and dynamically balanced.
 2. Features: Pump shall have casings of 300 psi duty gray cast iron, shafts shall be high tensile carbon steel, and bearings shall be grease-lubricated bronze sleeve or ball bearings. Provide pumps with John Crane (see Paragraph 2.01/A.4) mechanical seals, Alemite type grease fittings. A manually operated petcock shall be installed on the vent tapping on the top of the casing. Pump shall be provided with 125 lb flanged suction and discharge connections.
 3. Design: Pumps and motors shall be individually mounted on pump base so that bearing assembly and impeller can be removed without disconnecting piping, removing pump casing, or removing motor. Pump shaft shall be supported from removable bearing assembly bolted to pump casing and shall be connected to pump motors by flexible coupling.
 4. Motors: Pump motors shall be suitable for the electrical characteristics available. Motors shall be open drip-proof with service factor of 1.15, rated for a 104°F (40°C) temperature

rise. Motors shall not overload when operation is at any point of the pump characteristic curve.

5. Bearings: Bearings shall be grease lubricated and shall have a minimum B-10 life of 20,000 hours.

2.02 Circulating Pumps:

- A. General: In-line circulating pumps shall be cast iron body construction of the size, type, and capacity required by the application. Pumps shall be fitted with a hydraulically and dynamically balanced, bronze enclosed type impeller with mechanical seal. Mechanical seal shall be Type 1 or Type 2 material, Code BP-1D1 as manufactured by John Crane Company or an approved equal, suitable for service specified. Motor shall have a maximum speed of 1750 rpm. Pumps, casings, flanges, and seals shall be suitable for operation with the working pressures and temperatures required. The working pressure applies to the entire pump assembly.

2.03 Pump Accessories:

- A. Pump Suction Diffusers:
 1. Cast-iron body, with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 300 deg F maximum operating temperature; and complete with the following features:
 - a. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
 - b. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
 - c. Disposable fine mesh strainer to fit over cylinder strainer.
 - d. Permanent magnet, located in flow stream, removable for cleaning.
 - e. Adjustable foot support, designed to carry weight of suction piping.
 - f. Blowdown tapping in bottom; gage tapping in side.

Part 19 Execution

3.01 Inspection:

- A. General: Installer shall examine the bases upon which and conditions under which pumps are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 Installation of Pumps:

- A. General: Install pumps in accordance with manufacturer's written instructions and recognized industry practices to ensure that pumps comply with requirements and serve intended purposes. Comply with NEMA standards and requirements of NEC.
- B. Alignment: Align shafts of motors and pumps to manufacturer's tolerances in the presence of the manufacturer's representative. A certified report shall be submitted by the manufacturer for each pump.

- C. Vibration Isolation: Install units on vibration mounts and isolation bases as required to prevent vibration transfer to building structure.
- D. Lubrication: All pumps installed are to be lubricated per the manufacturers' recommendations.
- E. Pumps for chilled water service shall be provided with a factory installed welded seam drain pan under the pump . The drain pan outlet shall be piped to the nearest floor drain.

3.03 Pump Accessories:

- A. Install suction diffusers on all end-suction centrifugal pump's suction line in lieu of reducing elbow, entrance pipe, and pressure gage outlet. Install on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and shutoff valve in blowdown connection.
- B. Install flexible connectors on all pump on the equipment side of the shut-off valves. Piping and pumps flanges shall be aligned to prevent forces in flexible connectors and in compliance with manufacturer's requirements.

3.04 Electrical Connections:

- A. Grounding: Provide positive electrical pump and motor grounding in accordance with applicable requirements of the NEC.

3.05 Field Quality Control:

- A. Field Test: Upon completion of pump installation and after motor has been energized from normal power source, bleed air from pump casing and test pump to demonstrate compliance with requirements. When possible, field-correct malfunctioning units then retest to demonstrate compliance. Replace units that cannot be satisfactorily corrected.
- B. Start-up: During start-up and system flushing, fine-mesh construction strainers shall be installed. After start-up and completion of piping system flush, construction strainers are to be removed and final strainer sets installed.

3.06 Horizontal Split Case and End Suction Pumps:

- A. Erection: Pumps shall be leveled, then bolted and grouted to pump bases. Piping shall be arranged so that pump cases are not subjected to any piping forces. Contractor shall check for proper angular and concentric alignment of pumps and motors before pumps are operated. Run full sized drain connections from drip lip bases of horizontal split case pumps to nearest floor drain.

END OF SECTION 15170

Section 15190 – Mechanical Identification

Part 20 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements”, and Section 15010, “Basic Mechanical Requirements”, govern this Section.

1.02 Description of Work:

- A. Work Included: Identification of mechanical equipment shall consist of equipment labeling, ductwork marking, pipe marking, and valve tagging as specified hereinafter.
 - 1. In general, all equipment shall be labeled. This shall include all central plant, air handling or air conditioning equipment, and other similar and miscellaneous equipment.
 - 2. Pipe markings shall be applied to all piping.
 - 3. Each valve shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8 ½” x 11” paper, tabulating valve number, piping system, system abbreviation, location of valve (Room or area), and service (e.g. – 2nd Floor North Domestic Hot Water). The valve schedule shall be submitted to VPTC Management Partners, LLC for approval prior to ordering or installing valve tags. See Section 15010, “Basic Mechanical Requirements” for information and requirements regarding Operation and Maintenance Manuals.
 - 4. Labels, tags, and markers shall comply with ANSI A13.1 and other applicable state and local standards for lettering size, colors, and length of color field.
 - 5. Equipment and device identification specified in other sections shall be provided as a part of those requirements.

Part 21 Products

2.01 Equipment Labeling:

- A. Equipment labeling shall be one of the following, unless noted or specified otherwise:
 - 1. Permanently attached engraved brass or plastic laminated signs with 1” high lettering. Signs on exterior equipment shall be brass.
 - 2. Stencil painted identification, 2” high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.02 Ductwork Markings:

- A. Ductwork marking shall be color-coded, laminated plastic pressure sensitive vinyl tape, 2 ½” width, 3 mils minimum thickness. Identification shall include service (e.g. – Supply, return, exhaust, outside air), as well as the direction of air flow.

2.03 Pipe Markings:

- A. On piping less than 6” diameter, install plastic semi-rigid snap-on type, manufacturer’s standard pre-printed color-coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to the above. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.
- B. On piping and insulation 6” and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-

coded plastic tape not less than 1 ½" wide, full circle at both ends of the marker. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.04 Valve Tags:

A. Valve tags shall be polished brass or plastic laminate with solid brass S hook and chain. Tags shall be stamped or engraved with the appropriate abbreviation for the type of service (e.g. – CHW, HW), as approved by VPTC Management Partners, LLC, as well as the designated valve number.

B. A valve schedule is to be provided to VPTC Management Partners, LLC. For each page of valve schedules, a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.05 Approved Manufacturers:

A. Labels, markings, and tags shall be manufactured by W.H. Brady, Brimar Industries, Seton Name Plate Corp, Allen-Bailey Tag & Label, or Industrial Safety & Supply.

Part 22 Execution

3.01 General:

A. Identification labeling, marking, and tagging shall be applied after insulation and painting has been completed.

B. Coordinate names, abbreviations, and other designations used in mechanical identification work with corresponding designations shown, specified, or scheduled on drawings. Prior to ordering any labels, markings, or tags, obtain the approval of VPTC Management Partners, LLC regarding names, abbreviations, etc.

C. The Plumbing, HVAC, and Fire Suppression Contractors shall coordinate labeling, marking, and tagging to ensure consistent and coordinated identification. In existing buildings, utilize similar names, abbreviations, and other designations that are currently in use to remain consistent with existing identification.

D. Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or the room or area of service.

E. Pipe and ductwork markers shall be placed on piping and ductwork on 25' centers in mechanical rooms and concealed spaces. In locations where piping and ductwork is exposed, place markers on 50' centers. Flow directional arrows should be marked on the piping at taps from the main and riser.

F. Valve tags shall be placed on each valve except those intended for isolation of individual heat pumps or terminal units (e.g. - VAV boxes, fan coil units, unit heaters, etc.). Valve tag schedules shall be prepared as specified hereinbefore. Copies of one schedule shall be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION 15190

Section 15240 – Vibration Isolation

Part 23 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 15010, "Basic Mechanical Requirements", govern this Section.
- B. The requirements of this section shall apply to all other Division 15 equipment sections.
- C. Refer to Section 15510 – Mechanical Piping Systems, for flexible piping connections associated with vibration isolation.
- D. Refer to Section 15891 – Ductwork, for flexible ductwork connections associated with vibration isolation.

1.02 Description of Work:

- A. Work Included: Provide and install vibration isolation products as specified and indicated, including the following:
 - 1. Vibration control bases:
 - a. Support isolation for motor-driven mechanical equipment
 - b. Inertia base frames in conjunction with equipment isolation
 - 2. Vibration control mounts:
 - a. Support isolation of air-handling housings
 - 3. Vibration control hangers:
 - a. Support isolation of piping
 - b. Support isolation for piping risers
 - 4. Horizontal Thrust Restraints:
 - 5. Rooftop Isolation Curbs:

1.03 Quality Assurance:

- A. General: Except as otherwise indicated, obtain support isolation units from a single manufacturer.
- B. Supervision: Manufacturer shall provide technical supervision of the installation of support isolation units produced by him and of associated inertia bases.
- C. Manufacturers: Provide vibration isolation support units manufactured by one of the following or an approved equal:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Vibration Eliminator Co., Inc.
 - 4. The VMC Group
 - a. Amber/Booth Co.
 - b. Korfund Dynamics Corporation
 - c. Vibrations Mounting and Controls, Inc.

Part 24 Products

[EDIT THE FOLLOWING TO SUIT PROJECT]

2.01 General Application Requirements:

- A. General: Comply with the minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers, including the definitions of critical and non-critical locations, for the selection and application of vibration isolation materials and units as indicated.
 - 1. General: Except as otherwise indicated, select vibrations control products in accordance with ASHRAE Handbook, 2003 Applications Volume, Chapter 47 "Sound and Vibration Control", Table 42.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's instructions for selection and application of vibration isolation materials and units.
- C. "Outdoor" isolators shall be protected as follows: Steel parts other than springs shall be dry galvanized; springs and hardware shall be cadmium plated or otherwise suitably coated to resist corrosion.
- D. Vertical limit restraints shall be built-in to all units, rails and bases which support equipment whose weight varies with the addition or removal of large amounts of water, such as cooling towers, chillers, boilers and for equipment installed on rooftops subject to wind loads.

2.02 Vibration Control Bases:

- A. TYPE 1: Structural steel bases:
 - 1. Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and

pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells.

2. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
 3. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch.
- B. TYPE 2: Isolation rail bases:
1. Bases shall be structural beam sections with welded on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer.
 2. Beam sections shall not be structurally connected to each other.
 3. Minimum section depth of each member shall be equal to 8% of the longest span between supporting isolators, or as shown on the drawings or indicated on the project documents.
 4. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment.
- C. TYPE 3: Concrete filled inertia bases:
1. Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases shall be engineered for a minimum base to equipment weight ratio of 2: 1.
 2. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity
 3. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6".
 4. Forms shall include minimum concrete reinforcement consisting of half-inch bars or angles welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions
 5. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations.
 6. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base.

2.03 Vibration Control Mounts:

- A. TYPE 1: Neoprene pads:
1. Isolation pads shall be high quality elastomer suitable for minimum 120 psi loading.
 2. Pads shall be installed in multiple layers with galvanized steel shims between layers as required by loading. Single thickness pads of higher psi rating may be substituted for multiple layer pads with the approval of the Architect/Engineer.
- B. TYPE 2: Neoprene mounts:
1. Double deflection neoprene mountings shall have a minimum static deflection of 0.35".
 2. All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for these areas where bolting is required.

3. On equipment such as small vent sets and close-coupled pumps, steel rails shall be used above the mountings to compensate for the overhang.

C. TYPE 3: Spring mounts:

1. Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support.
2. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.
3. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

D. TYPE 4: Restrained spring mounts:

1. Equipment with operating weight different from installed weight, and equipment subject to wind loads shall be mounted on TYPE 3 Spring Mounts with integral housing as described herein.
2. Housing shall include vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection of cooling tower mounts and

shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same.

3. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operations.

2.04 Vibration Control Hangers:

A. TYPE 1: Spring hangers for pipe:

1. Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series.
2. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Submittals shall include a scale drawing of the hanger showing the 30° swing capability.

B. TYPE 2: Pre-compressed Spring hangers for pipe:

1. Vibration hangers shall be as described for TYPE 1, but shall be pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during the installation.
2. 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.
3. Deflection shall be clearly indicated by means of a scale.

C. TYPE 3: Spring hangers for ductwork:

1. Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod.
2. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short-circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Hangers shall be provided with an eyebolt on the spring end and provision to attach the housing to the flat iron duct straps.
6. Submittals shall include a scale drawing of the hanger showing the 30° capability.

2.05 Horizontal Thrust Restraints:

- A. Air handling equipment shall be protected against excessive displacement which might result from high air thrusts in relation to the equipment weight.
- B. The horizontal thrust restraint shall consist of a spring element in series with a neoprene pad as specified for TYPE 1 spring hanger and with the same deflection as specified for the mountings or hangers under the unit.

- C. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop.
- D. The assembly shall be furnished with one rod and angle brackets for attachment to both the equipment and ductwork or the equipment and the structure.
- E. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit.

2.06 Rooftop Equipment Isolation Curbs:

- A. Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment.
- B. The extruded aluminum top member shall overlap the bottom member to provide water run-off independent of the seal.
- C. The aluminum members shall house cadmium-plated springs having a 1" minimum deflection with 50% additional travel to solid.
- D. Spring diameters shall be no less than 0.8 of the spring height at rated load.
- E. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds.
- F. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible ductwork EPDM connection joining the outside perimeter of the aluminum members.
- G. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.

2.07 Isolator Applications:

- A. Isolation requirements for equipment on grade supported slabs, and on suspended concrete slabs of steel frame, concrete frame, and flat slab construction shall be based on the following tables. Isolation requirements for equipment on suspended lightweight construction such as bar joist shall be based on the table with twice the actual span, or as otherwise detailed or recommended by the isolator manufacturer for the duty.

B. EQUIPMENT ON GRADE SUPPORTED SLAB

EQUIPMENT DEFLECTION		BASE		MOUNT	
ITEM INCHES			TYPE		TYPE
Reciprocating Refrigerant Compressor 0.75	3			3	
Reciprocating Chiller 0.25		None		2	
Reciprocating Condensing Unit 0.25		None		2	
Packaged Centrifugal Chiller	None		1		0.25
Base Mounted Air Compressor 0.75		3			3
Close coupled pumps 10 Hp and up Frame Mounted, Flexible Coupled	1 or 2		3		0.75
Pumps 10 through 125 Hp Cooling Towers and Closed Circuit Coolers 0.25	None		3		0.25
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.25			1 or 2 if req'd	2	
Axial Fans, Tubular Fans and Fan Heads 24 in, dia. and over: Up to 300 RPM Note 1			1 or 2		3
Over 300 RPM 0.75			1 or 2		3
Centrifugal Fans and Vent Sets Up to 22 in. dia. 0.25			1 or 2 if req'd	2	
Centrifugal Fans and Vent Sets 24 in. dia. and over-Up to 50 Hp:					

Up to 300 RPM Note 1		1 or 2	3
301 to 500 RPM 1.50		1 or 2	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 Hp:			
Up to 300 RPM Note 1		1 or 2	3
Over 300 RPM 0.75		1 or 2	3
Packaged Air Handling Units	none	3	0.75

Note1: Deflection = $250,000 / (\text{RPM})^2$

C. EQUIPMENT ON SUSPENDED SLAB - MAX 20 FT. SPAN
 EQUIPMENT DEFLECTION

ITEM INCHES	BASE	MOUNT TYPE	MOUNT TYPE
Reciprocating Refrigerant Compressor 0.75	3	3	
Reciprocating Chiller 0.75	None	4	
Reciprocating Condensing Unit 0.75	None	4	
Packaged Centrifugal Chiller	None	4	0.75
Base Mounted Air Compressor 0.75	3		3
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over 0.75	3	3	
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 0.75	3		3
Cooling Towers and Closed Circuit Fluid Coolers			
Up to 300 RPM Note 1		none	4
301 to 500 RPM 2.50		none	4
501 RPM and over 0.75	none	4	
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.75	1 or 2 if req'd	3	
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over			
Up to 300 RPM Note 1	3		3

Over 300 RPM 1.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 1.50	3		3
Over 500 RPM 0.75	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 1.50	3		3
Over 300 RPM 0.75	3		3
Packaged Air Handling Units	None	3	0.75

Note1: Deflection = $250,000 / (\text{RPM})^2$

D. EQUIPMENT ON SUSPENDED SLAB - MAX 30 FT. SPAN
EQUIPMENT
DEFLECTION

ITEM INCHES	BASE	MOUNT TYPE	TYPE
Reciprocating Refrigerant Compressor			3
	3		
	1.50		
Reciprocating Chiller	None	4	
1.50			
Reciprocating Condensing Unit	None	4	
1.50			
Packaged Centrifugal Chiller	None	4	1.50
Base Mounted Air Compressor	3		3
1.50			
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over	3	3	
1.50			
Frame Mounted, Flexible Coupled			
Pumps 10 Hp through 125 Hp	3		3
1.50			
Cooling Towers and Closed Circuit			
Fluid Coolers			
Up to 300 RPM		none	4
Note 1			
301 to 500 RPM		none	4
2.50			
501 RPM and over	none	4	
1.50			
Axial Fans, Tubular Fans, and			
Fan Heads through 22 in. dia.	1 or 2 if req'd	3	
0.75			
Axial Fans, Tubular Fans, and			
Fan Heads 24 in. dia. and over			
Up to 300 RPM	3		3
Note 1			

Over 300 RPM 2.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 1.50	3		3
Over 500 RPM 0.75	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 2.50	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 1.50	3		3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

E. EQUIPMENT ON SUSPENDED SLAB - MAX 40 FT. SPAN

EQUIPMENT	BASE	MOUNT
DEFLECTION		
ITEM		
INCHES	TYPE	TYPE
Reciprocating Refrigerant Compressor 1.50	3	3
Reciprocating Chiller 2.50	None	4
Reciprocating Condensing Unit 2.50	None	4
Packaged Centrifugal Chiller	None	
	4	
	1.50	
Base Mounted Air Compressor 1.50	3	3
Close Coupled Pumps through 7.5 HP	1 or 2	3
		0.75
Close Coupled Pumps 10 Hp and over 1.50	3	3
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 2.50	3	3
Cooling Towers and Closed Circuit Fluid Coolers		
Up to 300 RPM Note 1	none	4
301 to 500 RPM 2.50	none	4
501 RPM and over 1.50	none	4
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.75	1 or 2 if req'd	3
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over		

Up to 300 RPM Note 1	3		3
Over 300 RPM 2.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75	1 or 2 if req'd	3	
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 1.50	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 2.50	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 2.50	3		3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

F. EQUIPMENT ON SUSPENDED SLAB - MAX 50 FT. SPAN

EQUIPMENT DEFLECTION	BASE	MOUNT	
ITEM INCHES		TYPE	TYPE
Reciprocating Refrigerant Compressor 2.50	3	3	
Reciprocating Chiller 2.50	None	4	
Reciprocating Condensing Unit	None	4	2.50
Packaged Centrifugal Chiller	None	4	1.50
Base Mounted Air Compressor 2.50	3		3
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over 1.50	3	3	
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 2.50	3		3
Cooling Towers and Closed Circuit Fluid Coolers			
Up to 300 RPM Note 1		none	4
301 to 500 RPM 3.50		none	4
501 RPM and over 2.50	none	4	
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 1.50	1 or 2 if req'd	3	
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over Up to 300 RPM Note 1		3	3

Over 300 RPM		3	3
2.50			
Centrifugal Fans and Vent Sets			
Up to 22 in. dia.		1 or 2 if req'd	3
0.75			
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM		3	3
Note 1			
301 to 500 RPM		3	3
2.50			
Over 500 RPM		3	3
2.50			
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM		3	3
Note 1			
301 to 500 RPM		3	3
3.50			
Over 500 RPM		3	3
2.50			
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

2.08 Vibration control bases:

- A. For hydronic pumps, provide concrete inertia bases with structural steel pouring forms sized and reinforced as required for the intended service. Size bases to support the piping elbow supports and furnish with Type RSW recessed spring isolators properly sized for one-inch static deflection. Mount springs on concrete bases 3-1/2" high. Inertia base is not required for pumps installed on slabs on grade.

2.09 Vibration control mounts:

- A. Design and coordinate the structural supports with the Structural Engineer. Isolator housing to be hot-dipped galvanized springs to be neoprene-coated. Provide tie-down adjustment to

prevent excessive movement when tower is drained. Provide vibration isolator rails or point isolators as required by the tower manufacturer.

2.10 Vibration control hangers:

- A. For suspended fans, isolate with not less than four combination spring and rubber-in-shear vibration isolators.
- B. Water source heat pumps shall be isolated with hanger and vibration isolation kit supplied by unit manufacturer or a vibration isolation manufacturer.
- C. All ductwork spring deflection shall be a minimum of 0.75 inches.
- D. Isolate fan coils and unit heaters with not less than four combination spring and rubber "in-shear" vibration isolators.

2.11 Flexible Piping Connectors:

- A. All piping over 1 inch in diameter shall be isolated at mechanical equipment room walls.
- B. Isolate supply and return piping to the cooling tower with flexible piping connectors.
- C. Isolate supply and return piping to each pump with braided metal hose connectors between pump and valve.

2.12 Horizontal Thrust Restraints:

- A. For air handling equipment, install thrust restraints as indicated, and wherever thrust exceeds 10% of equipment weight.

2.13 Rooftop Isolation Curbs:

- A. Provide housed spring type isolators with vertical limit stops.

2.14 Flexible Ductwork Connections to Equipment:

- A. Install flexible connections between sheet metal ductwork and equipment or fan collar. Locate as close to fan as possible. Isolate the duct system from the equipment by at least 1".

Part 25 Execution

3.01 Examination of Related Work:

- A. Examination and Reporting: Installer of vibration isolation work shall observe the installation of other work related to and connected to vibration isolation work. After completion of other related work (but before equipment start-up), he shall furnish a written report to the Contractor, with a copy to VPTC Management Partners, LLC, listing observed inadequacies for proper operation and performance of vibration isolation work.
- B. Correction and Start-up: Do not start-up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation Installer.

3.02 Equal Loading:

- A. General: All isolation devices shall be selected for uniform static deflections according to distribution of weight. Equipment installed on vibration isolating mountings shall be level after

load is applied. Spring isolators with coils touching during equipment start-up or operation will not be acceptable.

3.03 Installation:

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units.
- B. Remove space blocks and similar devices intended for temporary support during installation.
- C. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points.
- D. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.
- E. All piping and equipment shall be installed and ready for operation (i.e. filled with water, etc.) prior to installation of flexible piping connection. Alignment of piping and equipment shall be such that flexible connections are not over extended and compressed from weight of piping, fittings, etc.

END OF SECTION 15240

Section 15250 – System Insulation

Part 26 General

1.01 Description:

- A. Furnish and install thermal insulation materials, coverings and accessories for mechanical piping, equipment and ductwork systems as specified herein. Extent of mechanical insulation

work required by this Section shall be as indicated on drawings, schedules and by requirements of this Section.

1.02 Insulation Schedule:

A. Piping:

1. Type A – Fiberglass with white kraft paper fire retardant. (See Part 2 – Products)
 - a. Heating hot water
 - b. Domestic cold water, hot water and hot water return
 - c. Storm drain lines at roof deck from drain body to vertical riser
2. Type B – Black, closed cell flexible foam insulation. (See Part 2 – Products)
 - a. Refrigerant piping
 - b. Condensate drain lines
 - c. Note: Type B insulation shall not be used for domestic cold and hot water piping.
3. Type C – (Exterior Piping Applications) Polyisocyanurate with glass fiber wrap and PVC or metal jacket. (See Part 2 – Products)
 - a. Chilled water
 - b. Condensing water systems when used for waterside system economizing or in geothermal applications
 - c. Exterior domestic hot and cold water piping
 - d. Exterior make up water piping

B. Equipment:

1. Type D(H) - Semi-rigid fibrous glass board. (See Part 2 – Products)
 - a. Hot water tanks not factory insulated
 - b. Heating hot water air separators
2. Type D(C) - Closed cell flexible foam insulation. (See Part 2 – Products)
 - a. Roof drain bodies
 - 1) Insulate all roof drain bodies at the roof deck.
 - b. Chilled water air separators or condenser water separators when used for waterside system economizer
 - c. Chilled water pump bodies or condenser water pump bodies when used for waterside system economizer
3. Type E - Calcium silicate block insulation. (See Part 2 – Products)
 - a. Emergency generator exhaust piping and muffler; 4" thickness

C. Ductwork Systems:

1. Type F – Fiberglass wrap with aluminum foil jacket. (See Part 2 – Products)
 - a. High, medium and low pressure ductwork
2. Type G – Duct liner – Glass fiber coated with black fire resistant and microbial resistant coating. (See Part 2 – Products)
 - a. High, medium and low pressure ductwork when used for sound attenuation or if ductwork is exposed.

- b. Low pressure return boot
- c. Transfer ducts

D. Insulation Installation Exceptions:

1. Exhaust ductwork, stairwell pressurization and dedicated smoke evacuation ductwork shall not be insulated, unless otherwise noted.
2. Exposed ductwork shall be internally lined.
3. The first 25 feet of supply ductwork downstream of rooftop or floor mounted air handling units shall be internally lined with Type G insulation for high frequency acoustical attenuation purposes.
4. The first 10 feet of supply ductwork (low pressure) downstream of heat pumps, VAV terminals and fan-powered terminals shall be internally lined with Type G insulation for acoustical attenuation purposes.
5. Return ductwork within 25 feet of floor-mounted air handling units or rooftop units shall be internally lined with Type G for high frequency acoustical attenuation purposes.
6. At the contractor's option and with the approval of VPTC Management Partners, LLC Construction, medium and low pressure supply ductwork insulation may be omitted in return air plenums if not required by local codes (including energy codes). If accepted, a

minimum of 2°F of duct temperature rise shall be applied in calculating supply airflows to the space.

7. Selection of insulation thickness shall be in compliance with all local codes and local energy codes.
8. All piping exposed to outdoors shall be insulated. Coordinate insulation with heat trace cable and controls.

1.03 Quality Assurance:

- A. All insulation, jacket and adhesive shall have a fire and smoke hazard ratings as tested under ASTM E-84, NFPA 255, and UL 723 not exceeding:
 1. Flame Spread: 25
 2. Fuel Contributed: 50
 3. Smoke Developed: 50

1.04 Submittals:

- A. Provide submittal data on all insulation types to be installed in accordance with Section 15010.

1.05 Definitions:

- A. The term "plenum" shall mean a ceiling space or mechanical room used for the transfer of conditioned return and/or outside air.

1.06 Manufacturers:

- A. The model numbers listed in the Specification establishes a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications:
 1. armacell engineered foams
 2. CertainTeed Corporation
 3. Dow Building Materials
 4. Knauf Insulation
 5. Johns-Manville
 6. Owens-Corning Fiberglass Corporation
 7. Pittsburgh Corning
 8. Rubatex International, LLC

Part 27 Products

2.01 Piping Insulation:

- A. Type A (Fiberglass, indoor):
 1. One piece glass fiber, rigid molded sectional pipe covering with factory applied aluminum foil and white craft paper flame retardant vapor barrier jacket, conforming to ASTM C547, Class II, Mineral Fiber Preformed Pipe Insulation.
 2. Conductivity (k) equals approximately 0.23 (BTU/HR., SF., Degree F, IN) at 75 °F mean temperature.
 3. Encase pipe fittings with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.

- a. Under pre-molded PVC fitting coverings, wrap two separate layers of blanket insulation to provide same thickness and density as adjacent pipe covering.
 - b. Mitered segments of pipe insulation are also acceptable under PVC fitting covers when installing fiberglass insulation.
4. Approved manufacturer's trade names:
- a. Johns-Manville Corp. - "Micro-Lok 650-AP-T"
 - b. Owens Corning Fiberglass Corp. - "One Piece" 25 ASJ/SSL"
 - c. Other equal by listed manufacturer
- B. Type B (Closed Cell, indoor):
- 1. Closed cell, flexible foamed plastic conforming to ASTM C534, "Preformed Flexible Elastomeric Cellular Thermal Insulation in Tubular Form." Insulation shall be 6 lb/sf density suitable for a temperature range from -40 degrees F to 220 degrees F.
 - 2. Conductivity (k) equals approximately 0.28 (BTUHR., SF., Degree F, IN) at 75 °F mean temperature.
 - 3. Pipe insulation shall be applied in a continuous length and shall not be longitudinally slit.
 - 4. Approved manufacturers and trade names:
 - a. armacell engineered foams "Armaflex".
 - b. Rubatex
 - c. Other equal by listed manufacturer
- C. Type C (Polyisocyanurate, outdoor):
- 1. Prefabricated 2 lb./cu.ft. density polyisocyanurate insulation with waterproof mastic and glass fiber jacket finished with an aluminum jacket with waterproof silicone caulk joints.
 - 2. Conductivity (k) equals approximately 0.14 (BTUHR., SF., degrees F, IN) at 75 °F.
 - 3. Insulation shall be applied per manufacturer's recommendations. Joint sealants and coatings shall be as approved by the insulation manufacturer for the intended application and service temperature range.
 - 4. Jacketing shall be an all service jacket with 1 mil. aluminum foil on pipe insulation and FSK jacket on board stock applied by the manufacturer to ASTM C-1136. Jacket shall have integral flap for sealing joint.
 - 5. Approved manufacturers and trade names:
 - a. Dow Building Materials Trymer 9501
 - b. Other equal by listed manufacturer

2.02 Equipment Insulation:

- A. Type D (Hot) (Fiberglass board for Hot Equipment):
- 1. Semi-rigid intermediate service fibrous glass board for operating temperatures greater than 850 degrees F.
 - 2. Conductivity (k) equals approximately 0.23 (BTU/HR., SF., degrees F, IN) at 75 °F mean temperature. Minimum density of 2.75 lb / cu ft.
 - 3. Approved manufacturers and trade names:
 - a. CertainTeed - " 850 Fiberglass Insulation Board"

- b. Johns-Manville Corp. - "1000 series Spin Glass"
- c. Owens Corning - "Intermediate Service Board"
- d. Other equal by listed manufacturer

B. Type D (Cold) (Foamed Plastic for Cold Equipment):

- 1. Foamed plastic sheet suitable for operating temperatures between –40 degrees F and 22-degrees F.
- 2. Density shall be 6 lb/sf Conductivity (k) equals approximately 0.287 (BTU/HR., SF., Degree F, IN) at 75 °F mean temperature.
- 3. Approved manufacturers and trade names:
 - a. Armacell engineered foams "Armaflex"
 - b. Rubatex
 - c. Other equal by listed manufacturer

C. Type E:

- 1. Calcium silicate block conforming to ASTM C 553, Type I (1200 degrees F. max), asbestos free.
- 2. Conductivity (k) equals approximately 0.42 (BTU-IN/HR., SF., degree F) per inch thickness at 200 °F.
- 3. Approved manufacturers and trade names:
 - a. Calislite
 - b. Pabco Insulation - "Super Caltemp"
 - c. Other equal by listed manufacturer

2.03 Ductwork Insulation:

A. Type F:

- 1. Duct insulation shall be minimum 2" thick, minimum 3/4 lb. density fiberglass
 - a. At locations with the International Energy Code, refer to Tables 6.8.2A and B for minimum duct insulation thickness.
- 2. Conductivity (k) equals approximately 0.24 (BTUHR., SF., degrees F, IN) at 75 °F mean temperature.
- 3. Integral UL rated vapor barrier of:
 - a. Aluminum foil reinforced with fiberglass scrim laminated to 30-lb. kraft paper.
 - b. Class I white vinyl 0.004 inch thick, where specified.
- 4. Approved Manufacturers and Trade Names
 - a. Certain Standard - "Universal"
 - b. Manville Corp. - "Microlite"
 - c. Owens Corning - "All Service Duct Wrap"
 - d. Other equal by listed manufacturer

2.04 Type G - Duct Liner:

1. ASTM C1071, Type II, Grade 2, R-6, 1" thickness, 1.5 lb. density for low pressure ductwork and 3.0 lb density for medium pressure ductwork, bonded mat of glass fiber coated with black fire resistant and microbial resistant coating, complying with TIMS AHC-101. Moisture adsorption shall not be greater than 0.5% moisture by volume when exposed to moisture-laden air at 120°F and 96% RH, per ASTM C553. Insulation shall be Schuller "Permacote Linacoustic" R-300, "Aeroflex Ductliner" as manufactured by Owens Corning Fiberglass Corp. or "Ultralite with Certa-Edge" by CertainTeed Corp. or equal by Knauf Fiberglass.
2. Duct liner adhesive shall comply with ASTM C916 "Specifications for Adhesives for Duct Thermal Insulation".
3. Liner Fasteners: Mechanical or weld secured fasteners for duct liner where finish of duct is not exposed. For exposed ductwork, except in mechanical rooms, provide adhesively secured fasteners. Position fasteners are recommended by SMACNA. The interior duct insulation shall be applied as recommended by the manufacturer including proper adhesive and adhered clips. Clip spacing shall not exceed 8" on center perpendicular to air flow and shall not exceed 12" on center in the direction of air flow.
4. All joints of the insulation shall have edges buttered with sealant, and shall be tightly buffed. Apply a brush coat of sealant at all joints on the surface of the duct liner extending at least 1" on each side of joint. Provide metal nosing on all exposed edges of duct liner at fire dampers, control dampers, fan discharges, etc.
5. Minimum Sound Absorption coefficients shall be per ASTM-E 477:

2.05 Exterior Protection:

A. Metal Jacket:

1. Smooth aluminum jacket 0.016 inch thick with integral polykraft or poly-surlyn moisture barrier. Provide banded locking joints with field applied silicone weatherproof sealant.
2. Approved manufacturers:
 - a. RPR Products, Inc.
 - b. Childers Products Co.
 - c. Manville Corp.
 - d. Pabco Division of A.J. Gerrard & Company

B. Foil/Film Facing for ductwork

1. Jacketing shall be a five-ply laminated foil/film facing for exterior applications. Product shall be a five-ply laminate alternating layers of aluminum foil (core and outer layers) with two

layers of polyester film. Substrate thickness shall be not less than 3.0 mils and the adhesive thickness shall be not less than 2.0 mils.

2. Product shall be coated with Venture Tape's cold weather acrylic, pressure sensitive adhesive system suitable for application in below freezing temperatures.
3. Laminate construction shall be highly puncture, tear resistant and flame retardant. Product shall be suitable for application between -10°F and 248°F. Product shall be suitable for use at temperatures up to 300°F.
4. All joints shall be sealed with manufacturer's recommended joint tape.
5. Product shall carry a ten year warranty

Part 3 - Execution

3.01 Piping Insulation General Requirements:

A. Preparation:

1. Do not apply insulation until piping has been leak tested.
2. All surfaces to be insulated shall be dry and free of loose scale, rust, dirt, oil or water.

B. Application:

1. Insulation shall be installed in a smooth, clean workmanlike manner. Joints shall be tight and finished smooth without fishmouths.
2. Insulation shall fit tightly against the surface to which it is applied to prevent air circulation between the insulation and the pipe or equipment to which it is applied.
3. Insulation applied to cold piping or equipment shall be completely vapor sealed, free of pinholes or other openings.
4. Do not use wet insulation materials.
5. All longitudinal joints on vertical pipe runs shall be staggered.
6. Apply insulation so as to permit expansion or contraction of pipelines without causing damage to insulation or surface finish.
7. Do not apply mastic or adhesive until all previous applications of mastic and adhesives have thoroughly dried.
8. No bands or staples shall be provided on covering.
9. The adhesive used in connection with all covering work shall contain an approved vermin and rodent-proof ingredient.
10. Provide 24-gauge sheetmetal saddle between the pipe hanger/support and the exterior of the insulation. Saddle length shall be the same as insulation inserts.

C. Application at Fittings:

1. Insulation of flanges and flanged fittings shall overlap adjacent pipe covering at least 1 inch. Valves shall be insulated up to the gland only.
2. Pipeline strainers shall be insulated in such a manner as to permit removal of strainer basket without disturbing insulation of the strainer body.
3. Insulation adjacent to uninsulated flanges shall be tapered back and neatly finished so as to allow access to and removal of bolts without injury to covering.

D. Insulation of valves and specialties (including PRVs and RPZs):

1. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation with disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
2. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings insulation that will allow passage of air to pipe surface.
3. At contractor's option, apply preformed covers manufactured of same material as pipe insulation. Attach per manufacturers installation instructions.

3.02 Type A Insulation Installation:

- A. Tightly butt together sections of insulation on pipe runs sealing longitudinal seams of jacket with a self-sealing adhesive. Seal end joints with 4-inch wide straps of matching vapor barrier tape. Seal off ends of insulation with vapor seal mastic at valves, fittings and flanges. No further finish required. Mastic shall extend onto the bare pipe and over the insulation O.D.
- B. PVC fitting jackets shall be used when they are available for the particular application. When molded or routed coverings are not available, the coverings shall be fabricated in the field similar to equipment insulation. Molded or routed fitting covers are highly recommended. Order PVC pre-curved.
- C. Cold Piping:
 1. Cover valves, fittings and flanges with insulation having the same thickness as adjacent pipe covering, securing in place reforming tape up to 12" O.D. and 1/2" wide SST bands on larger O.D. Apply a PVC jacket and seal joints with PVC cement (solvent welding).
- D. Hot Piping:
 1. Covers shall overlap the pipe insulation by the thickness of the insulation or 2" min. Cover valves, fittings and flanges with insulation similar to the adjacent pipe covering, securing in place with reforming tape up to 12" O.D. and 1/2" wide SST bands on larger O.D. Apply a PVC jacket and tape end joints to adjacent pipe insulation.
 2. Do not use PVC fitting jackets where the surface of the insulation is above 150 degrees F.
- E. Exterior Piping:
 1. Exterior above grade water piping shall be finished with a weatherproof jacket and an aluminum jacket. Lap and seal joints as per manufacturer's instructions. Place laps to shed water.

3.03 Type B Insulation Installation:

- A. Type B insulation shall be slipped on the pipe prior to connection, and the butt joints shall be sealed.
- B. All joints shall be completely butt sealed with the manufacturer's recommended adhesive.
- C. Do not apply Type B insulation in multiple layers.
- D. Type B insulation shall not be used in plenums or firewall penetrations.
- E. This Contractor shall paint Type B insulation exterior to the building with two coats of a vinyl acrylic paint recommended by the insulation manufacturer for protection against ultraviolet

degradation and shall be flexible with no cracking. It is recommended in high humid areas to coat the insulation with vapor barrier mastic to .037 min. DFT.

3.04 Type C Insulation Installation:

A. Exterior:

1. Butter joints of insulation with non-setting adhesive. Secure with factory applied self-seal laps. Installation shall be as per manufacturer's guidelines.
2. Finish shall be factory applied all service Jackets. All fittings shall be finished with vapor seal mastic reinforced with white glass mesh. Minimum .037 thick DFT of mastic.
3. Piping exposed in machine rooms shall be finished with vapor seal mastic and open weave membrane 10 x 10.
4. Piping exposed to weather shall be finished with all service jacket and additional finish of 0.16 thick aluminum jacket. Aluminum jacket shall be secured with stainless bands located

on maximum centers of 12 inches and at the overlap. No screws or pop rivets shall be used.

5. Fittings and valves shall be finished with vapor seal mastic, reinforced with min. .037" DFT of mastic, glass mesh and aluminum preformed fitting covers.

3.05 Type D and E Insulation Installation:

A. Equipment Insulation Application:

1. Apply insulation to fit as closely as possible to equipment.
2. Stagger joints where possible.
3. Bevel insulation around nameplates, ASME stamp and access plates.
4. Insulation on equipment that must be opened periodically shall be constructed so insulation can be removed and replaced without damage.
5. Do not install Type E insulation on aluminum surfaces or with aluminum jacket.

B. Hot Equipment:

1. Install 3/4-inch expanded metal over equipment with standing ribs or seams prior to applying insulation to eliminate ribs or seams penetrating through the insulation.
2. Secure the insulation with steel bands spaced on 12-inch centers.
3. Where required, use welded studs, clips or angles as anchors for wire or bands on flat surfaces.
4. Seal joints with insulating cement.
5. Over the insulation stretch 1-inch hexagonal mesh wire and lace the edges together.
6. Apply a 1/4-inch thick coat of finishing cement and trowel smooth.
7. Smooth insulation with lagging adhesive, cover with glass cloth and a final coat of lagging adhesive.
8. On small equipment where it is not practical, omit the wire mesh and finishing cement on Type D insulation.

C. Cold Equipment:

1. Cover irregular surfaces with a smoothing coat of insulating cement.
2. Secure insulation with wire or with stainless bands spaced on 12-inch centers.
3. Seal joints with vapor seal mastic.
4. Embed a layer of glass into a 1/16-inch coating of vapor seal mastic. Then coat the outside of the glass cloth with a 1/16-inch coating of vapor seal mastic.

D. Roof Drain Bodies:

1. Insulate similar to cold equipment.
2. Insulated boxes around roof drain bodies are not acceptable.

3.06 Type F Insulation Installation:

A. Ductwork Insulation Application:

1. Apply insulation tightly and smoothly to duct.
2. Secure insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag and max 3" from any corner.

3. Impale insulation over pins or anchors located not more than 18 inches apart and hold in place with washers and clips.
4. Cut off protruding pin after clips are secured and seal with 2-mil. aluminum foil backed pressure sensitive tape.
5. Apply insulation with joints tightly butted.
6. Seal all ductwork joints, punctures and fittings with a mastic type sealant containing a vapor barrier.
7. Cover all breaks, joints, punctures and voids with a vapor seal mastic and cover with a vapor barrier material identical to vapor barrier on the insulation, where gaps exceed 2".
8. Bevel insulation around nameplates, access plates and doors.
9. Insulation shall be continuous through walls and floors except at fire dampers.

3.07 Type G Insulation Installation:

A. Internal Lining Insulation Application:

1. Apply where specified herein.
2. Apply liner in accordance with SMACNA Duct Liner Application Standard, later edition.

3.08 Metal Jacket Installation:

- A. Cover all piping insulation exposed to the exterior with metal jacket as specified herein.

3.09 Hangers:

- A. Continue insulation through pipe hangers. Provide either rigid insulation inserts or sheet metal inserts at all outside pipe hangers. Provide rigid insulation inserts for piping operating below 60 °F. and sheet metal inserts for piping above 60 °F.
- B. Provide rigid insulation (on non-insulated piping) or sheet metal inserts (on insulated piping) between the pipe and pipe hanger - shall be of a thickness equal to the adjoining insulation and

shall be provided with vapor barrier where required. Insulation insert shall not be less than the following lengths:

1/2" to 2-1/2" pipe size	10 Inches Long
3" to 6" pipe size	12 Inches Long
8" to 10" pipe size	16 Inches Long
12" and over	22 Inches Long

- C. Inserts for cold piping shall have a vapor barrier facing of the same material as the adjacent pipe insulation. Seal inserts into insulation with vapor seal mastic.
- D. Sheet metal inserts shall be of steel sheet. Gauge shall conform to manufacturer's recommendation for pipe size. Sheet metal inserts shall have insulation filler of the same material as the adjacent pipe insulation.

3.10 Pipe Sleeves:

- A. Pipe insulation and vapor barrier shall be continuous through sleeves in walls and floors.
- B. Type B insulation shall not be used in sleeves through firewalls or fire rated (2-hour) floor systems. Use Type A or Type C through the sleeve instead and vapor seal the joint between the two insulations.
- C. Provide 26 gauge galvanized steel or 0.020 inch aluminum jacket over insulation on pipe passing through sleeves where sealant is required.
- D. Where penetrating interior walls, extend the metal jacket 2 inches out either side of the wall and secure each end with a metal band compressing the insulation slightly.
- E. Where penetrating floors, extend the metal jacket 2 inches below the floor and 5 inches above the floor. Secure with metal bands.

END OF SECTION 15250

Section 15400 – Plumbing Piping Systems

Part 28 General

1.01 Related Documents:

- A. A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide complete operating plumbing piping systems including pipe, tube, fittings, accessories and appurtenances as indicated and in compliance with these Specifications.

- B. Applications: Applications of piping systems include, but are not limited to, the systems; working pressure and operating temperatures as listed below:

1. Domestic Cold Water

- a. High 350 psig - 55 to 80°F
- b. Medium 300 psig - 55 to 80°F
- c. Low 150 psig - 55 to 80°F

2. Domestic Hot Water

- a. High 350 psig - 90 to 120°F
- b. Medium 300 psig - 90 to 120°F
- c. Low 150 psig - 90 to 120°F

3. Makeup Water

- a. High 350 psig - 55 to 80°F
- b. Medium 300 psig - 55 to 80°F
- c. Low 150 psig - 55 to 80°F

4. Condensate Drainage 40 to 60°F

5. Sanitary Drainage

6. Storm Drainage

1.03 Quality Assurance:

- A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, surfaces shall be

thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe.

Part 29 Products

2.01 Piping Materials:

- A. General: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.
1. Steel Pipe: ASTM A53, ASTM A106, or ASTM A120, black or hot-dipped galvanized as specified.
 2. Copper Tube: ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.
 3. Ductile Iron Pipe: ANSI A21.51, Class 150 with bell and spigot ends for push-on joints.
 4. Cast Iron Soil Pipe: ASTM A74, standard weight, hub and spigot-type.
 5. Hubless Cast Iron Pipe: CISPI 301, standard weight with spigot bead ends for coupling assembly.
 6. Polyvinyl Chloride (PVC) Pipe: Sewer main SDR 41, ASTM D3034 with bell ends and pre-inserted gasket joints.
 7. Pre-insulated Steel Pipe: ASTM A53, ASTM A106, ASTM A120, and ANSI B31.1.
 8. Polyvinyl Chloride (PVC) Water Pipe: Class 150, thickwall, Schedule 80, AWWA C90 mechanical joint.
 9. Copper Drainage Pipe: DWV copper piping.
 10. Polyvinyl Chloride (PVC) Drainage Pipe: Schedule 40 PVC.

2.02 Pipe/Tube Fittings:

- A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing

regulations, industry standards, and where applicable, with pipe manufacturer's instructions for selections.

1. Cast Iron Flanged Fittings: ANSI B16.1, Class 125 or Class 250, black or galvanized as specified, including bolting and gasketing.
2. Cast Iron Threaded Fittings: ANSI B16.4 or ASTM A126, Class 125 or Class 250, black or galvanized as specified.
3. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.
4. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
5. Threaded Pipe Plugs: ANSI B16.14.
6. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections.
7. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
8. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
9. Cast Iron Drainage Fittings: ANSI B16.22 galvanized with pitched threaded ends.
10. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2". Do not thread nipples full length (no all-thread nipples).
11. Wrought Copper/Bronze Solder-Joint Fittings: ANSI B16.22 suitable for working pressure up to 250 psig.
12. Hubless Cast Iron Pipe Fittings: CISPI 301-78 and comply with governing regulations.
13. Cast Iron Soil Pipe Fittings: ASTM A74.
14. Compression Gaskets: CISPI HSN-75.
15. Lead/Oakum Joint Materials: Comply with governing regulations for service use indicated.
16. Grooved End Fittings: ASTM A47 or ASTM A536 joined with Victaulic Style 77 couplings and Grade "E" gaskets.
17. Flanged Fittings: Comply with ANSI B16.15 for bolt-hole dimensioning, materials, and flange-thickness.
18. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap

screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.

19. Flange Bolt Thread Lubricant: Lubricant shall be an anti-seize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
20. Polyvinyl Chloride (PVC) Fittings: ASTM D2665, Carlon, Vylon "Z" high strength sewer fittings.
21. Copper Drainage Fitting: DWV copper drainage fittings.

B. Miscellaneous Piping Materials/Products:

1. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.
2. Brazing Materials: American Welding Society, AWS A5.B, Classification BCup-5.
3. Gaskets for Flanged Joints: 1/8" thick gaskets. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed non-asbestos or equal.
4. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation or equal.
5. Gaskets for Cast Iron Soil Pipe: ASTM C 564, neoprene, compression-type.
6. Push-on-Joints: ANSI A21.11, rubber compression-type, "Tyton Joint" as manufactured by US Pipe or equal.
7. Hubless Cast Iron Joints: CISPI 310, stainless steel corrugated shield and clamp assembly over one piece neoprene sealing sleeve. Coupling sizes through 4" shall have 4 bands and sizes over 4" shall have 6 bands.

2.03 Strainers:

A. General: Water strainers shall be as follows:

1. 150 psig Working Pressure: 150 psig working pressure, 2" and smaller, shall be Muessco No. 11, 400 pounds WOG, iron body with perforated 20 mesh monel screen with cleanout and screwed ends. 150 psig working pressure, 2-1/2 through 24", shall be Muessco No. 751, 150 pounds WOG, perforated monel screen with 1/16" perforations for sizes through 4", and 5/32" perforations for 5" and above, with blowdown connection with full sized gate valve, and Class 125 ANSI B16.1 flanged ends.
2. 300 psig Working Pressure: 300 psig working pressure, 2" and smaller, shall be Muessco No. 11, 400 pounds WOG, iron body with perforated 20 mesh monel screen with cleanout and screwed ends. 300 psig working pressure, 2-1/2 to 24", shall be Muessco No. 752, 300 pounds WOG, perforated metal monel screen with 1/16" perforations in sizes through

4", and 5/32" perforations for 5" and above, with blowdown connection with full sized gate valve, and Class 250 ANSI B16.5 flanges.

- B. Manufacturers: Strainers by Mueller, Crane, Muessco, Zurn, or Keckley or equal.

2.04 Escutcheon Plates:

- A. General: Provide escutcheon plates on exposed piping where piping penetrates the walls, floors, or ceilings where penetration is exposed to view including on exterior of building
- B. Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated.
- C. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any.
- D. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole is flush with adjoining surface.

2.05 Flexible Connections in Piping:

- A. General: Provide flexible connections in piping where shown on the Drawings or specified under Division 15.
- B. Types: For piping 2" and smaller, flexible pipe connections at pumps and other equipment, where shown, shall be Metal-Flex, Mason Industries or Flexonics double-braided, stainless steel flexible connections with screwed connections. For larger pipe sizes, flexible connections at pumps and other equipment shall be Amber Booth Style 2400, or equal, Flexonics triple bellows reinforced neoprene flexible connections with control units. Victaulic couplings may be used instead of flexible connections where approved by VPTC Management Partners, LLC.

2.06 Sleeves:

- A. General: Provide sleeves for piping passing through walls, floors, and roofs. Sleeves shall be of sufficient size to permit pipe or pipe and insulation, to pass through and leave an annular space for caulking. Sleeves through concrete construction, interior partitions, and ceilings shall be 18 gauge galvanized sheet steel. Masonry construction and exterior penetrations above and below grade shall be Schedule 40 galvanized steel pipe. Extend floor sleeves 2" above floor.
- B. Outside Walls Below Grade: Where pipes pass through outside walls that are below grade, provide schedule 40 galvanized steel pipe with water stop. When pipe is in place, seal with "Link-Seal" Unit with EPDM links as manufactured by Thunderline Corporation, Wayne, Michigan, or approved equivalent.
- C. Fire-rated Floor and Wall Penetration Sleeve packing and caulking shall consist of:
1. Provide the appropriate UL listed and approved materials for floor and wall penetrations.

3.01 Piping Installation:

- A. General:
1. Industry Practices: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections.

Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by VPTC Management Partners, LLC.

2. Systems: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms. Where pipes of different sizes join, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.
 3. Expansion and Contraction: Install loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment. Provide mechanical grooved connections required by the application to reduce vibration at equipment connections. Provide expansion joints in piping systems by mechanical grooved connections where required. Provide for expansion every 30 feet of horizontal and vertical PVC piping.
- B. Steel Pipe: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up.
 - C. Copper Pipe: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth or wire brush.
 - D. PVC Pipe: Cut PVC pipe square and remove all burrs. Clean fitting and pipe butt prior to installation. Install all PVC piping in accordance with the manufacturer's recommendations.
 - E. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where equipment is to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of hot water, condenser water, gas, domestic water, waste, and vent as required. Provide valves, unions, strainers, check valves, and traps as required for proper operation of systems

and equipment. Equipment not shown on the Architectural Drawings or noted by VPTC Management Partners, LLC shall not be included in the scope of this requirement.

3.02 Plumbing Services:

A. Scope:

1. This Contractor shall provide the building sanitary sewer to 5 feet outside the building and shall extend the domestic water service from the main shutoff valve stubbed above floor in the building.
2. Provide storm drainage system as required to 5 feet outside the building.
3. Verify locations and conditions.

B. General: Install the various piping systems as described hereinafter, and as required by the local plumbing inspection department.

1. Install soil, waste, and vent piping with horizontal lines pitched in accordance with local codes, but in no case less than $\frac{1}{8}$ " per foot for pipe 4" and larger. Install soil, waste, and vent piping with hubs of each length of piping in the upstream position.
2. Make-up lead and oakum joints with molten lead run into hubs in one continuous pour, to a minimum depth of one inch.
3. Make-up "Ty-Seal" or "Dual-Tite" gasketed joints using lubrication and joining tools as instructed by the manufacturers. Base of stacks, horizontal runs under pressure, and gasketed pipe 5" and larger shall be made up using "Lubrifast" joining material.
4. Torque "No-Hub" joints in accordance with manufacturer's instructions. Do not install "No-Hub" joints below ground. Install cast-iron hubless joints in accordance with the recommendations in the CISPI Cast Iron Soil Pipe and Fitting Handbook, Chapter IV.
 - a. Horizontal pipe and fittings 5 inches and larger must be suitably braced to prevent horizontal movement, at every branch opening or change of direction by use of braces, blocks, rodding or other approved method, to prevent movement or joint separation. All elbows and tees shall be braced against thrust loads which might result in joint

separation due to static pressure or dynamic forces caused by sudden, heavy impulse loading (water hammer) conditions

5. Provide chrome-plated piping at each fixture installed in a finished space. Install with proper strap wrenches to avoid marking or defacing.
 6. Provide proper restraints on riser and stack offsets.
- C. Plumbing Connections to Fixtures and Equipment:
1. General: Provide necessary pipe and fittings. Make final connections to provide cold water make-up and natural gas supply to mechanical equipment. Locate cold water make-up and gas supply where shown and connect with suitable stop valves.
 2. Cold Water Make-up: Provide cold water make-up to closed loop condenser water circulating systems, cooling tower system, and hot water heating systems.
- D. The domestic water service shall be Class 150 AWWA cement lined C.I. with Class 250 fittings, mechanical joints or push-on rubber ring gaskets, ASTM A377-66 or PVC AWWA C900 with solvent welded fittings. Provide tie rods and thrust blocks as required.

3.03 [Domestic Hot] and [Cold Water] Piping Systems:

- A. Interior Hot and Cold Water Piping:
1. Aboveground domestic water system piping 3" in size and smaller shall be Type L hard drawn copper tubing with wrought copper fittings and soldered joints.
 2. Aboveground domestic water piping 4" and larger shall be Type L hard drawn copper tubing with rolled grooved joints and fittings.
 3. Provide isolation fitting whenever dissimilar materials are used.
- B. Piping Runouts to Fixtures: Provide piping runouts to fixtures sized to comply with governing regulations. Each fixture shall be provided with a shut-off valve for each supply line. Provide all shutoff valves necessary to isolate mains to each restroom, janitor closet, kitchen/kitchenette, coffee station, etc. Exposed lines shall be chromium-plated. All lines branched off of the riser shall be valved at the riser. All core and future risers shall be valved at the bottom for individual isolation without having to shut off the main.
- C. Water Hammer Arrestors: Provide the necessary water hammer arrestors specifically sized for the application to prevent water hammer. All water hammer arrestors (WHA) shall be PDI Certified, Size A, B, C, D, E or F, as indicated for the fixture units served; Josam, Jay R. Smith or Zurn

3.04 Storm and Sanitary Drainage System:

- A. Soil, Waste, and Vent Piping Underground: Service weight hub and spigot cast iron soil pipe and fittings with lead and oakum joints or neoprene gasket joints made up with "Lubrifest"

joining material or PVC piping with solvent welded joints. Provide and install code-approved manholes as required.

1. All PVC piping above ceiling in return air plenums should be fire wrapped. In base bid include any insulation that needs to be added to pass proper municipality inspections
 2. All existing sanitary drains that are used should be cabled out at the end of a project to ensure the tenant is getting a new fresh clean line
- B. Storm Drainage Piping Underground: Same as soil, waste, and vent piping underground.
- C. Soil, Waste, and Vent Piping Above Ground: Hubless cast iron pipe and fittings with coupling assembly.
1. Option: At the Contractor's option, for branch piping only, galvanized steel, Schedule 40, ASTM A53 pipe with galvanized malleable iron fittings for vent piping and galvanized cast iron drainage fitting for soil and waste piping may be used instead of the above. NOTE: Use PVC piping with solvent welded joints only where allowed by code.
- D. Storm Piping Above Grade: Service weight hubless cast iron soil pipe and fittings with coupling assembly, or Schedule 40 PVC pipe with PVC drainage fittings. NOTE: Use PVC only where allowed by code.
- E. Pump Discharge Piping: Discharge from pumps to the horizontal gravity main shall be Schedule 40 galvanized steel with galvanized cast iron drainage fittings, or Schedule 40 PVC

piping and fittings where code allows. Each pump discharge shall be carried separately to the horizontal gravity main and shall discharge into the top of the horizontal gravity main.

F. Cleanouts: storm and sanitary

1. General: Care shall be used when locating cleanouts. Wherever possible, do not place cleanouts in "finished" areas. All locations shall be approved by VPTC Management Partners, LLC and the Architect.
2. Finished Floor: Zurn ZB-1400, cast iron adjustable assembly with nickel bronze cover and tapered thread bronze plug. Provide clamping collar when installed in floors having waterproof membrane.
3. Unfinished Areas: Zurn No. Z-1400 Supremo cleanout with cadmium-plated, cast iron plug.
4. Walls: Zurn Z-1440-3, cast iron with nickel bronze, square, smooth, access cover, vandal-proof screws.
5. Outside: Zurn Z-1420-25, non-slip, vandal-proof cover with anchoring lugs. Provide with traffic grade top where exposed to vehicle traffic.
6. Locations:
 - a. At base of every drainage stack
 - b. At every restroom branch, provide a cleanout at its upper terminal..
 - c. In horizontal runs at each change in direction of piping greater than 45 degrees and at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping.
 - d. As required by local code.

3.05 Cleaning, Flushing, Testing, and Inspecting:

- A. Cleaning: Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.
- B. Flushing: Flush piping systems with clean water prior to performing any required tests.
- C. Piping Tests:
 1. General: Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by VPTC Management Partners, LLC and local inspectors and the test results presented to VPTC Management Partners, LLC for acceptance and approval prior to concealing piping from view. Provide all necessary equipment for testing, including pumps and gauges. Note: All test results are to be submitted to VPTC Management Partners, LLC as specified in Section 15995.
 2. Domestic Water Systems: Test hot and cold water systems hydrostatically to a pressure of 150 psig or 1-1/2 times working pressure, whichever is greater, for a period of 4 hours. Repair all leaks, replacing materials as necessary, and repeat tests until systems are proven tight.
 3. Soil, Waste, and Vent Piping System: Test soil, waste, and vent piping by plugging all openings and filling system to height required by City Plumbing Inspector, but not less than 10'. Inspect all joints for leaks, repair all leaks found, and retest until piping is demonstrated to be free from leaks. In addition to water test, apply peppermint or smoke tests, if required

by local code. All underground main piping shall be inspected with a camera and the taped test results submitted to VPTC Management Partners, LLC.

4. Storm Drainage Piping System: Test storm drainage piping same as specified for Soil, Waste, and Vent Piping System.
 5. Disinfecting of Water Systems: Disinfect as required by code. Where code does not dictate tests to be conducted, at a minimum disinfect the hot and cold water systems as follows: Fill systems with water solution containing 50 ppm available chlorine; allow to stand for 4 hours, opening and closing all valves several times during this period; thoroughly flush; refill and place system in service; ensure a residual chlorine content of 2.5 ppm.
 6. Cleaning and Adjusting: Thoroughly clean and disinfect all plumbing fixtures, including all exposed trim. Adjust all flush valves for proper flushing, but without excess use of water.
- D. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories and appurtenances.
- E. Chemical Treating: Refer to Section 15545, "Water Treatment Systems", for flushing and cleaning systems.
- F. Identification: Refer to Section 15190, "Mechanical Identification" for nameplates and labeling requirements.

END OF SECTION 15400

Section 15440 – Plumbing Fixtures and Trim

Part 30 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide plumbing fixtures as specified.
- B. Work of Other Sections: Section 15510, "Hydronic Piping Systems".

1.03 Quality Assurance:

- A. Electrical Standards: Provide electrical products which have been tested, listed, and labeled by Underwriters' Laboratories, Inc. (UL) and which comply with National Electrical Manufacturers' Association (NEMA) standards.
- B. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of the basis-of-spec products listed in these Specifications.
 - 1. Electric Water Heaters
 - a. A. O. Smith, Inc.
 - b. Bradford White
 - c. Lochinvar
 - d. Rheem
 - e. Ruud
 - f. State Industries
 - 2. Fixtures:
 - a. American Standard
 - b. Crane Company
 - c. Eljer Plumbing Ware
 - d. Kohler Company
 - e. Toto USA
 - f. Zurn Industries, Inc.
 - 3. Faucets:
 - a. American Standard
 - b. Bradley Corp.
 - c. Chicago Faucet Company
 - d. Delta Faucet
 - e. Eljer Plumbing Ware
 - f. Elkay Mfg. Company
 - g. Just Mfg. Company

- h. Kohler Company
 - i. Sloan Valve Company
 - j. Speakman Company
 - k. Symmons
 - l. T & S Brass and Bronze Works, Inc.
 - m. Zurn Industries, Inc.
4. Flush Valves:
- a. Sloan Valve Company
 - b. Zurn Industries, Inc.
5. Seats:
- a. Beneke Corporation
 - b. Bemis
 - c. Church Products, Forbes-Wright Ind., Inc.
 - d. Olsonite Corporation
6. Carriers:
- a. Josam
 - b. J. R. Smith Mfg. Co.
 - c. Wade Div./Tyler Pipe
 - d. Zurn Industries, Inc.
7. Drinking Fountains:
- a. Ebco/Oasis
 - b. Elkay Mfg. Company
 - c. Halsey Taylor - Div. Household Int. Co.
8. Stainless Steel Sinks:
- a. American Standard
 - b. Dayton
 - c. Elkay Mfg. Company
 - d. Just Mfg. Company
 - e. Kohler Company

Part 31 Products

2.01 Electric Water Heaters:

- A. Heaters shall be guaranteed for 3 years against tank failure. Tanks shall be glass-lined with a minimum of 3" fiberglass insulation, factory-installed magnesium anodes, immersion type heating elements, high limit control and other necessary operating and safety controls.
- B. Provide a combination pressure and temperature relief valve complying with ANSI 21.22 with full size discharge pipe.

- C. Water heater size and capacity shall be as required to meet the water heating needs for each installation.
- D. Point of use water heaters shall not be used unless otherwise directed by VPTC Management Partners, LLC.

2.02 Water Closets:

- A. [Water Closet, WC-1:]
 - 1. Fixture: American Standard No. 2257.103, "Afwall" white vitreous china, siphon jet, 1.6 gallons per flush, elongated bowl, wall hung, with 1-1/2" top inlet.
 - 2. Seat: Olsonite No. 95 white, open front.
 - 3. [Flush Valve: Sloan "Royal" 111 (for non LEED buildings)].
 - 4. Carrier: Suitable for intended service.
- B. [Water Closet, WC-2 (ADA Compliant):]
 - 1. Fixture: American Standard No. 2257.103, "Afwall" white vitreous china, siphon jet, 1.6 gallons per flush, elongated bowl, wall hung, with 1-1/2" top inlet.
 - 2. Seat: Olsonite No. 95 white, open front.
 - 3. [Flush Valve: Sloan "Royal" 111 (for non LEED buildings)].
 - 4. Carrier: Suitable for mounting at ADA required height.

2.03 Lavatories:

- A. [Lavatory, L-1: (ADA Compliant)]
 - 1. Fixture: American Standard #0476.028 Aqualyn 20" x 17" vitreous china, self-rimming, oval lavatory complete with front overflow, 4" center faucet holes and 1 1/4" drain.
 - 2. Trim: American Standard Selectronic Innsbrook 6056.205 faucet, electronic proximity operation, all brass body with single inlet, built-in check valve and in-line strainer low energy use electronically operated solenoid valve and microprocessor controlled proximity sensors, 0.5 G.P.M. vandal resistant aerator, supply fitting. AC powered plug-in integral

low voltage transformer 115 VAC supply, chrome-plated tailpieces, strainers, P-trap, supply stops and all other trim

3. Supplies: Angle stop valves with escutcheons, 1/2" inlet, chrome-plated. Limit stops shall indicate maximum hot and cold water. Install for barrier free use, offset wall supply stops, drains, tailpieces and insulated drain and water supplies as required.

2.04 Sinks:

A. [Sink, S-1:]

1. Fixture: Elkay DLR-1722-10, self rim type 304 stainless steel, 10" deep with 1-3/4" radius covered corners. The underside of the sink shall be fully undercoated.
2. Faucet: Sink shall be fitted with Elkay LK-2442-BH, Hi-arc, dual blade handle, deck-mounted faucet.
3. Drain and P-trap: Provide Elkay chrome plated brass drain outlet with 1-1/2" O.D. tailpiece. Provide 1-1/2" X 1-1/2" P-trap with cleanout, slip joint inlet and 17 gauge tubing outlet to wall and wall escutcheon.
4. Supply and Stop: Provide supply and angle stop valves with escutcheons, 3/8" inlet, and chrome plated.

B. [Sink, S-2 (two-compartment):]

1. Fixture: Elkay DLR-3322-10, two-compartment self rim type 304 stainless steel, 10" deep with 1-3/4" radius covered corners. The underside of the sink shall be fully undercoated.
2. Faucet: Sink shall be fitted with Elkay LK-2443, Hi-arc, dual blade handle, deck-mounted faucet with sprayer.
3. Drain and P-trap: Provide Elkay chrome plated brass drain outlet with 1-1/2" O.D. tailpiece. Provide 1-1/2" X 1-1/2" P-trap with cleanout, slip joint inlet and 17 gauge tubing outlet to wall and wall escutcheon.
4. Supply and Stop: Provide supply and angle stop valves with escutcheons, 3/8" inlet, and chrome plated.

C. [Sink, S-3 (ADA Compliant):]

1. Fixture: Single compartment, 18 gauge stainless steel with sound-deadening, 13" x 16" outside dimensions, 10" x 10" inside dimensions, 6 1/2" deep; Elkay Model No. LRADQ-1316. Faucet punching shall be 3 hole; drain opening off-center rear.
2. Faucet: Set shall match the punching and shall be deck-mounted, lever-style chrome-plated, all brass, gooseneck faucet with aerator and wrist blade handles; American

Standard Heritage 6832 series and a stainless steel drain, cup strainer and rubber stopper. Provide complete trim such as service stops, tailpieces and P-trap.

2.05 Urinals:

A. Urinal, U-1:

1. Fixture: American Standard, "Allbrook" Mod. 6541.132, wall hung, white vitreous china, 1.0 gallon per flush, ¾-inch top inlet siphon jet.
2. Flush Valve: Sloan "Royal" No. 8186-1.0 battery-operated valve or approved equal.
3. Carrier: Suitable for intended service.

B. Urinal, U-2 (ADA Compliant):

1. Same as specified for U-2, accept mounted at ADA required height.

2.06 Electric Drinking Fountains:

A. Electric Drinking Fountain, EDF-1:

1. Fixture: Elkay No. EBFATL-8 stainless steel, combination (double unit, ADA Compliant) wall-mounted, barrier-free type with push bar water controls and hermetically sealed compressor using CFC-free refrigerant.
2. Trim: Angle stop valve with 1/2" inlet and 1-1/4" x 1-1/2" cast brass P-trap.
3. Support: Elkay wall mounting frame.

2.07 Janitor's Receptor:

- A. Service Sink, SS-1: Williams "Servi-I-Ceptor", Fiat, or Twin City Granite "Red-E-Basin," 24" x 24" x 6", 3" trap and Chicago 897 Faucet with vacuum breaker mounted 44" above floor. Provide 3' length of 3/4" garden hose threaded to connect to faucet. Provide stainless steel rim guard on exposed sides and stainless steel wall guards for walls adjacent to the receptor. Mount receptor level on floor, providing grout as required.

2.08 Hose Bibs and Wall Hydrants:

- A. Hose Bib, HB-1: Chicago Faucet No. 387, 3/4" female inlet, and No. E27 non-removable vacuum breaker, all polished chrome-plated.
- B. Wall Hydrant, WH-1: Non-freeze wall hydrants (NFWH) shall be non-freeze, bronze box type with vacuum breaker, loose key and wall clamp. Finish shall be rough bronze. Wall hydrants shall be Smith 5509QTPB or approved equal by Josam or Zurn.

2.09 [Emergency Eyewash & Showers:]

- A. Emergency Shower: When required per plan or chemical type(s) being used, a Guardian Equipment G1902P or equal, free-standing shower and eye wash, complete with deluge shower head, one inch full flow stay open ball valve actuated by pull rod and ring, aerated eye wash with plastic bowl and hand operated one half inch full flow stay open ball valve, , floor flange, and interconnecting fittings. Unit shall be securely anchored to wall and floor.
- B. Emergency Eyewash: All water cooled buildings containing a water treatment area shall be equipped with a Guardian Equipment G1814P or equal aerated eyewash station with plastic bowl and hand operated one half inch full flow ball valve securely mounted to a wall or other suitable structure.

2.10 [Showers:]

- A. Shower: Shower shall be equal to Symmons 4-500-X single control pressure balanced shower valve with lever handle, volume control and integral stop-checks, high temperature limit stop

set in field at 110° F. 4-131-2.5 super shower head with integral 2.5 gpm flow restrictor, 301 Nu-Arm head bracket fitting.

Part 3 - Execution

3.01 Installation:

- A. Heights: Set fixtures at heights as shown on the Architect's Drawings.
- B. Caulking: This Contractor shall caulk the joint between the finished wall surface and all plumbing fixtures. Verify colors with the Architect. Caulking material shall comply with the appropriate section of these Specifications.
- C. Emergency Eyewash & Shower: Install an emergency eyewash and when required, a combination emergency shower and eye wash adjacent to the chemical treatment feeder system, and in other locations as required by code or as indicated on the drawings. Station to be provided with tempered water between 65 and 95 degrees Fahrenheit. All installation means and methods to comply with any applicable plumbing specifications.
- D. Each fixture shall be provided with a shut-off valve for each supply line. All exposed lines shall be chromium-plated.
- E. Installation of electric water heaters shall be in accordance with manufacturer's written instructions.
- F. A drain pan is to be installed under all water heaters. The drain for the pan is to be piped to the nearest floor drain, mop basin or other approved point of safe discharge. The water heater needs to be installed at an elevation that will permit gravity draining of the drain pan. Install piping and appurtenances so that discharge will not overflow from drain.
- G. Water heaters shall be installed in a readily accessible location.
- H. For water heaters serving general lavatories, water temperature shall be set to 110°F. For water heaters serving kitchen areas, set water temperature at 140°F or as required by local codes.

END OF SECTION 15440

Section 15510 – Mechanical Piping Systems

Part 32 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide complete operating mechanical piping systems including pipe, tube, fittings, and appurtenances as indicated and in compliance with these Specifications.
- B. Applications: Applications of piping systems include, but are not limited to, the systems as listed below:
 1. **[Refrigeration]** 40 to 60°F
 2. **[Chilled Water]** 40 to 60°F
 3. **[Condensate Drainage]** 40 to 60°F
 4. **[Condenser Water]** 65 to 100°F
 5. **[Heating Water]** 100 to 180°F
 6. **[Generator Exhaust]** 900 to 1400°F

1.03 1.03 Quality Assurance:

- A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe.

Part 33 Products

2.01 Piping Materials:

- A. General: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.
 1. Steel Pipe: ASTM A53, ASTM A106, or ASTM A120, black or hot-dipped galvanized as specified.
 2. Copper Tube: ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.
 3. Pre-insulated Steel Pipe: ASTM A53, ASTM A106, ASTM A120, and ANSI B31.1.
 4. Polyvinyl Chloride (PVC) Water Pipe: Class 150, thick wall, Schedule 80, AWWA C90 mechanical joint.
 5. Copper Drainage Pipe: DWV copper piping.

2.02 Pipe/Tube Fittings:

- A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing

regulations, industry standards, and where applicable, with pipe manufacturer's instructions for selections.

1. Cast Iron Flanged Fittings: ANSI B16.1, Class 125 or Class 250, black or galvanized as specified, including bolting and gasketing.
2. Cast Iron Threaded Fittings: ANSI B16.4 or ASTM A126, Class 125 or Class 250, black or galvanized as specified.
3. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.
4. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
5. Threaded Pipe Plugs: ANSI B16.14.
6. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections.
7. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
8. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
9. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2". Do not thread nipples full length (no all-thread nipples).
10. Wrought Copper/Bronze Solder-Joint Fittings: ANSI B16.22 suitable for working pressure up to 250 psig.
11. Grooved End Fittings: ASTM A47 or ASTM A536 joined with Victaulic Style 77 couplings and Grade "E" gaskets.
12. Flanged Fittings: Comply with ANSI B16.15 for bolt-hole dimensioning, materials, and flange-thickness.
13. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
14. Flange Bolt Thread Lubricant: Lubricant shall be an anti-seize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
15. Copper Drainage Fitting: DWV copper drainage fittings.

B. Miscellaneous Piping Materials/Products:

1. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.
2. Brazing Materials: American Welding Society, AWS A5.B, Classification BCup-5.
3. Gaskets for Flanged Joints: 1/8" thick gaskets. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed non-asbestos or equal.
4. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Delvin" as made by Pipeline Seal and

Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation or equal.

5. Push-on-Joints: ANSI A21.11, rubber compression-type, "Tyton Joint" as manufactured by US Pipe or equal.

2.03 Strainers:

A. General: Water strainers shall be as follows:

1. 150 psig Working Pressure: 150 psig working pressure, 2" and smaller, shall be Muessco No. 11, 400 pounds WOG, iron body with perforated 20 mesh Monel screen with cleanout and screwed ends. 150 psig working pressure, 2-1/2 through 24", shall be Muessco No. 751, 150 pounds WOG, perforated monel screen with 1/16" perforations for sizes through 4", and 5/32" perforations for 5" and above, with blowdown connection with full sized gate valve, and Class 125 ANSI B16.1 flanged ends.
2. 300 psig Working Pressure: 300 psig working pressure, 2" and smaller, shall be Muessco No. 11, 400 pounds WOG, iron body with perforated 20 mesh Monel screen with cleanout and screwed ends. 300 psig working pressure, 2-1/2 to 24", shall be Muessco No. 752, 300 pounds WOG, perforated metal monel screen with 1/16" perforations in sizes through 4", and 5/32" perforations for 5" and above, with blowdown connection with full sized gate valve, and Class 250 ANSI B16.5 flanges.

B. Manufacturers: Strainers by Mueller, Crane, Muessco, Zurn, Keckley or equal.

2.04 Sleeves:

- A. General: Provide sleeves for piping passing through walls, floors, and roofs. Sleeves shall be of sufficient size to permit pipe or pipe and insulation, to pass through and leave an annular space for caulking. Sleeves through concrete construction, interior partitions, and ceilings shall be 18 gauge galvanized sheet steel. Masonry construction and exterior penetrations above and below grade shall be Schedule 40 galvanized steel pipe. Extend floor sleeves 2" above floor.
- B. Outside Walls Below Grade: Where pipes pass through outside walls that are below grade, provide schedule 40 galvanized steel pipe with water stop. When pipe is in place, seal with

"Link-Seal" Unit with EPDM links as manufactured by Thunderline Corporation, Flexicraft, Wayne, Michigan, or approved equivalent.

- C. Fire-rated Floor and Wall Penetration Sleeve packing and caulking shall consist of:
1. Provide the appropriate UL listed and approved materials for floor and wall penetrations.

2.05 Escutcheon Plates:

- A. General: Provide escutcheon plates on exposed piping where piping penetrates the walls, floors, or ceilings where penetration is exposed to view including on exterior of building
- B. Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated.
- C. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any.
- D. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole is flush with adjoining surface.

2.06 Flexible Connections in Piping:

- A. General: Provide flexible connections in piping to isolate vibrations from mechanical equipment or as specified under other Division 15 sections.
- B. Types of Flexible Connections:
1. Metal Expansion Joints:
 - a. Stainless steel corrugated bellows with woven flexible stainless steel wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250 deg. F operating temperature, capable of 3/4 inch misalignment.
 - b. Sizes 4" and smaller shall have single-braid outer jacket; sizes larger than 4" shall have double-braid to achieve minimum 150 psig rating. For applications with operating pressures greater than 150 psig, provide triple-braided.
 - c. Provide screwed connections for piping sizes 2" and smaller; flanged end connections on sizes larger than 2".
 2. Non-Metallic Expansion Joints:
 - a. Double-spherical neoprene connectors shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.
 - b. Connectors up to and including 1-1/2" diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges.
 - c. Connectors shall be rated a minimum of 150 psig at 220° F. 12" and larger sizes operating above 100 psig shall employ control cables with end fittings isolated by means of 1/2" thick bridge bearing neoprene washer bushings designed for a maximum of 1000 psig.
 - d. Non-metallic expansion joints may only be used on critical applications where required by an acoustical consultant and as directed by VPTC Management Partners, LLC.
 3. Flexible Hose Connections:
 - a. Flexible hoses shall have an EPDM Kevlar reinforced tube core with 304 stainless outer braid, brass end fittings and a rating of 400 psig, 250F. Hoses shall be full port,

fire retarding and conform to ASTM E84 and E81A. All hoses shall have minimum one swivel end fitting.

- b. Flexible hose connections shall only be used for connection of water source heat pumps; maximum 1" piping size.
- C. Provide flexible connections by one of the following manufacturers:
 1. Flexicraft Industries
 2. Hyspan
 3. Mercer Rubber Company
 4. Metal Flex
 5. The Metraflex Company
 6. Senior Flexonics
- D. All connectors shall be installed on the equipment side of the shut-off valves.

Part 34 Execution

3.01 Piping Installation:

- A. General:
 1. Industry Practices: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leak proof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections. Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by VPTC Management Partners, LLC.
 2. Systems: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms.

Where pipes of different sizes are joined, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.

3. Expansion and Contraction: Install loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment.
 4. Piping in Shafts: Mechanical joints for mechanical piping systems are not to be installed in locations that will not be accessible after construction is complete. (i.e. grooved fittings are not to be used on piping systems in shafts. The piping in this area is to be welded.)
- B. Steel Pipe: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up.
- C. Copper Pipe: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth or wire brush.
- D. PVC Pipe: Cut PVC pipe square and remove all burrs. Clean fitting and pipe butt prior to installation. Install all PVC water service piping in accordance with the manufacturer's recommendations.
- E. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where equipment is to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of hot water, condenser water, gas, domestic water, waste, and vent as required. Provide valves, unions, strainers, check valves, and traps as required for proper operation of systems and equipment. Equipment not shown on the Architectural Drawings or noted by VPTC Management Partners, LLC shall not be included in the scope of this requirement.
- F. Excavation, Installation, and Backfill for Underground Pipe:
1. Layout: Pipes shall be laid and pipe joints made in presence of VPTC Management Partners, LLC. Field measurements, layouts, batter board alignment, grade establishments, and similar locations shall be performed by a Professional Engineer or Surveyor in the employ of the Contractor. The Contractor's engineer or surveyor shall be on the job during all underground work. A "Bench-Mark" reference for use by the Contractor shall be provided by VPTC Management Partners, LLC.
 2. Pipe Grading: Lay and maintain all pipes at required lines and grades during the course of the Work.
 3. Trench: Excavate the trench to the depth required. Properly brace and de-water the trench and keep it free of water during installation, testing pipe, and backfilling. No water shall be discharged onto the street or freeway without approval by VPTC Management Partners, LLC.
 4. Excavation: The trench shall be at least 18" wider than the maximum diameter of the pipe or largest fitting and the pipe shall be laid in the center of the trench. The trench shall be excavated to a depth sufficient to provide for pipe cushions or supports as specified. Trench width may be increased as required and piling left in place until sufficient compacted backfill is in place. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill. Comply with all applicable national, state, and local codes and regulations. The quantity of excavation required to install sheeting and the installation and removal of sheetings and

bracings will not be regarded as Extra Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price.

5. Grading: Upon completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion, except where the cushion has been eliminated by VPTC Management Partners, LLC. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion material shall be as follows:
 - a. Open and Closed Loop Condenser Water and Hot Water Heating Piping: Material for pipe cushion shall comply with local codes and conform to the geo-technical report. In absence of local code requirements and/or geo-technical report, the cushion shall be bank sand or select backfill material approved by VPTC Management Partners, LLC.
 6. Anchors: Pipes shall have concrete anchors at each change in direction and/or as directed. Any change in direction exceeding 15 degrees shall be anchored. Concrete anchors shall rest against solid (virgin) ground with the required area of bearing on pipe and ground to provide suitable anchoring.
 7. Backfill: Backfill trenches only after piping has been inspected, tested, and approved by VPTC Management Partners, LLC. Backfill shall be provided as recommended in the geo-technical report included in these Contract Documents, or, in the absence of a geo-technical report, as required by site conditions. Refer to Division 2 or elsewhere in the Contract Documents for additional trenching and backfill requirements.
 8. Existing Surfaces: Restore existing streets, driveways, and sidewalks damaged during the excavation work to acceptable condition, subject to approval by VPTC Management Partners, LLC.
 9. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the local authorities.
- G. Pipe Sleeves:
1. Size and install sleeves so piping and insulation (if any) will have free movement in the sleeve, including allowance for thermal expansion. Install length of sleeve equal to

thickness of construction penetrated, except as noted in Paragraph 2.04/A. Pack and caulk or otherwise seal between pipes and sleeve as specified in Paragraph 2.04.

2. Where pipes or ducts pass through floors, furnish sleeves at a minimum of 1" larger than outside diameter of pipe or duct and insulation, or as required by code.
3. After installing pipe, grout or caulk sleeves through non fire walls to make watertight.
4. Provide sleeves for pipe installation under footings. Provide a slurry fill for pipe passing under floors.
5. Extend sleeves one foot beyond each side of footing.
6. Make installation of pipes passing through exterior walls watertight.
7. Pack and caulk sleeves as required.
8. Where sleeves are set in walls for future connections, close openings in sleeves with foam sealant.
9. Seal between ducts and sleeves where ducts penetrate floor, wall or ceiling with safing insulation. Seal shall maintain wall rating.
10. Where pipes pass through walls below grade into excavated areas such as pits, tunnels or basements, furnish pipe sleeve 1" or one pipe size larger than pipe and close opening with hydrostatic seals.
11. Coordinate with work of masons to properly locate sleeves so that sleeves are true to line, grade, position and plumb or level, ends of sleeves through walls are flush with finished wall surface and, in areas where floors are likely to become wet, ends of sleeves through floors are set 4" above finished floor.

3.02 [Open and Closed Loop Chilled Water, Condenser Water and Heating Water Piping Systems:]

- A. General: On each floor, provide isolating valves on core water supply and return mains to permit half of the floor to be isolated while maintaining service to the other half of the floor.
- B. Aboveground Pipe: Black steel, ASTM A53, Schedule 40, up to 12" and standard weight for 12" and above. As an option for piping below 1 ½", provide Type L hard drawn copper tubing meeting ASTM B88 or ASTM B280. Fittings - Wrought copper meeting ANSI B16.22. Joints - Silver brazed with sil-fos or silver solder.
- C. Underground Piping: Polyvinyl Chloride (PVC) Water Pipe: Class 150, thickwall, Schedule 80, AWWA C90 mechanical joint.
- D. Fittings:
 1. Service Pressure at or Less Than 150 psig:
 - a. Fittings, 2" in diameter and smaller, threaded, Class 150 rated, black, banded, malleable iron.
 - b. Fittings, 2-1/2" in diameter and larger, factory-fabricated, Class 150, weld-type.
 - c. Flanges, Class 150, forged steel weld neck.
 2. Taps and Branches: "Weld-O-Lets", "Thread-O-Lets", or "Branch-Lets" may be employed at locations where taps or branches join line pipe, provided the tap or branch does not

exceed 1/2 the size of the line pipe. Factory-fabricated wye and tee fittings may be welded into the main.

3. Service Pressure Greater Than 150 psig:
 - a. Fittings, 2" in diameter and smaller, threaded, 300 psig, black, banded, malleable iron.
 - b. Fittings, 2-1/2" in diameter and larger, factory-fabricated, weld-type, rated for greater than 300 psig.
 - c. Flanges, 300 psig, weld neck, welding flanges at valves and all flanged connections.
- E. Contractor Options:
 1. Schedule 40 pipe with cut grooves and victaulic fittings may be used for 2-1/2" and above.
- F. Cold-springing: Cold-springing of piping will not be permitted.
- G. Automatic Air Vents:
 1. An automatic air vent shall be installed at the air separator and piped to the floor drain, at a minimum. All other system high points and at other locations as required, shall be manually vented. Vents shall be designed to eliminate air from the system automatically and/or manually without permitting the passage of any water and shall be similar and approved equal to the following:
 - a. 150 psig working pressure service - Sarco Type 13W or approved equal.
 - b. 300 and 400 psig working pressure service - Sarco Type 13WH or approved equal.
 2. Automatic air vents shall have a 3/4" ips inlet connection and 3/8" outlet. Provide 3/8" OD hard drawn, Type "L" copper tubing from vent outlet for overflow in case of defective action. Copper tubing shall run to a suitable drain. Provide 3/4" stop valve in vent line for servicing of automatic air vent.

3.03 [Condensate Drainage:]

- A. General: Provide a condensate drain pipe to connect each cooling unit drain pan or funnel and to extend to and discharge into an open type drain in the sanitary plumbing system. Funnel type floor drain requirements are to be coordinated with the Plumbing Contractor. Provide union or solder joint at connection to heat pumps.
- B. Assembly: Use hard drawn Type "M" or DWV copper tubing with matching fittings, or Schedule 40, galvanized steel made up with Class 125, galvanized, threaded fittings. Assemble fittings to form a trap with depth equal to or greater than operating pressure of the unit served. Drains shall be of the size not less than the full size of the drain pan connection. Air handling unit

drains shall have deep seal traps to permit unit pan drainage. The deep seal trap shall be installed for each blow-through or draw-through air handling unit to maintain the water seal.

3.04 [Refrigerant Piping:]

- A. General: Refrigerant piping systems including fittings and accessories shall conform to ANSI B31.5-1966.

3.05 [Chemical Treatment Piping for Open and Closed Loop Piping Systems]

- A. Chemical treatment piping systems shall be selected and installed based on the recommendations of the chemical treatment contractor. Refer to specification 15545 for additional information.
- B. Where a fluid cooler water treatment by-pass loop is installed, all valves utilized in increasing system pressure shall be marked to identify position.
 - 1. Fluid cooler valves are not to be utilized to increase system pressure for the water treatment by-pass loop if the flow conditions to the fluid cooler cannot be maintained.
- C. All water treatment piping shall be schedule 40 black iron or schedule 80 CPVC. Return piping back to the system from brominators shall be schedule 80 CPVC.

3.06 [Emergency Generator Systems:]

- A. Exhaust: Install the muffler and flexible connection provided by the Electrical Contractor and furnish and install black steel pipe, exhaust pipe from the muffler to the outside as indicated on the Drawings. Coordinate requirements with the Electrical Contractor where packaged weatherproof outside units are specified.

3.07 Cleaning, Flushing, Testing, and Inspecting:

- A. Cleaning: Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.
- B. Flushing: Flush piping systems with clean water prior to performing any required tests. All piping system flushing is to be conducted in a manner not to adversely affect the performance of the equipment connected to the piping system.
 - 1. Flushing of Closed Loop Piping Systems:
 - a. All flushing shall comply with details in 15545, The supply and return runouts must be disconnected from each terminal unit or packaged unit and connected via a by-pass hose to allow circulation to the system, but not through the connected equipment. The system shall be chemically cleaned then flushed by opening the drain valve at the lowest point in the system. While the system is being drained, adequate make-up to the system will be provided to ensure the system remains full. Within 24 hours after adequate and certification of system cleanliness by the chemical treatment contractor (refer to specification 15545 for additional requirements) the units shall be reconnected and an approved inhibitor shall be introduced to the loop.
- C. Piping Tests:
 - 1. General: Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by VPTC Management Partners, LLC and local inspectors and the test results presented to VPTC Management Partners, LLC for acceptance and approval prior to concealing piping from view. Provide all necessary

equipment for testing, including pumps and gauges. Note: All test results are to be submitted to VPTC Management Partners, LLC as specified in Section 15995.

2. Heating Open Loop Condenser, Closed Loop Condenser, and Cooling Water System: Test water systems hydrostatically to a pressure of 150 psig or 1-1/2 times working pressure, whichever is greater, for a period of 4 hours. Repair all leaks, replacing materials as necessary, and repeat tests until systems are proven tight.
- D. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories and appurtenances.
- E. Chemical Treating: Refer to Section 15545, "Water Treatment Systems", for additional requirements on flushing and cleaning of systems.
- F. Identification: Refer to Section 15190, "Mechanical Identification" for nameplates and labeling requirements.

END OF SECTION 15510

Section 15545 – Water Treatment

Part 35 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Project Scope:

- A. This section includes the following:
 1. Water Treatment Open Loop Initial Setup
 2. Water Treatment Closed Loop Initial Setup
 3. Closed Loop Cleaning Washout Procedures
 4. Water Treatment Maintenance Program

1.03 Quality Assurance:

- A. Supplier: Water treatment chemical and service supplier who has been active in the field of industrial water treatment for not less than 5 years, and who has full-time service personnel located within trading area of the project.

1.04 Codes and Standards:

- A. Chemical Standards: Provide only chemical products which are acceptable under state and local pollution control standards.

Part 36 Products

2.01 Water Treatment Open Loop Initial Setup:

- A. Goal & Objectives: Provide a complete drumless chemical feed program using solid chemicals that will protect critical equipment and piping from deterioration due to corrosion and fouling of

waterside surfaces while allowing this equipment to operate at optimum efficiency. Specific objectives are as follows:

1. Provide protection of capital equipment for all hydronic systems within current industry corrosion guidelines; (NACE, AWT, ASHRAE, CTI)
2. Utilize Certified Water Technologists (CWT) designated professionals to administer, supervise, and oversee the treatment program;
3. Optimize efficiencies and energy consumption by maintaining clean, scale free surfaces;
4. Reduce microbiological growth and potential bio-fouling;
5. Proactively test and treat for Legionella bacteria;
6. Provide cost effective solutions for limiting exposure of chemicals to employees and operators.
7. Choose chemistries that minimally impact the environment and are approved for discharge in accordance with Federal, State, and local ordinances.

B. Equipment:

1. The following products and materials shall be provided by the water treatment consultant and installed by the mechanical contractor.

C. Dual Solid Chemical Feed System:

1. The dual feed system shall house the cooling tower inhibitor and the secondary non-oxidizing biocide. The panel will require a ½" domestic water feed line for chemical mixing,

120 VAC power supply for fill/mixing valves, holding tank overflow piped to the nearest floor drain.

2. Acceptable manufacturers: 21st Century & Advantage Controls Inc.

D. Tower Microprocessor Chemical Controller:

1. The tower microprocessor chemical controller shall be capable of controlling:
 - a. Tower conductivity via conductivity monitoring and tower blow down via motorized ball valve or solenoid.
 - b. Tower cycles of concentration vial comparison to incoming make up water conductivity.
 - c. ORP monitor if the water treatment consultants program requires a constant oxidizing biocide residual
 - d. PH monitor and control if water characteristics require control of PH.
 - e. Non oxidizing biocide control via timer
 - f. Tower inhibitor control via water meter contact.
2. The tower microprocessor shall at a minimum have the following options:
 3. Flow switch
 4. Temperature probe
 5. Local user control interface
 6. Open protocol communication to BAS via Modbus TCP/IP
 7. Run away chemical feed protection.
 8. Make up and blow down water usage data logging
 9. Spare I/O points for chemical feed totalization, chemical feed no flow alarming, etc.

E. Acceptable manufacturers: Walchem, Advantage & Pulsafeeder

F. Corrosion Coupon Rack:

1. The corrosion coupon rack shall be schedule 80 CPVC and shall incorporate flow control valves, strainer, flow meter and two coupon sample ports: Copper and mild steel coupons shall be provided at the time of start up.
2. Acceptable manufacturers: Advantage Controls Inc. or equal

G. Separator:

1. For packaged cooling towers with integral cold water sumps, a **side stream separator** shall be provided sized to 10% of the condenser water pump design flow. The mechanical contractor responsible for the system design shall approve sizing.
2. For fluid coolers or systems with remote sump basins, an **independently pumped packaged separator** shall be provided sized to 1 GPM per square foot of sump area (verify with system manufacturer). The mechanical contractor responsible for the system design shall approve sizing. The packaged unit will include all necessary control equipment, sump

spray nozzle, pump station, separator and drains. The controller shall be equipped with alarm points that can be reported to the building's BAS.

3. Acceptable manufacturers: Wingert or Lakos

H. Water Meters

1. Water meters shall be provided for make up and blow down. Both meters will be equipped with contact heads to provide usage feedback to the cooling tower controller.
2. The water treatment consultant shall verify with the mechanical contractor the size of the make up water line and provide a meter that is one size smaller than the make up line. The blow down meter shall be sized the same as the drain port of the side stream separator.
3. Acceptable manufacturers: Carlon or Master Meter

I. Brominator:

1. A brominator suitable for solid tablet feed shall be provided. The brominator shall include a pressure relief valve, solenoid valve, flow meter and two balancing/isolation valves. The brominator shall be sized so that refilling the unit is minimized to not more than monthly. In no case shall the brominator be sized at less than 25-pound capacity.
2. Acceptable manufacturers: Neptune or equal

J. Chemical Metering Pumps:

1. Two (1 for inhibitor and 1 for secondary biocide) diaphragm-metering pumps sized according to the chemical addition requirements and pressures with wetted parts being compatible with the chemical program shall be provided. Metering pumps shall have a minimum of 360:1 turndown with a digital display of pump speed. Each metering pump shall be fitted with a flow verification device that will confirm that the pump is metering chemical when it is actuated. The flow verification device shall be compatible with the multi

I/O controller and allow for the totalization of chemical metered and through the multi I/O controller raise an alarm.

2. Acceptable manufacturers: Pulsafeeder, Advantage & Iwaki
- K. Blow Down Valve:
1. A full-ported motorized ball valve shall be provided for installation on the drain of the side stream separator.
 2. Acceptable manufacturers: Belimo or Clay
- L. Miscellaneous:
1. The following miscellaneous items shall be provided by the water treatment consultant:
 - a. Pasivation/start up equipment and chemicals
 - b. Program control manuals
 - c. MSDS Sheets
 - d. Test kits and reagents
 - e. Standard solutions
 - f. Installation drawings for piping and wiring
 - g. Biocides, inhibitors, etc (90 day supply)
 - h. System commissioning
 - i. Operator training
- M. Installation, System Start Up & Equipment Commissioning:
1. The water treatment consultant shall provide the following services to ensure that all equipment is properly installed, all metals are properly passivated and all equipment is properly started up and commissioned.
 - a. Pre-installation Meeting: will be held with the installing contractor, show that equipment locations can be discussed, installation drawings can be provided & reviewed, and all materials can be turned over for installation.
 - b. Pre-start Up Review Meeting: will be held to confirm proper and complete installation.
 - c. Start Up & Commissioning: The equipment shall be started up and checked for correct operation. All chemicals will be installed, mixing functions tested and controller will be set up.
 - d. Pasivation & Program Set Up: The water treatment consultant shall provide appropriate system passivation and set up the chemistry program once all equipment has been installed and commissioned.
 - e. Operator Training: provide a half day training session with the building operators after turnover has occurred. This training shall include a proper operation of all installed equipment, safety, chemical testing, daily logging, calibration, etc.
- N. Chemical Treatments and New System Passivation:
1. The water treatment consultant must follow the cooling tower manufacturer's guidelines for recommended water chemistries as listed below. The vendor shall supply a monitoring (pH) and chemical feed system for use during the passivation process. This process must be completed in accordance with the manufacturers specification prior to the cooling tower

being put into operation. These startup guidelines are essential for prevention of white rust corrosion.

2. Baltimore Air Coil:
 - a. Passivation Treatment: Use of inorganic PO₄ treatment helps passivate zinc coating.
 - b. PH for initial service: 6.5-8.0
 - c. Hardness (as CaCO₃): > 30 PPM
 - d. General Comments: Avoid soft water, <30 PPM Ca, combined with higher alkalinity. Routine passivate if operating at a pH >8.3.
 - e. (Reference) Baltimore Aircoil Company. (1992) White Rust on galvanized steel cooling towers.
 3. Evapco:
 - a. Passivation Treatment: 400-450 PPM Po₄ w/100 PPM Ca (as CaCO₃) for 45-60 days.
 - b. PH for initial/routine service: 6.5-8.0
 - c. Hardness (as CaCO₃): 100-300 PPM
 - d. Alkalinity (as CaCo₃): 100-300 PPM
 - e. Chlorides (as Cl): <250 PPM
 - f. Sulfates (as SO₄): <250 PPM
 - g. General Comments: Avoid soft water <50 PPM Ca as (CaCO₃). Avoid using acids. Routinely passivate if at a pH >8.3. Immediately clean and repassivate areas of white rust.
 - h. (Reference) EVAPCO (2002) White Rust. Engineering Bulletin No. 036.
 4. Marley:
 - a. Passivation Treatment: Use inorganic PO₄ for at least 8 weeks to help passivate zinc coating.
 - b. PH for initial/routine service: 6.5-8.0
 - c. Hardness (as CaCO₃): 100-300 PPM
 - d. Alkalinity (as CaCo₃): 100-300 PPM
 - e. Chlorides (as Cl): <250 PPM
 - f. Sulfates (as SO₄): <250 PPM
 - g. General Comments: Avoid soft water. If purchase has not been made, consider stainless basin.
 - h. (Reference) Marley Cooling Tower Company (1992) White Rust & water treatment. Manual 92-1184A
- O. Treatment (For non-aggressive make up water):
1. Inhibitor: Provide a concentrated solid corrosion/scale/fouling-inhibiting formulation containing molybdate (as a tracer), azole, polymers, and phosphonate without other materials in excess of allowable, local, effluent limits. The formulation must be suitable for the quality of the make up water so that the performance objectives can be met. Feed shall be automatic and maintained with the water treatment consultants published control

ranges. The inhibitor package recommended shall be capable of maintaining (at the recommended cycles of concentration) the following:

- a. Molybdenum: 1-3 ppm as Mo (to be used as a tracer)
 - b. Azole: minimum 1 ppm as available tolytriazole (TTA) or benzotriazole (BZT) (Available equals total azole minus 2 times the copper level).
 - c. Organic Phosphorus: 5 – 15 ppm as PO₄
 - d. Polymer: Minimum 10 ppm
2. The inhibitor product shall contain dispersants to control fouling and suspended matter.
 3. Maintain system pH within a safe range to optimize corrosion control and to minimize the potential for scale and deposit formation
 4. **Notes:**
 - a. **Orthophosphate-containing products shall not be used.**
 - b. **Chromate and/or Zinc-containing products shall not be used.**
 5. Microbiocides:
 - a. The program must include an bromine based oxidizing biocide and a non-oxidizing biocide specific to Legionella and a dedicated biological penetrant and dispersant
 - b. Oxidizing Biocide: Solid Bromine briquettes, Great Lakes Hydantoin BCDMH or equal shall; be provided as the oxidizing biocide. This product shall be "shock fed" once daily at a rate that will achieve a residual of 1,0 ppm one hour after feed.
 - c. If a continuous halogen level is desired maintain 0.1 – 0.5 PPM as a maximum. This method shall also incorporate an ORP controller.
 - d. Non-Oxidizing Biocides: The secondary biocide shall be 98% active Solid DBNPA (Clearon C103G), shock fed weekly to maintain a 5 PPM residual. Water treatment consultant must show calculations for Holding Time Index, retention times, and

blowdown rates to determine non –oxidizing biocide dosage rates. Biological testing via ATP is preferred, as “dip slide” media measure only aerobic organisms.

6. PH Control:

- a. If PH control is required due to make up water characteristics, contact VPTC Management Partners, LLC’s Mechanical & Electrical Systems Manager for further information.

P. Installation Notes:

1. All installations shall be neat and all equipment shall be easy to access. All equipment shall be wall, stand or rack mounted. When possible, components will be mounted as a complete system on a 1/2” thick PVC panel suitable for wall mounting.
2. All downstream chemical injection lines shall be schedule 80 socket welded CPVC. All sample lines shall be sourced from a point that provides at least five gallons per minute at 60 psig and can overcome the pressure at the sample return point.
3. All electrical connections shall be hard wired. Any pump or controller cord sets shall not be extended to over three feet.

2.02 Water Treatment Closed Loop Initial Setup:

A. All closed loop systems shall be equipped with the following equipment:

1. Side Stream Pot Feeder: Each closed system shall have a five-gallon side stream pot feeder installed. The pot feeder shall be equipped with isolation valves on the inlet/outlet and a drain line piped to the nearest floor drain.
 - a. Acceptable Manufactures: Neptune, Vector or equal
2. Side Stream Filtration: Side stream filtration will be provided for each closed loop. When possible, this filtration shall reside at the lowest point of the system that will allow for adequate flow rates. The side stream filters shall be sized at 5 – 10% of the respective system’s flow rate for the cleaning process of the primary chilled water and hot water recirculating systems. Filter vessel shall be made of 304L or 316L stainless steel, split shell construction with 316 stainless steel internals, brass vent, and stainless pipe plugs. The housing shall be equipped with a pressure gauge on the each of the inlet and outlet of the housing that are of appropriate pressure scale for the respective system. The vessel shall be equipped with isolation valves on the inlet/outlet and a drain line piped to the nearest floor drain. Filter vessels shall be suitable for operating pressures of 150 psi and operating temperatures of 200°F degrees. Filter media shall be wound propylene cartridges with steel cores. Filter cartridges shall have a nominal 30 micron rating. Flow rate per 10” length shall not exceed 6 GPM. Bag filter housings and filters will not be accepted!
 - a. Acceptable Manufactures: Mordock or equal
3. Corrosion Coupon Rack: Each closed loop system shall be equipped with a corrosion coupon rack. The corrosion coupon rack shall be schedule 80 CPVC and shall incorporate

flow control valves, strainer, flow meter and two coupon sample ports: Copper and mild steel coupons shall be provided at the time of start up.

a. Acceptable manufacturers: Advantage Controls Inc. or equal

B. Chilled Water Treatment:

1. Molybdenum 100 PPM min. as MoO₆ in chilled systems.
2. Azole (10 PPM)
3. ATP bacteria <300 r.l.u.'s, BIOTRACE or equal
4. pH – 8.5 – 9.5

C. Hot Water Closed Loop Systems:

1. Nitrite (1,000 PPM min. as NO₂),
2. Azole (10 PPM)
3. ATP bacteria <300 r.l.u.'s, BIOTRACE or equal.
4. pH – 8.5 – 9.5
5. Biocide additions may be necessary based on ATP results. Nitrite treated systems may breed nitrite reducing bacteria, i.e. nitrite is added constantly with little or no makeup.

Oxidizing biocides are not recommended. Glycol percentages >25% will prevent biological growth.

D. Inhibited Glycol Fluid Specifications (When applicable):

1. Refer to Section 15546 Anti-Freeze Heat Transfer Fluids for requirements.

E. Installation Notes:

1. All installations shall be neat and all equipment shall be easy to access. All equipment shall be wall, stand or rack mounted.
2. All electrical connection shall be hard wired unless a manufactured UL approved cord set is provided. No cord set shall be extended over three feet to the outlet.
3. With the exception of the corrosion coupon rack, all closed loop components shall be piped in with materials of the same as the system it is connected to.

2.03 Closed Loop Washout Procedures

Vendor MUST verify and follow all OEM specifications for washout and cleaning.

A. Vender shall have available:

1. Sufficient quantity of washout compound and Inhibitor.
2. Chemical transfer or recirculating pump (if required).
3. Protective gear (rubber gloves, protective face mask, rubber apron and all other personal protection equipment indicated by the washout procedure Material Safety Data Sheet, product bulletin and coding on the product label.
4. Stainless steel cartridge filter vessel rated for appropriate temperatures and pressures.

B. Washout Procedure:

1. Flush all "mud" legs and strainers thoroughly until only clear water runs out. Flush especially well all areas of low flow and low lying points of the circulating system. Install cartridge filter vessel and new 20 micron rated cartridges.
2. Add the recommended amount of washout product to the system utilizing a chemical transfer or recirculating pump assembly. Product can be added to pot feeders or other suitable methods of product introduction may be used. Bring the system to full volume fresh, clean water. Maintain as high a temperature as possible, as this will facilitate cleaning of oils and greases. However; in no case should the temperature of the system exceed 200 F.
 - a. NOTE: Some foaming may occur and is considered normal. Excessive foaming can be controlled by the addition of Anti-Foam. Add two (2) ounces of Anti-Foam to one (1) gallon fresh water.
3. Add recommended dosage of washout treatment base on appropriate system volume and OEM specifications. (e.g. PRE CLN at 10 GLS. Per 1,000 gallons system volume) Circulate throughout the system, being sure that all that sections of the piping system are open to full flow and all tube bundles, condenser coils and plate & frame heat exchange equipment are **bypassed**. Cleaning duration at full flow should be a minimum of six (6) hours and a

maximum of twenty-four (24) hours or until the cleaning is completed. Change cartridge filters as needed to facilitate cleaning.

4. Remove filters from vessel and connect fresh water makeup via hydrant to the CWR somewhere at the top of the system and connect drain hose on the CWS somewhere near the bottom of the system.
 5. Flush system thoroughly while draining until water treatment vendor verifies washout compound is removed.
 6. Immediately following completion and verification of flushing, certification records covering the cleaning operation shall be submitted to necessary parties. Water treatment vendor will collect a final retain sample. Vendor to document flushing is completed by testing water to insure conductivity is within 25 mmho's of incoming makeup source and Total "M" alkalinity is also within 25 PPM of makeup source.
 7. Within 24 hours of cleaning procedure and acceptance the loop will be filled with USP Propylene glycol (when applicable) and inhibitor package. Water Treatment vendor to verify glycol (when applicable) and inhibitor concentrations within 48 hours of glycol circulation.
- C. Acceptable Closed System Treatment Program:
1. Primary treatment is for corrosion and microbiological attack. Scale control may be an issue if large amounts of hard water makeup are introduced. Systems that typically take on more than 2,000 gallons of makeup per year should utilize a water softener.
 2. Supply sufficient quantity plus 25% to provide the following levels:
 - a. Chilled & Condenser Water Treatment
 - 1) Molybdenum 100 PPM min. as MoO₆ in chilled or condenser water systems.
 - 2) Azole (10 PPM)
 - 3) ATP bacteria <300 r.l.u.'s, BIOTRACE or equal
 - 4) pH – 8.5 – 9.5
 - b. Hot Water Closed Loop Systems
 - 1) Nitrite (1,000 PPM min. as NO₂),
 - 2) Azole (10 PPM)
 - 3) ATP bacteria <300 r.l.u.'s, BIOTRACE or equal.
 - 4) pH – 8.5 – 9.5
 - 5) Tolytriazole (TT) yellow metal corrosion inhibitors should be reported "as available", meaning dosage minimums must be determined as total Azole minus two times the system copper levels. Copper levels should be below 0.2 PPM at all times.
 - c. Biocide additions may be necessary based on ATP results. Nitrite treated systems may breed nitrite reducing bacteria, i.e. nitrite is added constantly with little or no

makeup. Oxidizing biocides are not recommended. Glycol percentages >25% will prevent biological growth.

- d. Testing for iron levels (<1.0 PPM) is recommended. Corrosion control via Steel coupons (<0.5 MPY), Copper coupons should show (<0.08 MPY).

2.04 Cooling Water Treatment Maintenance Program

A. Scope of Services

1. Each of the items outlined below shall be provide under an annual contract with fixed costs. Vendor will provide fixed costs for these services when submitting the proposal for the initial plant set up. The annual cost of this contract shall be divided by four and billed quarterly.

B. Routine Visits

1. During the primary cooling season the water treatment consultant shall visit the site no less than twice per month. During the off season, the consultant shall visit the site no less than once per month

C. Routine Testing (Water Treatment Consultant)

1. Each Visit:

- a. During each routine visit the water treatment consultant shall conduct appropriate water analysis of the cooling and make up water to insure proper treatment.
- b. Review the operator's daily log to insure proper program maintenance by VPTC Management Partners, LLC staff members.
- c. Check for the correct operation of all water treatment systems and equipment.
- d. Troubleshoot water treatment related problems.
- e. Recommend/make all necessary corrections/adjustments.
- f. Provide additional training/consulting as required.
- g. Provide a written report of test results, recommendations, and adjustments. One copy of the report shall be left with the on-site engineer and a second copy shall be sent to the Operations Manager.

2. Quarterly:

- a. To insure the water treatment program is properly controlling Legionella, each quarter the water treatment consultant shall collect water samples for each open system and send these samples to an independent laboratory for analysis. The results of these analyses shall be submitted to the on -site engineer and the Operations Manager. These submittals shall include a summary from the consultant, necessary corrective actions, and the independent laboratory reports.
- b. Each quarter the consultant shall remove all corrosion coupons from each system and send them to an independent laboratory for analysis. The results of these analyses shall be submitted to the on- site engineer and the Operations Manager. These submittals shall include a summary from the consultant, necessary corrective actions, and the independent laboratory reports.

3. Annually:

- a. The water treatment consultant shall visit the site to inspect any cooling towers, chillers, and heat exchangers that are taken off line for cleaning/maintenance. A report of the

findings as well as necessary corrective actions will be left with the on site engineer and one copy will be sent to the Operations Manager.

- b. If a system contains glycol, the water treater shall analyze the freeze protection levels. Glycol shall be maintained at 40% of the system volume with a freeze protection of – 13 degrees Fahrenheit.

D. Program Control

1. The treatment program shall meet or exceed the standards set by NWT, ASHRAE, BOMA, and NACE.
2. The open systems shall be treated with a concentrated solid corrosion/scale/fouling-inhibiting formulation containing molybdate (as a tracer), azole, polymers, and phosphonate without other materials in excess of allowable, local, effluent limits. The formulation must be suitable for the quality of the make up water so that the performance objectives can be met. Feed shall be automatic and maintained with the water treatment consultants published control ranges for scale and corrosion. The inhibitor package recommended shall be capable of maintaining (at the recommended cycles of concentration) the following:
 - a. Molybdenum: 1-3 ppm as Mo (to be used as a tracer)
 - b. Azole: minimum 1 ppm as available tolytriazole (TTA) or benzotriazole (BZT) (Available equals total azole minus 2 times the copper level).
 - c. Organic Phosphorus: 5 – 15 ppm as PO₄
 - d. Polymer: Minimum 10 ppm
3. The systems shall be treated for biological control using a combination of oxidizing and non-oxidizing products. Solid Bromine briquettes, Great Lakes Hydantoin BCDMH or equal shall be provided as the oxidizing biocide. This product shall be “shock fed” once daily at a rate that will achieve a residual of 1.0 ppm one hour after feed. If a continuous halogen level is desired maintain 0.1 – 0.5 PPM as a maximum. This method shall also incorporate an ORP controller. The secondary biocide shall be 98% active Solid DBNPA (Clearon C103G), shock fed weekly to maintain a 5 PPM residual.
4. The treatment program shall be designed to insure efficient operation of all heat transfer/rejection systems. Cooling towers systems shall be run at >4.5 to 5.0 cycles of concentration or 1000-1200 MMHOs depending on the make up water chemistry. The water treatment consultant shall perform annual efficiency studies to each system and make adjustments as required.
5. Those open systems that are left on line during the winter (low flow months) shall be adjusted and controlled to provide proper corrosion and bacteria treatment. The consultant

shall insure that the on site staff is properly instructed on the methods of control during the low flow months.

6. Closed systems shall be maintained at the following levels:
 - a. Molybdenum 100 PPM min. as MoO₆ in chilled systems.
 - b. Nitrite (1,000 PPM min. as NO₂),
 - c. Azole (10 PPM)
 - d. ATP bacteria <300 r.l.u.'s, BIOTRACE or equal.
 - e. pH – 8.5 – 9.5
 - f. **Note:** Biocide additions may be necessary based on ATP results. Nitrite treated systems may breed nitrite reducing bacteria, i.e. nitrite is added constantly with little or no makeup. Oxidizing biocides are not acceptable.
 - g. **Note:** chemical additions to closed loops that are considered “maintenance” shall be part of the annual contract. Large dose additions VPTC Management Partners, LLC to drain downs, etc, are not part of the contract and shall be invoiced separately.
7. Mild steel corrosion levels shall be maintained at <2 mpy on open systems and <.5 mpy on closed systems. Yellow metal corrosion levels shall be maintained at <.3 mpy on both open and closed systems.
8. System Copper levels shall be below 0.2 PPM at all times.
9. If a system contains glycol, the levels shall be maintained to provide freeze protection to – 13 degrees Fahrenheit. **Note:** glycol additions are not included in the annual contract pricing, these shall be invoiced separately.

E. Products/Materials

1. The water treatment consultant shall provide all chemicals necessary to properly treat the cooling system including Water Chillers, Cooling Towers, Remote Sumps, Heat Exchangers, Boilers, and open/closed loop piping. The water treatment consultant will provide all test kits, calibration “standard” solutions, reagents, Agar slides (Biological control performance), and corrosion coupons.
2. The water treatment consultant shall provide repair, maintenance, and replacement of any control or feed equipment at an additional cost to the annual contract.
3. The water treatment consultant will provide all daily test log sheets, program control manuals, product sheets, and MSDS sheets.

END OF SECTION 15546

Section 15070 – Electric Heating Cable

Part 37 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 16010 Basic Electrical Requirements", govern this Section.

1.02 Description of Work:

- A. General: The extent of electric heating cable work is as indicated by the requirements of this Section and as specified elsewhere in these Specifications. In general, electric heating cable shall be furnished and installed by the Mechanical and Plumbing Contractors in accordance

with this Specification. Coordinate power wiring requirements for electric heating cable with the Electrical Contractor.

B. Applications: Pipe heat tracing applications required for this project include, but are not limited to, the following:

1. Provide pipe freeze protection heat tracing for all sanitary and storm piping, hydronic piping, domestic hot and cold water piping, and for sump pump and sewage ejector

discharge piping which is exposed to outdoor temperatures. Heat tracing on wet fire protection systems is allowed only if acceptable to the local Fire Marshall.

- C. Types: The type of electric heating cable required for the project is self-limiting parallel resistance heat tracing cable.

1.03 Quality Assurance:

- A. Manufacturers: Provide products produced by one of the following:
1. Chromalox Precision Heat and Control
 2. ESG Electrical Group
 - a. Easy Heat
 - b. Nelson Heat Trace
 3. Raychem, Division of Tyco Thermal Controls
 4. Thermon Manufacturing Company
- B. UL Standards: Electric heating cable shall conform to all applicable standards and shall be UL-labeled.

Part 38 Products

2.01 Materials and Components:

- A. Parallel Resistance Heat Tracing Cable: Provide parallel resistance heat tracing cable in the ratings required with non conductive thermoplastic material jacket as required.
- B. Electric Heating Cable Thermostat: Provide raintight NEMA 4 enclosure electric heating cable thermostat with temperature range from 0 to 90°F, single or double-pole, single-throw switch with heavy-duty 600 volt ac, 20 ampere contacts and as instructed by the cable manufacturer.
- C. Electric Heating Cable Accessories: Provide electric heating cable accessories, including heat transfer foil, stainless steel banding strips and fiberglass tape as instructed by the manufacturer for each particular application.

Part 39 Execution

3.01 Installation:

- A. General: Install electric heating cable in accordance with the manufacturer's written instructions, the applicable portions of the NEC and recognized industry practices to ensure that products serve the intended functions.
- B. Installation: Install electric heating cable where shown. The tracing system shall be designed to maintain a 40°F water temperature within the traced pipe, with an ambient temperature of 0°F.
- C. Thermostats: Install thermostat sensing bulb on opposite side of pipe from electric heating cable to provide pipe heat sensing control.
- D. Coordination: Coordinate installation of electric heating cable with piping, fittings, valves and insulation.
- E. Insulation: Pipe insulation over heating tape and cable is specified in Section 15250.
- F. Power Circuit: Connect electric heating cables only to circuits protected by ground fault circuit interrupters providing 30 ma equipment protection.

3.02 Testing:

- A. General: Test heating tape and cable to demonstrate proper operation. Repair or replace malfunctioning or damaged tape and cable. Retest to demonstrate proper operation.

END OF SECTION 15070

Section 15080 — Electronic Variable Speed Drives

Part 1 - General

1.02 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.03 Description of Work:

- A. Included: Furnish and mount all electronic variable speed drives (VSD) ready for wiring as required for equipment furnished under this division. All line voltage wiring shall be done by the Division 16 Contractor.
- B. The technical requirements of this section shall also apply to variable speed drives provided as part of factory packaged equipment.
- C. Types: The types of electronic variable speed drives required for the project include, but are not limited to variable frequency motor speed controllers.

1.04 Standards:

- A. Products shall be designed, manufactured, tested, and installed in compliance with the latest applicable standards of IEC, UL, ANSI, and NEMA.
- B. VSD design and construction shall comply with all applicable provisions of the National Electric Code.
- C. Each VSD shall comply with Part 15, Subpart J of FCC rules for Class A computing devices in the range of 7 to 30 MHz for conduction. FCC label of compliance shall be displayed on the VSD.

1.05 Quality Assurance:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
 - 1. Eaton Cutler-Hammer
 - 2. Square D
 - 3. Toshiba
 - 4. Yaskawa
- B. Factory Testing: To ensure quality, each VSD shall be subjected to the following factory tests:
 - 1. The integrated circuits shall undergo a 120-hour "burn-in" to test reliability. During the "burn-in" the temperature shall be cycled between 0 and 70°C.
 - 2. The completed unit shall undergo a fully loaded 24-hour "burn-in" while serving a varying induction motor load. Test load shall vary between 50% and 100% of rated HP capacity and shall include a minimum of 12 hours at rated HP.
 - 3. The unit shall be subject to a series of in-plant quality controlled inspections before approval for shipment from manufacturer's facilities.

1.06 Submittals:

- A. Shop drawing submittals shall include, but not be limited to, the following:
 - 1. Cut sheets of individual speed controllers with construction, dimensions, weights, ratings, voltage, poles, options, and all associated accessories clearly indicated.

2. Wiring diagrams for the drive power, bypass, and control sections.
3. A detailed description of drive operation and adjustable parameters.
4. A detailed description of factory testing.
5. Additional information as required in Section 15010.

1.07 Product Delivery, Storage and Handling:

- A. Store speed controllers in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle speed controllers carefully to avoid damage to material components, enclosure and finish.

Part 2 - Production

2.02 Electronic Variable Speed Drives:

- A. General: Provide electronic variable speed drives for control of standard or high-efficiency NEMA Design B induction motors as required for equipment
- B. Operation: Each variable speed drive shall convert available utility power to adjustable voltage/frequency, 3-phase, ac power for stepless motor control from 25 to 110% of motor 60 Hz speed.
 1. The variable speed drive (VSD) shall produce an adjustable ac voltage/frequency output for complete motor speed control. Speed control shall be stepless throughout the range under a variable torque load on a continuous basis. The VSD shall be automatically controlled by an external control signal.
 2. The VSD maximum output current rating shall be greater than or equal to the motor nameplate full load. The input power factor of the controller shall be 0.95 or greater under all speed and load conditions and the unit shall be rated for 100% operation at full rated current, voltage and frequency.
 3. The VSD shall contain a fused input power disconnect or circuit breaker with door interlock.
 4. A dedicated line filter shall be provided at the input of the VSD to limit EMI from interference with vital electrical equipment if required for FCC compliance as specified in Paragraph 2.09/C/3.
- C. Components: Each controller shall include, but not be limited to an input rectifier, constant voltage dc link, filter, sine-weighted pulse width modulation inverter and accessory sections with each section modularized for ease of troubleshooting. Controller shall be protected with I²T fuses or circuit breakers per the manufacturer's design and specification. All components shall be factory mounted and wired on a dead-front, grounded, free-standing or wall-mounted minimum NEMA 1 enclosure arranged for top or bottom conduit entry. The free-standing enclosure shall be suitable for mounting on a steel platform or on a concrete housekeeping pad.
 1. The controller enclosure shall be provided with the manufacturer's illustrated operating instructions and parts list mounted inside the enclosure door, manual speed control potentiometer or electronic manual control, three position mode selector switch (manual-

off-auto), "power on" light, diagnostic/frequency display, auxiliary relays, and contacts for interlock and control wiring.

D. Features: VSD features shall include, but not be limited to, the following:

1. Input Power: [208] [480] volts ac $\pm 10\%$, 60 Hz, ± 1.8 Hz. Input power factor shall be 0.95 or greater from full motor speed to zero speed for any motor load.
2. Output Power: Three phase, 0-[480] [208] volts, 2-60 Hz.
3. Ambient Temperatures: Operating: 0°C to 40°C (32°F to 104°F). Storage: -20°C to 60°C (-4°F to 140°F).
4. Frequency Stability: Output frequency will be held to $\pm 0.1\%$ of maximum frequency regardless of load, $\pm 10\%$ input voltage change or temperature changes within the ambient specification.
5. Disconnect: Locking type input disconnect switch with external operating handle.
6. Bypass: Manual bypass that isolates the drive from the circuit and allows motor operation at full across-the-line speed. Bypass shall include motor contactor, drive isolation contactors, motor overload protection, fused control power transformer and front panel mounted bypass controls.
7. Input Filter: Input line filter capable of protecting the electronics against transient voltage spikes or notches.
8. Current Limit: To limit output current to 110% of that of the drive rating. The current limit shall be designed to function automatically to prevent overcurrent trip due to momentary overload conditions, allowing the drive to continue operation.
9. Instantaneous Overcurrent Trip: To safely limit the output current in under 50 microseconds due to short circuit or severe overload conditions.
10. Undervoltage Trip: To protect the drive due to non-momentary power or phase loss. The undervoltage trip will activate automatically when line voltage drops 15% below rated input voltage.
11. Overvoltage Trip: To protect the drive due to voltage levels in excess of its rating. The overvoltage trip will activate automatically when the inverter bus in the controller exceeds 950 volts dc.
12. Ground Fault Protection: Fuseless electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.
13. Overload Protection: Electronic output overload protection shall be provided to eliminate the use of bimetallic overloads. The drive shall not be phase sequence sensitive. The overload protection shall also protect the motor when it is operated at full speed in the bypass mode.
14. Overtemperature Trip: To protect the drive from elevated temperatures in excess of its rating. An indicating light which begins flashing with 10°C of the trip point will be provided to alert the operator to the increasing temperature condition. When the overtemperature trip point is reached, this light will be continuously illuminated.
15. Automatic Reset/Restart: The drive shall be equipped such that a trip condition resulting from overcurrent, undervoltage, overvoltage or overtemperature shall be automatically reset, and the drive shall automatically restart upon removal, or correction of the causative condition. The number of reset/restart attempts for undervoltage, overvoltage, overtemperature and overcurrent shall be limited to five. If, in five attempts, a reset/restart is not successful, the drive shall shut down safely, requiring a manual restart. If, within five

attempts, a successful reset/restart occurs, the Auto Reset/ Restart circuit will reset the attempts counted to zero after approximately 10 minutes of continuous operation.

16. Power Interruption: In the event that an input or output power contactor is opened or closed while the drive is activated, no damage to the drive shall result.
17. Short Circuit Protection: In the event of a phase-to-phase short circuit the drive shall be designed to shut down safely without component failure.
18. Sustained Power Loss: In the event of a sustained power loss, the drive shall be designed to shut down safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation.
19. Momentary Power Loss: In the event of a momentary power loss, the drive shall be designed to ride-through a power interruption up to five cycles and shut down safely without component failure. Upon a more extended momentary power loss, the system shall be designed to automatically return to normal operation upon return of power.
20. Stand Alone Operation: To facilitate start-up troubleshooting, the drive shall be designed to operate without a motor or any other equipment connected to the drive output.
21. Start/Stop Control: The drive may be started or stopped by any one of the following:
 - a. A contact closure rated 50 ma, 115 volt ac minimum.
 - b. Use of a motor starter or contactor in the input power line.
 - c. The speed control signal dropping below or rising above minimum.
 - d. An external 115 volt ac signal.
 - e. Operation of momentary start/stop switch or pushbuttons. The drive shall include built-in holding contacts for this purpose.
22. Speed Control: The drive will adjust the output frequency in proportion to a [0-10 volt dc analog] [4-20 ma dc analog] input.
23. Minimum and Maximum Speed Control: Adjustable minimum and maximum speed potentiometers for all speed signals. Minimum range shall be 0-80%, field set at 40%. Maximum range shall be 100-0%, field set at 100%.
24. Signal Gain and Offset: Adjustable signal gain (1:1 to 10:1 range) and offset (0-50% of input signal for all speed signals).
25. Inverted Signal: Inverted speed signal selector switch to invert the response to input speed signal.
26. Automatic Reversing: Reversing terminals to automatically reverse the rotation of the motor(s) shall be available for customer use if so desired. When a contact closure is made across these terminals, the motor shall decelerate from its operating speed to zero at the

preset deceleration rate. Upon reaching zero, it shall reverse direction and accelerate to the set speed at the present acceleration rate.

27. Adjustable Accel/Decel: Independently adjustable acceleration and deceleration time potentiometers from 30-300 seconds, field set at 90 seconds.
28. Control Isolation: Low voltage logic and 115 volt control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.
29. Control Adjustments: All control adjustments shall be made without the necessity of an extender board or specialized meters, and from front accessible controls.
30. Diagnostics: A diagnostic fault detection center shall be integral to each VSD, providing an indication of the following fault conditions:
 - a. External fault.
 - b. Processor line fault.
 - c. Low ac line voltage.
 - d. High ac line voltage.
 - e. Current overload.
 - f. High dc bus voltage.
 - g. VSD output fault.
31. Status Indication: Status indication of conditions described in Items 1 through 5 shall be provided. An SPDT contact for remote indication of Items 2 through 5 shall be provided. Additionally, status to show "Power On", "Zero Speed", and "Drive Enabled" shall be

provided. All status indication shall be self-contained in the front panel of the unit and shall be duplicated for ease of troubleshooting on the inside of the unit.

32. Indicating Lights:

- a. Power On: Lights any time input power is applied to the drive.
- b. Zero Speed: Illuminates whenever the drive is at zero frequency.
- c. Enabled: Lights to indicate that the drive has a start command.
- d. Over Temperature: Begins flashing when the internal temperature of the drive is within 10°C of overheating. Upon reaching the overtemperature trip point, the light is continuously illuminated.
- e. Current Limit: Indicates that the Accel, Decel or Run Limit circuit is in operation.
- f. Undervoltage: Indicates that an undervoltage trip has occurred.
- g. Overvoltage: Indicates that an overvoltage trip has occurred.
- h. Overcurrent: Indicates that the current rating of the drive has been exceeded and the overcurrent trip circuit has been activated.

33. External Alarm Contacts: A single pole, double throw contact rated 115 volt ac, 28 volt dc, 1 amp resistive, shall be available for external monitoring. Contact will change state when any trip condition has occurred.

34. Speed Reference Signal: A 0 to 5 volt dc signal shall be provided for customer use. This 0 to 5 volt dc signal shall vary in direct proportion to the drive speed.

35. User Interface: The VSD shall have the following door mounted user interface devices:

- a. "Power On" light.
- b. Hand/Off/Auto (or equivalent) selector switch.
- c. Manual speed potentiometer.
- d. Digital Readout Frequency Meter/Diagnostic Display.

36. Cooling: The VSD shall be convection-cooled. Units requiring fan cooling are not acceptable. The unit shall have high temperature protection.

37. Control Power: A 115 volt ac, control power shall be available for customer use whenever drive input power is applied.

38. External Safeties: Fire alarm interface, safety and temperature control interlock terminals with door mounted "external fault" light.

39. Open Communication: The VFD shall be equipped with a factory installed open communications such as Modbus. The open communication will allow the DDC system to both push commands to the drive and pull information from the drive unit. All control points

shall be available to the DDC system and the unit shall be completely configurable without the use of proprietary software.

E. System Operation:

1. Selector switch in the "off" position - the controller run circuit will be open and the system will not operate.
2. Selector switch in the "manual" position - the speeds of the motor will be controlled by the manual speed potentiometer.
3. Selector switch in the "auto" position - operation will be via the external control input signal with the output speed proportional to the input signal.

Part 3 - Execution

3.03 Installation of Electronic Variable Speed Drives:

- A. General: Install electronic variable speed drives where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
- B. Supports: Provide all electronic variable speed drives with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Drives shall not be supported by conduit alone. Where drives are mounted on equipment served, the drive shall

not inhibit removal of any service panels or interfere with any required access areas. All drives shall be installed plumb and aligned in the plane of the wall in/on which they are installed.

- C. Coordination: The Division 15 Contractor shall coordinate electronic variable speed drive selection and installation including, but not limited to, the following:
1. Coordinate power wiring to electronic variable speed drives and served motors with the Division 16 Contractor.
 2. Coordinate selection of variable speed drives and served motors to insure compatibility.
 3. Coordinate variable speed drive control interface with controls and sequence of operation specified in Section 15950, "Direct Digital Control Systems".

3.04 Start-up/Testing:

- A. Pre-energization Check: The Division 16 Contractor shall check electronic variable speed drive power wiring for continuity of circuits and for short circuits.
- B. Start-up Services: A representative of the variable speed drive manufacturer shall provide start-up services for each drive including, but not limited to, the following:
1. Check out of drive control and power wiring.
 2. Start-up drive and demonstrate proper manual, automatic, and bypass operation.
 3. Adjust variable speed drive overload protection and other adjustable parameters to suit project requirements.
- C. Motor/Controller Coordination Documentation: Provide motor/controller coordination documents including, but not limited to, the following information in the operation and maintenance manuals.
1. Motor size in horsepower.
 2. Motor full load amps.
 3. Motor efficiency.
 4. Motor service factor.
 5. Size and manufacturer's catalog number of electronic variable speed drives.
 6. Setting of electronic variable speed drive overload protection and other adjustable parameters.
- D. Motor Rotation: Verify that motor rotation is correct as connected. Where rotation must be changed, the Division 16 Contractor shall reconnect phase conductors to motor leads at motor junction box.

3.05 Training:

- A. General: A representative of the variable speed drive manufacturers shall provide for and present to the Owner, at no cost, a training and troubleshooting course at the owner's location. This course shall be comprised of 4 hours of instructions complete with visual aids, documentation, circuit diagrams, and hands-on training. This course is not to be construed as a sales meeting, but rather as a school to familiarize the owner with the care, troubleshooting,

and servicing of the variable speed drives. The manufacturer's representative shall provide a list of recommended spare parts.

3.06 Identification:

- A. Refer to Section 15190 for nameplate requirements for all electronic variable speed drives.
- B. Each electronic variable speed drive shall have an internal wiring diagram on the inside of the drive cover and shall be labeled inside the cover to indicate the type, ampacity and horsepower rating of the unit.

END OF SECTION 15080

Section 15100 – Valves

Part 40 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide valves as specified and indicated.

[EDIT THE FOLLOWING SECTIONS TO SUIT PROJECT]

1.03 Quality Assurance:

- A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable, subject to compliance with the requirements of these Specifications.

1. General Valves:
 - a. Crane Company
 - b. Grinnell
 - c. Jenkins Bros. Valves
 - d. Kennedy Valve
 - e. Nibco
 - f. Stockham Valves and Fittings
 - g. Walworth Company
2. Ball Valves:
 - a. Apollo
 - b. Jamesbury Corporation
 - c. Jenkins Bros. Valves
 - d. Nibco
 - e. Stockham Valves and Fittings
3. Backflow Preventers:
 - a. Febco Sales, Inc.
 - b. Watts Regulator Company
 - c. Zurn Industries, Inc.; Wilkens-Regulator Division
4. Refrigerant Valves:
 - a. Henry Valve Company
 - b. Mueller Brass Company
 - c. Sporlan Valve Company
 - d. Superior Valve Company
5. Check Valves:
 - a. Clow Valve Company

- b. Crane Company
 - c. Gruvlok
 - d. Jenkins Bros. Valves
 - e. Milwaukee
 - f. Muesco, Inc.
 - g. Nibco
 - h. Stockham
 - i. Victaulic
6. Butterfly Valves:
- a. Apollo
 - b. Centerline
 - c. Demco
 - d. Grinnell
 - e. Gruvlok
 - f. Jamesbury Corporation
 - g. Jenkins Bros. Valves
 - h. Keystone
 - i. Nibco
 - j. Stockham Valves and Fittings
 - k. Victaulic

Part 41 Products

2.01 Materials:

- A. General: All valves shall be similar to numbers listed. All similar type and size valves shall be products of one manufacturer.
- B. Refrigerant Valves: Valves manufactured specifically for use in refrigerant systems shall be used in such systems.
- C. Butterfly Valves: All butterfly valves shall be full tapped and threaded lug type, manufacturer certified for bubble-tight, dead end shut off from either direction at design working pressure and temperature. Valves 2-1/2 through 5" in size shall have lever type operators. Valves 6" and larger shall have enclosed, self-locking worm gear type operators, waterproof, and factory-lubricated. Gear segment shall be manganese bronze or ductile iron with a steel or ductile iron worm and oil impregnated bronze bushings or worm shaft. Operator shall have built-in adjustable mechanical stops and position indicators. Valves used for balancing shall be certified suitable for continuous throttling service. Butterfly valves shall not be used on steam or high temperature hot water systems.
- D. Ball Valves: Valves shall be furnished with blowout-proof stems. Valves used for chilled water service shall be insulated as specified for the pipe in which the valve is installed. All ball valves shall be full-line size to prevent flow restriction through the ball.
- E. Gate Valves: All bronze gate valves shall have packing boxes with adequate depth to allow space for sufficient amounts of stem packing. Malleable iron handwheels and gland followers

shall be furnished on all bronze gate valves. All gate valves shall have non-asbestos stem packing suitable for pressure and service. OS&Y and IBBM gate valves shall be furnished with a stem lubrication fitting on all sizes. All gate valves shall be designed to permit repacking while the valve is in line.

2.02 Valves:

A. Valves for service at or less than 150 PSIG:

1. Block (Stop) Valves: Ball valves 2" and smaller shall be red brass, cast bronze, or yellow forged bronze with brass, stainless steel, or bronze ball and stem, 150 psig nonshock WOG at 200°F, equal to Jenkins Fig. No. 900T. Valves 2-1/2" and larger shall be butterfly type, 200 psig nonshock WOG at 200°F, ANSI Class 150 with ductile iron lug body. The replaceable resilient elastomer seat shall be Buna N or EPDM. The disc shall be silicon or aluminum bronze and shaft shall be No. 316 or No. 416 stainless steel. Secondary O-ring seals shall be provided at the top and bottom of the upper and lower shafts to guarantee zero leakage to the shaft, equal to Jenkins Fig. No. 232EL/EG or No. 632E.
2. Balancing Valves: Valves shall comply with the general requirements specified for block valves. Valves used for balancing shall have adjustable memory stops or position indicators. Valves 2" and smaller shall be equal to Jenkins Fig. No. 900TE. Valves 2-1/2" and larger shall be equal to Jenkins Fig. No. 232EL.
3. Gate Valves: As a general rule, gate valves shall not be used for sizes 2-1/2" and smaller. If necessary, with prior approval from the Construction Manager, valves 2-1/2" and smaller shall be equal to Jenkins Fig. No. 47-U, 200 psig WOG bronze body with screwed bonnet and ends. Valves 3" and larger shall be equal to Jenkins Fig. No. 651-A, 200 psig WOG.
4. Globe Valves: Valves 2" and smaller shall be equal to Jenkins Fig. No. 546-P, bronze body, bronze rising stem, screw-in bonnet, renewable seat, and screwed or solder ends. Valves 2-1/2" and larger shall be Jenkins Fig. No. 613, 200 psig WOG, outside screw and yoke (OS&Y), iron body, bronze-trimmed, renewable seat, Pressure Class 125, with ANSI B16.1 flanged ends.

B. Valves for Service Over 150 PSIG:

1. Block Stop Valves: Ball valves 2" and smaller shall be red brass cast bronze or yellow forged bronze with brass, stainless steel, or bronze ball and stem, 300 psig nonshock WOG at 200°F with Teflon packing and gaskets, equal to Jenkins Fig. No. 900T. Valves 2-1/2" and larger shall be 300 psig nonshock WOG, with Class 300 ANSI B16.5 flanges, full tapped and threaded cast steel lug body. Valves shall have 300 pounds body drilling and shall be suitable for service indicated on the Plans. Disc shall be cast steel and the shaft shall be No. 416 stainless steel. Secondary O-ring or gland seals at the top and bottom of the upper and lower shafts shall guarantee zero leakage to the shaft. Seals and backing rings shall be TFE or Viton. Seal retainer rings shall be No. 316 stainless steel, Dezurik No. 645.
2. Balancing Valves: Valves shall comply with the general requirements specified for block valves. Valves used for balancing shall have adjustable memory stops or position indicators.
3. Gate Valves: As a general rule, gate valves shall not be used for sizes 2-1/2" and smaller. If necessary, with prior approval from the Construction Manager, valves 2-1/2" and smaller shall be equal to Jenkins Fig. No. 270-U, 300 pounds WOG, bronze body, rising stem, with screwed bonnet and screwed ends. Valves 3" through 12" shall be equal to Jenkins Fig. No. 204, 500 pounds WOG, OS&Y valves with Class 250 ANSI B16.1 flanged ends, cast iron body and bronze trim.
4. Globe Valves: Valves 2" and smaller shall be equal to Jenkins Fig. No. 556-P, 400 pounds WOG, bronze body and trim, rising stem, union bonnet, renewable seat, and screwed ends.

Valves 2 1/2" through 8" shall be equal to Jenkins Fig. No. 923, 500 pounds WOG, iron body, bronze trim rising stem, OS&Y Class 250 ANSI B16.1 flanged ends.

- C. Check Valves: Chilled, hot, condenser, and domestic water pipes 2-1/2" and larger shall be, spring-loaded, quiet type. Valve nonshock pressure temperature rating shall be as specified for piping in which it is installed. Valve shall be full-threaded, lug body, or flanged body. Valves 2" and smaller shall be equal to Jenkins Fig. No. 92A. Threaded valves installed at pump discharge shall have its shaft perpendicular to the pump shaft. Valves located in pumped sewage pipes and in storm pipes shall be equal to Crane No. 383 outside weight, 200 pounds WOG, iron body, bronze trimmed, with swing check design.
- D. Valves for Water Make Up Connections: Valves 2" and smaller shall be equal to Jenkins Fig. No. 900T. Valves 2-1/2" and larger shall be equal to Jenkins Fig. No. 632B or No. 632E, butterfly valve operator furnished per Paragraph 2.01/C.
- E. Relief Valve: Temperature and pressure, self-closing, lever operated with thermo-bulb extension, 3/4", ANSI B2.1 taper thread male inlet connection, 210°F (98.8°C) and 125 psig setting, ANSI Z1.22, equal to Watts Regulator Company Type No. 40XL.
- F. Combination Pressure Reducing and Relief Valve for Make Up Water: Bell and Gossett Model Number 3, dual unit.
- G. Reduced Pressure Backflow Preventer: Backflow preventer shall be equal to Watts Regulator No. 909 Series, 2-1/2" and larger shall be provided with dual "Y" pattern spring-loaded check valves and independent relief valve located between checks. Backflow preventers shall be

rated for pressure up to 150 psig working pressure at 140°F (60°C) and sized according to the maximum design flow.

- H. Domestic Water Pressure Reducing Valves: Watts Regulator 223S or Clayton 90G-01. Pressure and flow schedule as indicated on the Drawings.

Part 42 Execution

3.01 Installation:

- A. General: Except as otherwise indicated, comply with the following requirements.
- B. Ball Valves: Provide ball valves on branch service runout to each piece of terminal equipment, at each coil, and elsewhere as shown on the Drawings.
- C. Valve Stems: Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.
- D. Chain Operators: In central plant and in fan or mechanical rooms where chilled water and condenser water valves are installed over 8' above floor, provide chain operators.
- E. Swing Check Valves: Swing check valves shall be installed in horizontal piping only.
- F. Unions and Companion Flanges: Provide unions or companion flanges where required to facilitate dismantling of valves and equipment.
- G. Access Doors and Panels: Verify the location and quantity of access doors or panels required to provide full valve access.
- H. Backflow Preventer: All relief assemblies off of backflow prevention devices shall be piped to the nearest floor drain.
- I. Relief Valve: All relief valves including factory installed relief valves on boilers and domestic water heaters shall be piped to the nearest floor drain.

END OF SECTION 15100

Section 15135 - Meters and Gauges

Part 43 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide meters, gauges, taps, and accessories as specified and indicated.

Part 44 Products

2.01 Gauges and Thermometers:

- A. Pressure Gauges: Gauges shall be Ashcroft, Ernst Gage, Marsh Instrument, Miljoco, Terrice, Weksler, Moeller, or Weiss with 4-1/2" dial face, cast aluminum case, stainless steel movement with Grade A phosphor bronze bourdon tube, Plexiglas dial cover and micrometer type calibration adjustment screw. Accuracy shall be ½% of full scale. Provide a gauge cock and

pulsation dampener in pressure tube to gauge. Use liquid filled gauges, using duplex style (pressure & vacuum), where required. Graduation shall be one pound or less.

- B. Thermometers: Thermometers shall be Trerice, Weksler, Miljoco, Moeller, or Weiss solar-operated electronic type with high-impact ABS plastic case, minimum 3-1/2" union stem and complete with separable brass or stainless steel socket well. Thermometers shall be straight, incline or recline, selected and installed as best suited for ease in reading
- C. Range and Graduations: Gauges and thermometers shall be selected to give range and graduations best suited for quantities to be measured. Generally, gauges and thermometers shall be selected so that normal operating pressures and temperatures are neither more than 2/3 nor less than 1/2 of the range, scale division shall be 2°F or less. Typical ranges shall be:
 - 1. Heating Hot Water: 30 - 240 °F with 2 °F scale divisions.
 - 2. Chilled Water: 0 - 100 °F with 1 °F scale divisions.
 - 3. Condenser Water: 30-130°F with 1°F scale divisions.
 - 4. Domestic Hot Water (Dial Type): 30 - 240 °F with 2 °F scale divisions.
 - 5. Water: 0 - 100 psi with 1 pound scale divisions.
- D. Thermometer Wells: Thermometer wells shall be located so that the sensing bulb will give a true and correct reading. Thermometer wells shall be installed so as not to cause undue restriction in small piping. Where wells are located in pipe lines 1-1/2" and smaller, provide a section of pipe of such diameter that the net area of the pipe line will not be reduced by the thermometer well. Wells shall be filled with thermal grease and complete with caps and chains.

2.02 Pressure and Temperature Taps:

- A. Location: Provide pressure and temperature taps as required for start-up, balancing, and trouble shooting.
- B. Taps: Taps shall be 1/2" solid brass fittings which will receive either a pressure or temperature probe, with valve core of Nordel, and fitted with a color coded cap and gasket. Taps shall be "Pete's Plug" (Peterson Engineering Company, PO Box 217, Richardson, Texas 75080, 214/235-8393) or "Sisco P/T Plugs", (Sisco, PO Box 197, Riverton, N. J. 09077, 609/829-8686) No. 710, rated at 275°F and 1000 psig.
- C. Instruments: Furnish two each, No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes and four each 5" stem pocket thermometers: Two "Pete's Plug" or "Sisco

P/T Plug" No. 601 with 25 to 125°F range for condenser water and two "Pete's Plug" No. 603 with zero to 220°F range for heating water.

2.03 Gauge Cocks:

- A. Locations: Gauge cocks to be used for test gauges shall be provided in the entering and leaving piping to equipment, coil, coil control valve, orifice metering flange, and at other locations required for balancing and start-up.
- B. Manufacturer: Gauge cocks shall be brass lever handle type equal to Crane No. 88 needle valves, or approved equal.

Part 45 Examination

3.01 Installation:

- A. General: Install meters and gauges in accordance with the manufacturer's written instructions and in locations indicated. Position meters and gauges so that they are easy to read standing on the floor and accessible for inspection and maintenance.
- B. Thermometers and gauges shall be selected so that normal operating conditions is located the middle of the gauge range.
- C. Pressure Gauge Locations: A gauge shall be installed in the following locations:
 - 1. To indicate the suction and discharge pressures of each pump
 - a. A single gauge valved to read either inlet or outlet pressure shall be acceptable at pumps so long as the low and high of the normal operating pressure do not fall outside of the upper or lower ½ of the range.
 - 2. At incoming city water pressure
 - 3. Downstream of domestic booster pump
 - 4. Downstream of each pressure reducing valve
 - 5. At each fire system riser
 - 6. Dry system air pressure
 - 7. At inlet and outlet of each plate type heat exchanger
 - a. A single gauge valve to read either inlet or outlet pressure shall be acceptable at hat exchanger so long as the low and high of the normal operating pressure do not fall outside of the upper or lower ½ of the range.
 - 8. At the inlet and outlet of each strainer/filter including at air separators and pump suction diffusers.
 - 9. Elsewhere as indicated or required for proper balancing and maintenance of the system.
- D. Thermometer Location: A thermometer shall be installed in the following locations:
 - 1. In each supply and return main located at the central plant
 - 2. At inlet and outlet of each boiler, chiller, or cooling tower
 - 3. At the connections to each air handling unit coil
 - 4. At inlet and outlet of each heat exchanger
 - 5. Adjacent to each immersion controller
 - 6. Elsewhere as required for proper balancing and maintenance of the system

END OF SECTION 15135

Section 15140 –Hangers, Supports, and Anchors

Part 46 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.
- B. Reference applicable project piping system specifications for additional support requirements.

1.02 Description of Work:

- A. Work Included: Provide hangers, supports, and required appurtenances as specified and indicated.

1.03 Quality Assurance:

- A. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.
- B. Acceptable Manufacturers: The manufacturer specific model numbers listed herein establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of this Specification:
 - 1. Anvil Corporation (formerly ITT Grinnel Corporation)
 - 2. Carpenter and Patterson, Inc.
 - 3. Central Iron Manufacturing Company
 - 4. Cooper B-line, Inc.
 - 5. Elcen Metal Products Co.
 - 6. Fee and Mason Mfg. Co.
 - 7. F & S Manufacturing Company.
 - 8. Michigan Hanger
 - 9. Persing & Co.
 - 10. PHD Manufacturing
 - 11. Powerstrut
 - 12. Thomas & Betts Superstrut

Part 47 Products

2.01 Pipe Hangers and Supports:

- A. General: Comply with local codes and standards for pipe and equipment support and anchorage.
- B. Materials: Pipe supports shall be of material that will prevent electrolytic action. Exterior pipe supports and supporting materials shall be galvanized finished with zinc-coated fasteners. Use a galvanizing repair finish of not less than 94 percent zinc dust by weight for regalvanizing exterior welds of ferrous metals.

- C. Inserts: Provide Grinnell No. 282 inserts for concrete construction.
- D. Piping in Single Runs: Provide Fee and Mason Fig. 239 or Grinnell No. 260 clevis hanger.
- E. Piping in Multiple Parallel Runs: Provide Grinnell No. 45 or No. 50 with Grinnell No. 137 U-bolt pipe clamps or structural channels or angles with U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Select and size members for weights to be carried and span dimensions between supports.
- F. Hanger Rod: Provide hanger rods of required length at appropriate to handle piping loads and structure movements.
- G. Riser Clamps: Provide Fee and Mason Figure 241 riser clamps. Riser clamps for copper tube shall be copper-plated.
- H. Saddles and Shields:
 - 1. Saddles for Horizontal Insulated Piping Without Vapor Barrier: At each hanger or support on horizontal runs, provide Grinnell No. 160 or Fee and Mason Figure 171, 1710, 1712, or 172 saddles, as applicable. Shields as described below may be used instead of the saddles. Where dissimilar materials are used, provide dielectric separation. Carry insulation over the hanger and seal where hanger is sized for pipe.
 - 2. Shields for Horizontal Insulated Water Piping With Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed 6 PCF density fiberglass or rigid calcium silicate, with jacket of adjacent insulation brought across unbroken, supported on semicircular 16 gauge shields. Shields for pipe 4" and smaller shall be 12" long; shields for pipe 5 to 8" shall be 18" long; and shields for larger pipe shall be 24" long.
- I. Piping on Roof: Roof mounted pipe supports are discouraged. If roof supports are necessary, installation methods must be approved by VPTC Management Partners, LLC and the Roofing Contractor.

2.02 Roof Supports:

- A. Large (over 6-inch diameter) gas piping or cooling water line supports:
 - 1. Shall be prefabricated system with bases to accommodate uni-strut tube frame as required to support number and size of piping to be supported.
 - a. C-Port CB-Series support with hanger accessory components, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 6-H with clevis hangers, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PSE with clevis hangers, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- B. Medium (3-inch to 6-inch diameters) gas line or conduit line supports:
 - 1. Gas line supports shall be prefabricated system with base to accommodate threaded rods and roller support:
 - a. C-Port CE-Series support with roller accessory components, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 5-RAH or 5-RAH-12 with roller, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PPH-RB18 with roller, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
 - 2. Conduit line supports shall be prefabricated system with base to accommodate threaded rods and channel/strut support as required by number and size of lines:

- a. C-Port CE-Series support by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 16-Base Strut P, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PP10 with Channel, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- C. Small (less than 3-inch diameter) gas line pipe supports:
- 1. Shall be prefabricated system with base to accommodate threaded rods and roller support:
 - a. C-Port CR-Series support, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 3-RAH or 3-RAH-12, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PP10 with Roller, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
 - 2. Shall be prefabricated system with base to accommodate threaded rods and channel/strut support with clevis hanger(s):
 - a. C-Port CE-Series support with hanger accessory components, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model 2.5 SB-H, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PP10 with Channel & Hanger, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- D. Duct supports:
- 1. Shall be prefabricated system with bases to accommodate uni-strut tube frame as required to support exact ductwork sizes and equipment to be installed.
 - a. C-Port CS-Series support, by Cooper B-Line, Inc., Highland, IL, (618) 654-2184.
 - b. Model No. 8-DS, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - c. Model PPH-D, by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.

Part 48 Execution

3.01 Installation:

- A. Independent Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards.
- B. Provisions for Movement:
 - 1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
 - 2. Load Distribution: Install hangers and supports to evenly distribute weight and so piping live and dead loading and stresses from movement will not be transmitted to any pipe or connected piece of equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations. Piping shall be fully supported from hangers and supports prior to connection to equipment and/or flanges.
 - 3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.
- C. Insulated Piping: Comply with the following installation requirements:
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold, chilled, or heating water piping, install coated protective shields. For pipe 8" and over, install rigid calcium silicate insulation between saddles and pipe.
 3. Where insulation without vapor barrier is indicated, install protection saddles, or use hangers as indicated in Paragraph 2.01/G.1.
- D. Spacing: Hangers and supports shall be installed as required by the following table. Local code requirements shall override. Refer to MSS Standard SP-69 for applications not listed:

HANGER SPACING BY PIPING MATERIAL

<u>Nominal Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Minimum Rod Size</u>
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Schedule 40 Steel

≤1"	7'	1/4"
1-1/4"-1-1/2"	9'	3/8"
2"	10'	3/8"
2-1/2"	11'	3/8"
3"	12'	3/8"
4"	14'	1/2"
5-6"	17'	1/2"
8"	19'	5/8"
10"	20'	3/4"
12"	23'	7/8"
14"	25'	1"

Copper Tubing

≤3/4"	5'	1/4"
1"	6'	1/4"
1-1/4"-2"	8'	3/8"
2-1/2"	9'	3/8"
3"	10'	3/8"
4"	12'	1/2"

Lead and Oakum Cast Iron

All sizes	Maximum 5', except 10' spacing where 10' lengths of pipe are installed, located within 18" of joint.	1/2"
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Compression and Hubless Cast Iron

All sizes	Up to 4' section length - at every other joint; >4' pipe lengths -on each side of coupling, located within 18" of joint.	1/2"
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Schedule 40 PVC and ABS

≤2"	4'	1/4"
3-8"	4'	3/8"
≥10"	4'	1/2"

- E. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 10'.
 2. Steel pipe shall be supported at the base and at not less than every other story level, but in no case at intervals greater than 25'.
 3. Copper tube shall be supported at each story level, but in no case at intervals greater than 10'.
 4. Plastic pipe shall be supported at mid point between floors and at ceiling to prevent movement, but in no case at intervals greater than 8'.
- F. Guides: Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.
- G. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.
1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturers written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.

2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
- H. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.
- I. Hangers: Refer to Section 15240, "Vibration Isolation", for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.

END OF SECTION 15140

Section 15170 – Mechanical Pumps

Part 49 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 15010, "Basic Mechanical Requirements", govern this Section.

1.02 Description of Work:

- A. Work Included: Provide pumps as specified and indicated.
- B. Work of Other Sections:
1. Refer to Division 16 for electrical connection work required in conjunction with pump motors (not work of this Section), controllers, and alarms.
 2. Refer to Section 15240, "Vibration Isolation", for materials required for isolation of pumps.
 3. Refer to Section 15250, "System Insulation", for piping and equipment thermal insulation work required in conjunction with pumps.
 4. Refer to Section 15510, "Mechanical Piping Systems", for flexible piping connections at pumps.

1.03 Quality Assurance:

- A. Manufacturers: Provide products by one of the following:
1. Armstrong Pumps, Inc.
 2. Aurora Pump Company
 3. Bell and Gossett, ITT Division,
 4. Marshall Engineered Products Company
 5. Peerless Pump Company
 6. TACO Incorporated
 7. Wienman Pumps
- B. Electrical Standards: Provide electric motors and products which have been listed and labeled by Underwriters' Laboratories, Inc. (UL) and comply with National Electrical Manufacturers' Association (NEMA) standards.
- C. Certification, Pump Performance: Provide pumps whose performance, under specified conditions, is certified by the manufacturer.

Part 50 Products

[EDIT THE FOLLOWING SECTIONS TO SUIT PROJECT]

2.01 [Chilled, Condenser and Heating Hot Water Pumps:]

A. [Horizontal Split Case Pumps:]

1. General: Horizontal split case pumps, where used, shall have the capacities required for the application. Pump performance shall be shown on curves of pressure versus flow. Operating point shall be at a minimum efficiency of 75% and impeller diameter shall not materially exceed 85% of the maximum size that the casing will accept. Pump discharge velocities shall not exceed 12' per second for chilled water and heating water service. Total dynamic head shall be a maximum at no-flow and decrease from no-flow to design flow. Shut-off head shall be more than 110% of design head but less than 140% of design head. Pumps shall have hydraulically and dynamically balanced impellers. Pumps shall be free of flashing and cavitation at all flow rates from 25 to 125% of design flow under the suction conditions of the pump installation. The percent of maximum diameter shall be noted on the Shop Drawing submittal.
2. Features: Pumps shall have 300 psig minimum casings, enclosed double suction impellers, SAE 1045 steel shafts for packing gland pumps, stainless steel shafts for mechanical steel pumps, cast iron casing wearing rings, bronze impeller wearing rings, cast iron deflectors, stainless steel impeller key, coated fiber parting gasket, steel casing studs and bolts, and internal drilled passages to lantern rings. Mechanical seals shall be used on all chilled and heating water pumps. Packing gland seals, used on condenser water pumps, shall consist of five rings of graphite asbestos packing, bronze split glands, bronze lantern rings, brass gland clips, stainless swing bolts and nuts, and 500 Brinnell hardness stainless steel sleeves. A manually operated petcock shall be installed on the vent tapping on the top of the casing. Removal of the upper half of the pump casing shall allow removal of the rotating element without disconnecting the suction and discharge piping. Pump shall be provided with 125 lb flanged suction and discharge connections.
3. Performance: Pumps having motors larger than 10 HP shall be capacity tested after final assembly. Provide for each pump, a certified shop performance test curve indicating capacity, head, horsepower, and efficiency at flow rates from shutoff to 125% of design flow. When the pumps are shipped from the factory, the manufacturer shall transmit three copies of a certified letter stating that the pumps have been dynamically balanced, pressure tested, and capacity tested. The certified shop performance test curves shall accompany the certified letter. No pump shall be installed before its test data has been reviewed by the Design Engineer and VPTC Management Partners, LLC.
4. Seals: The mechanical seals shall be as manufactured by John Crane Company, Environamic Inc., Chesterton, or Durometallic Inc. and shall be suitable for the service specified:
 - a. Seals for stuffing box working pressures 150 psig and below shall be equal to John Crane Company Type 1 or Type 2.
 - b. Seals for stuffing box working pressures greater than 150 psig shall be equal to John Crane Company Type 1B.
 - c. After the pumps are in operation for 90 days, the Contractor shall check the seals and replace any that are defective.
5. Bearings: Pumps shall have grease-lubricated ball bearings, grease fittings, and relief plugs. Bearings shall have a minimum B-10 life of 40,000 hours minimum life below 200 psig suction pressure and 20,000 hours for suction pressures above 200 psig. Bearings shall be removable without removing the rotating element or dismantling the pump.
6. Base: Base shall have cast iron or fabricated steel drip lip bases, coupling guard, provisions for grouting, anchor bolts, and collection of all seal leakage. The base shall

have machined surfaces for the motor and pump mounting surfaces. Motor mounting shall permit horizontal adjustment. A threaded outlet of 3/4" minimum size shall be provided in the base at the pump end for field piping of drainage to drain. The base shall be of sufficient strength to prevent vibration, warping, or misalignment of the pump and motor when installed without grouting. The base shall be rigidly bolted to the concrete base. After final alignment, all pumps 25 HP and over shall have the pump and motor doweled to the base. In addition, the minimum requirements of the fabricated structural steel base shall be as follows:

- a. Pumps with 20 HP and smaller motors shall have steel bases adequately stiffened as required to prevent "oil-canning".
- b. Pumps with 25 HP and larger motors shall have bases constructed of structural shapes and formed steel section. The main structural member and formed steel sections shall have a depth of at least 1/2 the overall length of the base, but not less than 4". Standard or factory bases that do not meet this requirement shall be certified by the pump manufacturer to be constructed with sufficient strength to prevent vibration, warping, and misalignment of the pumps. The base shall be filled with concrete or grout after installation on the isolation base. Concrete and grout shall be provided by this Contractor.

1) Grout-less bases by ITT Bell & Gossett may be installed on pumps with 25 HP and larger motors with prior approval from VPTC Management Partners, LLC.

7. Couplings: Pumps shall have couplings using tapered split hubs and resilient torque transmitting members, not requiring shrink fit or press fit to pump or motor shaft. Align shafts of motors and pumps within recommended tolerances by the manufacturer, and in the presence of the manufacturer's representative. Provide a certified report for each pump
8. Motors: Pumps shall have drip-proof motors suitable for electrical service with a service factor of 1.15 and a rated temperature rise of 104°F (40°C). Motors and pumps shall be factory-mounted and aligned on bases. Motors shall not overload when operation is from 0 to 125% of design flow on the pump characteristic curve.

B. [End Suction Base-mounted Pumps:]

1. General: End suction, vertical split case, base-mounted pumps, where used, shall have the capacities required by the application. Pump performance shall be shown on curves of pressure versus flow. Operating point shall be at a minimum efficiency of 70% and impeller diameters shall not materially exceed 85% of the maximum size the pump casing will accept. Where pump curve has a "hump", operating point shall fall below the head at the shutoff point. Impellers shall be enclosed and shall be hydraulically and dynamically balanced.
2. Features: Pump shall have casings of 300 psi duty gray cast iron, shafts shall be high tensile carbon steel, and bearings shall be grease-lubricated bronze sleeve or ball bearings. Provide pumps with John Crane (see Paragraph 2.01/A.4) mechanical seals, Alemite type grease fittings. A manually operated petcock shall be installed on the vent tapping on the top of the casing. Pump shall be provided with 125 lb flanged suction and discharge connections.
3. Design: Pumps and motors shall be individually mounted on pump base so that bearing assembly and impeller can be removed without disconnecting piping, removing pump casing, or removing motor. Pump shaft shall be supported from removable bearing assembly bolted to pump casing and shall be connected to pump motors by flexible coupling.
4. Motors: Pump motors shall be suitable for the electrical characteristics available. Motors shall be open drip-proof with service factor of 1.15, rated for a 104°F (40°C) temperature

rise. Motors shall not overload when operation is at any point of the pump characteristic curve.

5. Bearings: Bearings shall be grease lubricated and shall have a minimum B-10 life of 20,000 hours.

2.02 Circulating Pumps:

- A. General: In-line circulating pumps shall be cast iron body construction of the size, type, and capacity required by the application. Pumps shall be fitted with a hydraulically and dynamically balanced, bronze enclosed type impeller with mechanical seal. Mechanical seal shall be Type 1 or Type 2 material, Code BP-1D1 as manufactured by John Crane Company or an approved equal, suitable for service specified. Motor shall have a maximum speed of 1750 rpm. Pumps, casings, flanges, and seals shall be suitable for operation with the working pressures and temperatures required. The working pressure applies to the entire pump assembly.

2.03 Pump Accessories:

- B. Pump Suction Diffusers:
 1. Cast-iron body, with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 300 deg F maximum operating temperature; and complete with the following features:
 - a. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
 - b. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
 - c. Disposable fine mesh strainer to fit over cylinder strainer.
 - d. Permanent magnet, located in flow stream, removable for cleaning.
 - e. Adjustable foot support, designed to carry weight of suction piping.
 - f. Blowdown tapping in bottom; gage tapping in side.

Part 51 Execution

3.01 Inspection:

- A. General: Installer shall examine the bases upon which and conditions under which pumps are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 Installation of Pumps:

- A. General: Install pumps in accordance with manufacturer's written instructions and recognized industry practices to ensure that pumps comply with requirements and serve intended purposes. Comply with NEMA standards and requirements of NEC.
- B. Alignment: Align shafts of motors and pumps to manufacturer's tolerances in the presence of the manufacturer's representative. A certified report shall be submitted by the manufacturer for each pump.

- C. Vibration Isolation: Install units on vibration mounts and isolation bases as required to prevent vibration transfer to building structure.
- D. Lubrication: All pumps installed are to be lubricated per the manufacturers' recommendations.
- E. Pumps for chilled water service shall be provided with a factory installed welded seam drain pan under the pump . The drain pan outlet shall be piped to the nearest floor drain.

3.03 Pump Accessories:

- A. Install suction diffusers on all end-suction centrifugal pump's suction line in lieu of reducing elbow, entrance pipe, and pressure gage outlet. Install on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and shutoff valve in blowdown connection.
- B. Install flexible connectors on all pump on the equipment side of the shut-off valves. Piping and pumps flanges shall be aligned to prevent forces in flexible connectors and in compliance with manufacturer's requirements.

3.04 Electrical Connections:

- A. Grounding: Provide positive electrical pump and motor grounding in accordance with applicable requirements of the NEC.

3.05 Field Quality Control:

- A. Field Test: Upon completion of pump installation and after motor has been energized from normal power source, bleed air from pump casing and test pump to demonstrate compliance with requirements. When possible, field-correct malfunctioning units then retest to demonstrate compliance. Replace units that cannot be satisfactorily corrected.
- B. Start-up: During start-up and system flushing, fine-mesh construction strainers shall be installed. After start-up and completion of piping system flush, construction strainers are to be removed and final strainer sets installed.

3.06 Horizontal Split Case and End Suction Pumps:

- A. Erection: Pumps shall be leveled, then bolted and grouted to pump bases. Piping shall be arranged so that pump cases are not subjected to any piping forces. Contractor shall check for proper angular and concentric alignment of pumps and motors before pumps are operated. Run full sized drain connections from drip lip bases of horizontal split case pumps to nearest floor drain.

END OF SECTION 15170

Section 15190 – Mechanical Identification

Part 52 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements”, and Section 15010, “Basic Mechanical Requirements”, govern this Section.

1.02 Description of Work:

- A. Work Included: Identification of mechanical equipment shall consist of equipment labeling, ductwork marking, pipe marking, and valve tagging as specified hereinafter.
 - 1. In general, all equipment shall be labeled. This shall include all central plant, air handling or air conditioning equipment, and other similar and miscellaneous equipment.
 - 2. Pipe markings shall be applied to all piping.
 - 3. Each valve shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8 ½” x 11” paper, tabulating valve number, piping system, system abbreviation, location of valve (Room or area), and service (e.g. – 2nd Floor North Domestic Hot Water). The valve schedule shall be submitted to VPTC Management Partners, LLC for approval prior to ordering or installing valve tags. See Section 15010, “Basic Mechanical Requirements” for information and requirements regarding Operation and Maintenance Manuals.
 - 4. Labels, tags, and markers shall comply with ANSI A13.1 and other applicable state and local standards for lettering size, colors, and length of color field.
 - 5. Equipment and device identification specified in other sections shall be provided as a part of those requirements.

Part 53 Products

2.01 Equipment Labeling:

- A. Equipment labeling shall be one of the following, unless noted or specified otherwise:
 - 1. Permanently attached engraved brass or plastic laminated signs with 1” high lettering. Signs on exterior equipment shall be brass.
 - 2. Stencil painted identification, 2” high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.02 Ductwork Markings:

- A. Ductwork marking shall be color-coded, laminated plastic pressure sensitive vinyl tape, 2 ½” width, 3 mils minimum thickness. Identification shall include service (e.g. – Supply, return, exhaust, outside air), as well as the direction of air flow.

2.03 Pipe Markings:

- A. On piping less than 6” diameter, install plastic semi-rigid snap-on type, manufacturer’s standard pre-printed color-coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to the above. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.
- B. On piping and insulation 6” and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-

coded plastic tape not less than 1 ½" wide, full circle at both ends of the marker. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.

- C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.04 Valve Tags:

- A. Valve tags shall be polished brass or plastic laminate with solid brass S hook and chain. Tags shall be stamped or engraved with the appropriate abbreviation for the type of service (e.g. – CHW, HW), as approved by VPTC Management Partners, LLC, as well as the designated valve number.
- B. A valve schedule is to be provided to VPTC Management Partners, LLC. For each page of valve schedules, a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.05 Approved Manufacturers:

- A. Labels, markings, and tags shall be manufactured by W.H. Brady, Brimar Industries, Seton Name Plate Corp, Allen-Bailey Tag & Label, or Industrial Safety & Supply.

Part 54 Execution

3.01 General:

- A. Identification labeling, marking, and tagging shall be applied after insulation and painting has been completed.
- B. Coordinate names, abbreviations, and other designations used in mechanical identification work with corresponding designations shown, specified, or scheduled on drawings. Prior to ordering any labels, markings, or tags, obtain the approval of VPTC Management Partners, LLC regarding names, abbreviations, etc.
- C. The Plumbing, HVAC, and Fire Suppression Contractors shall coordinate labeling, marking, and tagging to ensure consistent and coordinated identification. In existing buildings, utilize similar names, abbreviations, and other designations that are currently in use to remain consistent with existing identification.
- D. Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or the room or area of service.
- E. Pipe and ductwork markers shall be placed on piping and ductwork on 25' centers in mechanical rooms and concealed spaces. In locations where piping and ductwork is exposed, place markers on 50' centers. Flow directional arrows should be marked on the piping at taps from the main and riser.
- F. Valve tags shall be placed on each valve except those intended for isolation of individual heat pumps or terminal units (e.g. - VAV boxes, fan coil units, unit heaters, etc.). Valve tag schedules shall be prepared as specified hereinbefore. Copies of one schedule shall be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION 15190

Section 15240 – Vibration Isolation

Part 55 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 15010, "Basic Mechanical Requirements", govern this Section.
- B. The requirements of this section shall apply to all other Division 15 equipment sections.
- C. Refer to Section 15510 – Mechanical Piping Systems, for flexible piping connections associated with vibration isolation.
- D. Refer to Section 15891 – Ductwork, for flexible ductwork connections associated with vibration isolation.

1.02 Description of Work:

- A. Work Included: Provide and install vibration isolation products as specified and indicated, including the following:
 - 1. Vibration control bases:
 - a. Support isolation for motor-driven mechanical equipment
 - b. Inertia base frames in conjunction with equipment isolation
 - 2. Vibration control mounts:
 - a. Support isolation of air-handling housings
 - 3. Vibration control hangers:
 - a. Support isolation of piping
 - b. Support isolation for piping risers
 - 4. Horizontal Thrust Restraints:
 - 5. Rooftop Isolation Curbs:

1.03 Quality Assurance:

- A. General: Except as otherwise indicated, obtain support isolation units from a single manufacturer.
- B. Supervision: Manufacturer shall provide technical supervision of the installation of support isolation units produced by him and of associated inertia bases.
- C. Manufacturers: Provide vibration isolation support units manufactured by one of the following or an approved equal:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Vibration Eliminator Co., Inc.
 - 4. The VMC Group
 - a. Amber/Booth Co.
 - b. Korfund Dynamics Corporation
 - c. Vibrations Mounting and Controls, Inc.

Part 56 Products

[EDIT THE FOLLOWING TO SUIT PROJECT]

2.01 **General Application Requirements:**

- A. General: Comply with the minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers, including the definitions of critical and non-critical locations, for the selection and application of vibration isolation materials and units as indicated.
 - 1. General: Except as otherwise indicated, select vibrations control products in accordance with ASHRAE Handbook, 2003 Applications Volume, Chapter 47 "Sound and Vibration Control", Table 42.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's instructions for selection and application of vibration isolation materials and units.
- C. "Outdoor" isolators shall be protected as follows: Steel parts other than springs shall be dry galvanized; springs and hardware shall be cadmium plated or otherwise suitably coated to resist corrosion.
- D. Vertical limit restraints shall be built-in to all units, rails and bases which support equipment whose weight varies with the addition or removal of large amounts of water, such as cooling towers, chillers, boilers and for equipment installed on rooftops subject to wind loads.

2.02 **Vibration Control Bases:**

- A. TYPE 1: Structural steel bases:
 - 1. Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and

pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells.

2. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
 3. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch.
- B. TYPE 2: Isolation rail bases:
1. Bases shall be structural beam sections with welded on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer.
 2. Beam sections shall not be structurally connected to each other.
 3. Minimum section depth of each member shall be equal to 8% of the longest span between supporting isolators, or as shown on the drawings or indicated on the project documents.
 4. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment.
- C. TYPE 3: Concrete filled inertia bases:
1. Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases shall be engineered for a minimum base to equipment weight ratio of 2: 1.
 2. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity
 3. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6".
 4. Forms shall include minimum concrete reinforcement consisting of half-inch bars or angles welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions
 5. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations.
 6. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base.

2.03 Vibration Control Mounts:

- A. TYPE 1: Neoprene pads:
1. Isolation pads shall be high quality elastomer suitable for minimum 120 psi loading.
 2. Pads shall be installed in multiple layers with galvanized steel shims between layers as required by loading. Single thickness pads of higher psi rating may be substituted for multiple layer pads with the approval of the Architect/Engineer.
- B. TYPE 2: Neoprene mounts:
1. Double deflection neoprene mountings shall have a minimum static deflection of 0.35".
 2. All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for these areas where bolting is required.

3. On equipment such as small vent sets and close-coupled pumps, steel rails shall be used above the mountings to compensate for the overhang.

C. TYPE 3: Spring mounts:

1. Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support.
2. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.
3. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

D. TYPE 4: Restrained spring mounts:

1. Equipment with operating weight different from installed weight, and equipment subject to wind loads shall be mounted on TYPE 3 Spring Mounts with integral housing as described herein.
2. Housing shall include vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection of cooling tower mounts and

shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same.

3. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operations.

2.04 Vibration Control Hangers:

A. TYPE 1: Spring hangers for pipe:

1. Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series.
2. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Submittals shall include a scale drawing of the hanger showing the 30° swing capability.

B. TYPE 2: Pre-compressed Spring hangers for pipe:

1. Vibration hangers shall be as described for TYPE 1, but shall be pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during the installation.
2. 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.
3. Deflection shall be clearly indicated by means of a scale.

C. TYPE 3: Spring hangers for ductwork:

1. Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod.
2. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short-circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Hangers shall be provided with an eyebolt on the spring end and provision to attach the housing to the flat iron duct straps.
6. Submittals shall include a scale drawing of the hanger showing the 30° capability.

2.05 Horizontal Thrust Restraints:

- A. Air handling equipment shall be protected against excessive displacement which might result from high air thrusts in relation to the equipment weight.
- B. The horizontal thrust restraint shall consist of a spring element in series with a neoprene pad as specified for TYPE 1 spring hanger and with the same deflection as specified for the mountings or hangers under the unit.

- C. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop.
- D. The assembly shall be furnished with one rod and angle brackets for attachment to both the equipment and ductwork or the equipment and the structure.
- E. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit.

2.06 Rooftop Equipment Isolation Curbs:

- A. Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment.
- B. The extruded aluminum top member shall overlap the bottom member to provide water run-off independent of the seal.
- C. The aluminum members shall house cadmium-plated springs having a 1" minimum deflection with 50% additional travel to solid.
- D. Spring diameters shall be no less than 0.8 of the spring height at rated load.
- E. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds.
- F. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible ductwork EPDM connection joining the outside perimeter of the aluminum members.
- G. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.

2.07 Isolator Applications:

- A. Isolation requirements for equipment on grade supported slabs, and on suspended concrete slabs of steel frame, concrete frame, and flat slab construction shall be based on the following tables. Isolation requirements for equipment on suspended lightweight construction such as bar joist shall be based on the table with twice the actual span, or as otherwise detailed or recommended by the isolator manufacturer for the duty.

B. EQUIPMENT ON GRADE SUPPORTED SLAB

EQUIPMENT DEFLECTION		BASE		MOUNT	
ITEM INCHES			TYPE		TYPE
Reciprocating Refrigerant Compressor 0.75	3			3	
Reciprocating Chiller 0.25		None		2	
Reciprocating Condensing Unit 0.25		None		2	
Packaged Centrifugal Chiller	None		1		0.25
Base Mounted Air Compressor 0.75		3			3
Close coupled pumps 10 Hp and up Frame Mounted, Flexible Coupled	1 or 2		3		0.75
Pumps 10 through 125 Hp Cooling Towers and Closed Circuit Coolers 0.25	None		3		0.25
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.25			1 or 2 if req'd	2	
Axial Fans, Tubular Fans and Fan Heads 24 in, dia. and over: Up to 300 RPM Note 1			1 or 2		3
Over 300 RPM 0.75			1 or 2		3
Centrifugal Fans and Vent Sets Up to 22 in. dia. 0.25			1 or 2 if req'd	2	
Centrifugal Fans and Vent Sets 24 in. dia. and over-Up to 50 Hp:					

Up to 300 RPM Note 1		1 or 2	3
301 to 500 RPM 1.50		1 or 2	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 Hp:			
Up to 300 RPM Note 1		1 or 2	3
Over 300 RPM 0.75		1 or 2	3
Packaged Air Handling Units	none	3	0.75

Note1: Deflection = $250,000 / (\text{RPM})^2$

C. EQUIPMENT ON SUSPENDED SLAB - MAX 20 FT. SPAN

EQUIPMENT DEFLECTION	BASE	MOUNT	
ITEM INCHES		TYPE	TYPE
Reciprocating Refrigerant Compressor 0.75	3		3
Reciprocating Chiller 0.75	None		4
Reciprocating Condensing Unit 0.75	None		4
Packaged Centrifugal Chiller	None	4	0.75
Base Mounted Air Compressor 0.75	3		3
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over 0.75	3		3
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 0.75	3		3
Cooling Towers and Closed Circuit Fluid Coolers			
Up to 300 RPM Note 1		none	4
301 to 500 RPM 2.50		none	4
501 RPM and over 0.75	none		4
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.75		1 or 2 if req'd	3
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over			
Up to 300 RPM Note 1	3		3

Over 300 RPM 1.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 1.50	3		3
Over 500 RPM 0.75	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 1.50	3		3
Over 300 RPM 0.75	3		3
Packaged Air Handling Units	None	3	0.75

Note1: Deflection = $250,000 / (\text{RPM})^2$

D. EQUIPMENT ON SUSPENDED SLAB - MAX 30 FT. SPAN
EQUIPMENT DEFLECTION

ITEM INCHES	BASE	MOUNT TYPE	MOUNT TYPE
Reciprocating Refrigerant Compressor			3
	3		
	1.50		
Reciprocating Chiller	None	4	
1.50			
Reciprocating Condensing Unit	None	4	
1.50			
Packaged Centrifugal Chiller	None	4	1.50
Base Mounted Air Compressor	3		3
1.50			
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over	3	3	
1.50			
Frame Mounted, Flexible Coupled			
Pumps 10 Hp through 125 Hp	3		3
1.50			
Cooling Towers and Closed Circuit			
Fluid Coolers			
Up to 300 RPM		none	4
Note 1			
301 to 500 RPM		none	4
2.50			
501 RPM and over	none	4	
1.50			
Axial Fans, Tubular Fans, and			
Fan Heads through 22 in. dia.	1 or 2 if req'd	3	
0.75			
Axial Fans, Tubular Fans, and			
Fan Heads 24 in. dia. and over			
Up to 300 RPM	3		3
Note 1			

Over 300 RPM 2.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 1.50	3		3
Over 500 RPM 0.75	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 2.50	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 1.50	3		3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

E. EQUIPMENT ON SUSPENDED SLAB - MAX 40 FT. SPAN

EQUIPMENT	BASE	MOUNT
DEFLECTION		
ITEM		
INCHES	TYPE	TYPE
Reciprocating Refrigerant Compressor 1.50	3	3
Reciprocating Chiller 2.50	None	4
Reciprocating Condensing Unit 2.50	None	4
Packaged Centrifugal Chiller	None	
	4	
	1.50	
Base Mounted Air Compressor 1.50	3	3
Close Coupled Pumps through 7.5 HP	1 or 2	3
		0.75
Close Coupled Pumps 10 Hp and over 1.50	3	3
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 2.50	3	3
Cooling Towers and Closed Circuit Fluid Coolers		
Up to 300 RPM Note 1	none	4
301 to 500 RPM 2.50	none	4
501 RPM and over 1.50	none	4
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.75	1 or 2 if req'd	3
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over		

Up to 300 RPM Note 1	3		3
Over 300 RPM 2.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75	1 or 2 if req'd	3	
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 1.50	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 2.50	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 2.50	3		3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

F. EQUIPMENT ON SUSPENDED SLAB - MAX 50 FT. SPAN

EQUIPMENT	DEFLECTION	BASE	MOUNT	
ITEM	INCHES		TYPE	TYPE
Reciprocating Refrigerant Compressor	3		3	
2.50				
Reciprocating Chiller		None	4	
2.50				
Reciprocating Condensing Unit		None	4	2.50
Packaged Centrifugal Chiller		None	4	1.50
Base Mounted Air Compressor		3		3
2.50				
Close Coupled Pumps through 7.5 HP	1 or 2		3	0.75
Close Coupled Pumps 10 Hp and over	3		3	
1.50				
Frame Mounted, Flexible Coupled				
Pumps 10 Hp through 125 Hp		3		3
2.50				
Cooling Towers and Closed Circuit				
Fluid Coolers				
Up to 300 RPM			none	4
Note 1				
301 to 500 RPM			none	4
3.50				
501 RPM and over		none	4	
2.50				
Axial Fans, Tubular Fans, and				
Fan Heads through 22 in. dia.		1 or 2 if req'd	3	
1.50				
Axial Fans, Tubular Fans, and				
Fan Heads 24 in. dia. and over				
Up to 300 RPM			3	3
Note 1				

Over 300 RPM		3	3
2.50			
Centrifugal Fans and Vent Sets			
Up to 22 in. dia.		1 or 2 if req'd	3
0.75			
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM		3	3
Note 1			
301 to 500 RPM		3	3
2.50			
Over 500 RPM		3	3
2.50			
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM		3	3
Note 1			
301 to 500 RPM		3	3
3.50			
Over 500 RPM		3	3
2.50			
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

2.08 Vibration control bases:

- A. For hydronic pumps, provide concrete inertia bases with structural steel pouring forms sized and reinforced as required for the intended service. Size bases to support the piping elbow supports and furnish with Type RSW recessed spring isolators properly sized for one-inch static deflection. Mount springs on concrete bases 3-1/2" high. Inertia base is not required for pumps installed on slabs on grade.

2.09 Vibration control mounts:

- A. Design and coordinate the structural supports with the Structural Engineer. Isolator housing to be hot-dipped galvanized springs to be neoprene-coated. Provide tie-down adjustment to

prevent excessive movement when tower is drained. Provide vibration isolator rails or point isolators as required by the tower manufacturer.

2.10 Vibration control hangers:

- A. For suspended fans, isolate with not less than four combination spring and rubber-in-shear vibration isolators.
- B. Water source heat pumps shall be isolated with hanger and vibration isolation kit supplied by unit manufacturer or a vibration isolation manufacturer.
- C. All ductwork spring deflection shall be a minimum of 0.75 inches.
- D. Isolate fan coils and unit heaters with not less than four combination spring and rubber "in-shear" vibration isolators.

2.11 Flexible Piping Connectors:

- A. All piping over 1 inch in diameter shall be isolated at mechanical equipment room walls.
- B. Isolate supply and return piping to the cooling tower with flexible piping connectors.
- C. Isolate supply and return piping to each pump with braided metal hose connectors between pump and valve.

2.12 Horizontal Thrust Restraints:

- A. For air handling equipment, install thrust restraints as indicated, and wherever thrust exceeds 10% of equipment weight.

2.13 Rooftop Isolation Curbs:

- A. Provide housed spring type isolators with vertical limit stops.

2.14 Flexible Ductwork Connections to Equipment:

- A. Install flexible connections between sheet metal ductwork and equipment or fan collar. Locate as close to fan as possible. Isolate the duct system from the equipment by at least 1".

Part 57 Execution

3.01 Examination of Related Work:

- A. Examination and Reporting: Installer of vibration isolation work shall observe the installation of other work related to and connected to vibration isolation work. After completion of other related work (but before equipment start-up), he shall furnish a written report to the Contractor, with a copy to VPTC Management Partners, LLC, listing observed inadequacies for proper operation and performance of vibration isolation work.
- B. Correction and Start-up: Do not start-up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation Installer.

3.02 Equal Loading:

- A. General: All isolation devices shall be selected for uniform static deflections according to distribution of weight. Equipment installed on vibration isolating mountings shall be level after

load is applied. Spring isolators with coils touching during equipment start-up or operation will not be acceptable.

3.03 Installation:

- F. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units.
- G. Remove space blocks and similar devices intended for temporary support during installation.
- H. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points.
- I. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.
- J. All piping and equipment shall be installed and ready for operation (i.e. filled with water, etc.) prior to installation of flexible piping connection. Alignment of piping and equipment shall be such that flexible connections are not over extended and compressed from weight of piping, fittings, etc.

END OF SECTION 15240

Section 15240 – Vibration Isolation

Part 58 General

1.01 Related Documents:

- A. The Conditions of the Contract and applicable requirements of Division 1 and Section 15010, "Basic Mechanical Requirements", govern this Section.
- B. The requirements of this section shall apply to all other Division 15 equipment sections.
- C. Refer to Section 15510 – Mechanical Piping Systems, for flexible piping connections associated with vibration isolation.
- D. Refer to Section 15891 – Ductwork, for flexible ductwork connections associated with vibration isolation.

1.02 Description of Work:

- A. Work Included: Provide and install vibration isolation products as specified and indicated, including the following:
 - 1. Vibration control bases:
 - a. Support isolation for motor-driven mechanical equipment
 - b. Inertia base frames in conjunction with equipment isolation
 - 2. Vibration control mounts:
 - a. Support isolation of air-handling housings
 - 3. Vibration control hangers:
 - a. Support isolation of piping
 - b. Support isolation for piping risers
 - 4. Horizontal Thrust Restraints:
 - 5. Rooftop Isolation Curbs:

1.03 Quality Assurance:

- A. General: Except as otherwise indicated, obtain support isolation units from a single manufacturer.
- B. Supervision: Manufacturer shall provide technical supervision of the installation of support isolation units produced by him and of associated inertia bases.
- C. Manufacturers: Provide vibration isolation support units manufactured by one of the following or an approved equal:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Vibration Eliminator Co., Inc.
 - 4. The VMC Group
 - a. Amber/Booth Co.
 - b. Korfund Dynamics Corporation
 - c. Vibrations Mounting and Controls, Inc.

Part 59 Products

[EDIT THE FOLLOWING TO SUIT PROJECT]

2.01 General Application Requirements:

- A. General: Comply with the minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers, including the definitions of critical and non-critical locations, for the selection and application of vibration isolation materials and units as indicated.
 - 1. General: Except as otherwise indicated, select vibrations control products in accordance with ASHRAE Handbook, 2003 Applications Volume, Chapter 47 "Sound and Vibration Control", Table 42.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's instructions for selection and application of vibration isolation materials and units.
- C. "Outdoor" isolators shall be protected as follows: Steel parts other than springs shall be dry galvanized; springs and hardware shall be cadmium plated or otherwise suitably coated to resist corrosion.
- D. Vertical limit restraints shall be built-in to all units, rails and bases which support equipment whose weight varies with the addition or removal of large amounts of water, such as cooling towers, chillers, boilers and for equipment installed on rooftops subject to wind loads.

2.02 Vibration Control Bases:

- A. TYPE 1: Structural steel bases:
 - 1. Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and

pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells.

2. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
 3. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch.
- B. TYPE 2: Isolation rail bases:
1. Bases shall be structural beam sections with welded on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer.
 2. Beam sections shall not be structurally connected to each other.
 3. Minimum section depth of each member shall be equal to 8% of the longest span between supporting isolators, or as shown on the drawings or indicated on the project documents.
 4. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment.
- C. TYPE 3: Concrete filled inertia bases:
1. Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases shall be engineered for a minimum base to equipment weight ratio of 2: 1.
 2. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity
 3. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6".
 4. Forms shall include minimum concrete reinforcement consisting of half-inch bars or angles welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom, or additional steel as is required by the structural conditions
 5. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations.
 6. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base.

2.03 Vibration Control Mounts:

- A. TYPE 1: Neoprene pads:
1. Isolation pads shall be high quality elastomer suitable for minimum 120 psi loading.
 2. Pads shall be installed in multiple layers with galvanized steel shims between layers as required by loading. Single thickness pads of higher psi rating may be substituted for multiple layer pads with the approval of the Architect/Engineer.
- B. TYPE 2: Neoprene mounts:
1. Double deflection neoprene mountings shall have a minimum static deflection of 0.35".
 2. All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided for these areas where bolting is required.

3. On equipment such as small vent sets and close-coupled pumps, steel rails shall be used above the mountings to compensate for the overhang.

C. TYPE 3: Spring mounts:

1. Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support.
2. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.
3. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

D. TYPE 4: Restrained spring mounts:

1. Equipment with operating weight different from installed weight, and equipment subject to wind loads shall be mounted on TYPE 3 Spring Mounts with integral housing as described herein.
2. Housing shall include vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection of cooling tower mounts and

shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same.

3. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operations.

2.04 Vibration Control Hangers:

A. TYPE 1: Spring hangers for pipe:

1. Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series.
2. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Submittals shall include a scale drawing of the hanger showing the 30° swing capability.

B. TYPE 2: Pre-compressed Spring hangers for pipe:

1. Vibration hangers shall be as described for TYPE 1, but shall be pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during the installation.
2. 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.
3. Deflection shall be clearly indicated by means of a scale.

C. TYPE 3: Spring hangers for ductwork:

1. Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short-circuiting of the hanger rod.
2. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short-circuiting the spring.
4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
5. Hangers shall be provided with an eyebolt on the spring end and provision to attach the housing to the flat iron duct straps.
6. Submittals shall include a scale drawing of the hanger showing the 30° capability.

2.05 Horizontal Thrust Restraints:

- A. Air handling equipment shall be protected against excessive displacement which might result from high air thrusts in relation to the equipment weight.
- B. The horizontal thrust restraint shall consist of a spring element in series with a neoprene pad as specified for TYPE 1 spring hanger and with the same deflection as specified for the mountings or hangers under the unit.

- C. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop.
- D. The assembly shall be furnished with one rod and angle brackets for attachment to both the equipment and ductwork or the equipment and the structure.
- E. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit.

2.06 Rooftop Equipment Isolation Curbs:

- A. Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment.
- B. The extruded aluminum top member shall overlap the bottom member to provide water run-off independent of the seal.
- C. The aluminum members shall house cadmium-plated springs having a 1" minimum deflection with 50% additional travel to solid.
- D. Spring diameters shall be no less than 0.8 of the spring height at rated load.
- E. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds.
- F. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible ductwork EPDM connection joining the outside perimeter of the aluminum members.
- G. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.

2.07 Isolator Applications:

- A. Isolation requirements for equipment on grade supported slabs, and on suspended concrete slabs of steel frame, concrete frame, and flat slab construction shall be based on the following tables. Isolation requirements for equipment on suspended lightweight construction such as bar joist shall be based on the table with twice the actual span, or as otherwise detailed or recommended by the isolator manufacturer for the duty.

B. EQUIPMENT ON GRADE SUPPORTED SLAB

EQUIPMENT DEFLECTION		BASE		MOUNT	
ITEM INCHES			TYPE		TYPE
Reciprocating Refrigerant Compressor 0.75	3			3	
Reciprocating Chiller 0.25		None		2	
Reciprocating Condensing Unit 0.25		None		2	
Packaged Centrifugal Chiller	None		1		0.25
Base Mounted Air Compressor 0.75		3			3
Close coupled pumps 10 Hp and up Frame Mounted, Flexible Coupled	1 or 2		3		0.75
Pumps 10 through 125 Hp Cooling Towers and Closed Circuit Coolers 0.25	None		3		0.25
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.25			1 or 2 if req'd	2	
Axial Fans, Tubular Fans and Fan Heads 24 in, dia. and over: Up to 300 RPM Note 1			1 or 2		3
Over 300 RPM 0.75			1 or 2		3
Centrifugal Fans and Vent Sets Up to 22 in. dia. 0.25			1 or 2 if req'd	2	
Centrifugal Fans and Vent Sets 24 in. dia. and over-Up to 50 Hp:					

Up to 300 RPM Note 1		1 or 2	3
301 to 500 RPM 1.50		1 or 2	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 Hp:			
Up to 300 RPM Note 1		1 or 2	3
Over 300 RPM 0.75		1 or 2	3
Packaged Air Handling Units	none	3	0.75

Note1: Deflection = $250,000 / (\text{RPM})^2$

C. EQUIPMENT ON SUSPENDED SLAB - MAX 20 FT. SPAN
 EQUIPMENT DEFLECTION

	BASE	MOUNT	
ITEM INCHES		TYPE	TYPE
Reciprocating Refrigerant Compressor 0.75	3		3
Reciprocating Chiller 0.75	None		4
Reciprocating Condensing Unit 0.75	None		4
Packaged Centrifugal Chiller	None	4	0.75
Base Mounted Air Compressor 0.75	3		3
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over 0.75	3		3
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 0.75	3		3
Cooling Towers and Closed Circuit Fluid Coolers			
Up to 300 RPM Note 1		none	4
301 to 500 RPM 2.50		none	4
501 RPM and over 0.75	none		4
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.75		1 or 2 if req'd	3
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over			
Up to 300 RPM Note 1	3		3

Over 300 RPM 1.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 1.50	3		3
Over 500 RPM 0.75	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 1.50	3		3
Over 300 RPM 0.75	3		3
Packaged Air Handling Units	None	3	0.75

Note1: Deflection = $250,000 / (\text{RPM})^2$

D. EQUIPMENT ON SUSPENDED SLAB - MAX 30 FT. SPAN
EQUIPMENT
DEFLECTION

ITEM INCHES	BASE	MOUNT TYPE	TYPE
Reciprocating Refrigerant Compressor			3
	3		
	1.50		
Reciprocating Chiller	None	4	
1.50			
Reciprocating Condensing Unit	None	4	
1.50			
Packaged Centrifugal Chiller	None	4	1.50
Base Mounted Air Compressor	3		3
1.50			
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over	3	3	
1.50			
Frame Mounted, Flexible Coupled			
Pumps 10 Hp through 125 Hp	3		3
1.50			
Cooling Towers and Closed Circuit			
Fluid Coolers			
Up to 300 RPM		none	4
Note 1			
301 to 500 RPM		none	4
2.50			
501 RPM and over	none	4	
1.50			
Axial Fans, Tubular Fans, and			
Fan Heads through 22 in. dia.	1 or 2 if req'd	3	
0.75			
Axial Fans, Tubular Fans, and			
Fan Heads 24 in. dia. and over			
Up to 300 RPM	3		3
Note 1			

Over 300 RPM 2.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 1.50	3		3
Over 500 RPM 0.75	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 2.50	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 1.50	3		3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

E. EQUIPMENT ON SUSPENDED SLAB - MAX 40 FT. SPAN

EQUIPMENT	BASE	MOUNT
DEFLECTION		
ITEM		
INCHES	TYPE	TYPE
Reciprocating Refrigerant Compressor 1.50	3	3
Reciprocating Chiller 2.50	None	4
Reciprocating Condensing Unit 2.50	None	4
Packaged Centrifugal Chiller	None	
	4	
	1.50	
Base Mounted Air Compressor 1.50	3	3
Close Coupled Pumps through 7.5 HP	1 or 2	3
		0.75
Close Coupled Pumps 10 Hp and over 1.50	3	3
Frame Mounted, Flexible Coupled Pumps 10 Hp through 125 Hp 2.50	3	3
Cooling Towers and Closed Circuit Fluid Coolers		
Up to 300 RPM Note 1	none	4
301 to 500 RPM 2.50	none	4
501 RPM and over 1.50	none	4
Axial Fans, Tubular Fans, and Fan Heads through 22 in. dia. 0.75	1 or 2 if req'd	3
Axial Fans, Tubular Fans, and Fan Heads 24 in. dia. and over		

Up to 300 RPM Note 1	3		3
Over 300 RPM 2.50	3		3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75	1 or 2 if req'd	3	
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 1.50	3		3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM 2.50	3		3
301 to 500 RPM 2.50	3		3
Over 500 RPM 2.50	3		3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection = 250,000/(RPM)²

F. EQUIPMENT ON SUSPENDED SLAB - MAX 50 FT. SPAN

EQUIPMENT	DEFLECTION	BASE	MOUNT
ITEM	INCHES	TYPE	TYPE
Reciprocating Refrigerant Compressor	3		3
2.50			
Reciprocating Chiller		None	4
2.50			
Reciprocating Condensing Unit	None	4	2.50
Packaged Centrifugal Chiller	None	4	1.50
Base Mounted Air Compressor		3	3
2.50			
Close Coupled Pumps through 7.5 HP	1 or 2	3	0.75
Close Coupled Pumps 10 Hp and over	3		3
1.50			
Frame Mounted, Flexible Coupled			
Pumps 10 Hp through 125 Hp		3	3
2.50			
Cooling Towers and Closed Circuit			
Fluid Coolers			
Up to 300 RPM		none	4
Note 1			
301 to 500 RPM		none	4
3.50			
501 RPM and over		none	4
2.50			
Axial Fans, Tubular Fans, and			
Fan Heads through 22 in. dia.		1 or 2 if req'd	3
1.50			
Axial Fans, Tubular Fans, and			
Fan Heads 24 in. dia. and over			
Up to 300 RPM		3	3
Note 1			

Over 300 RPM 2.50		3	3
Centrifugal Fans and Vent Sets			
Up to 22 in. dia. 0.75		1 or 2 if req'd	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Up to 50 HP			
Up to 300 RPM Note 1		3	3
301 to 500 RPM 2.50		3	3
Over 500 RPM 2.50		3	3
Centrifugal Fans and Vent Sets			
24 in. dia. and over-Over 50 HP			
Up to 300 RPM Note 1		3	3
301 to 500 RPM 3.50		3	3
Over 500 RPM 2.50		3	3
Packaged Air Handling Units	None	3	1.50

Note1: Deflection =250,000/(RPM)²

2.08 Vibration control bases:

- A. For hydronic pumps, provide concrete inertia bases with structural steel pouring forms sized and reinforced as required for the intended service. Size bases to support the piping elbow supports and furnish with Type RSW recessed spring isolators properly sized for one-inch static deflection. Mount springs on concrete bases 3-1/2" high. Inertia base is not required for pumps installed on slabs on grade.

2.09 Vibration control mounts:

- A. Design and coordinate the structural supports with the Structural Engineer. Isolator housing to be hot-dipped galvanized springs to be neoprene-coated. Provide tie-down adjustment to

prevent excessive movement when tower is drained. Provide vibration isolator rails or point isolators as required by the tower manufacturer.

2.10 Vibration control hangers:

- A. For suspended fans, isolate with not less than four combination spring and rubber-in-shear vibration isolators.
- B. Water source heat pumps shall be isolated with hanger and vibration isolation kit supplied by unit manufacturer or a vibration isolation manufacturer.
- C. All ductwork spring deflection shall be a minimum of 0.75 inches.
- D. Isolate fan coils and unit heaters with not less than four combination spring and rubber "in-shear" vibration isolators.

2.11 Flexible Piping Connectors:

- A. All piping over 1 inch in diameter shall be isolated at mechanical equipment room walls.
- B. Isolate supply and return piping to the cooling tower with flexible piping connectors.
- C. Isolate supply and return piping to each pump with braided metal hose connectors between pump and valve.

2.12 Horizontal Thrust Restraints:

- A. For air handling equipment, install thrust restraints as indicated, and wherever thrust exceeds 10% of equipment weight.

2.13 Rooftop Isolation Curbs:

- A. Provide housed spring type isolators with vertical limit stops.

2.14 Flexible Ductwork Connections to Equipment:

- A. Install flexible connections between sheet metal ductwork and equipment or fan collar. Locate as close to fan as possible. Isolate the duct system from the equipment by at least 1".

Part 60 Execution

3.01 Examination of Related Work:

- A. Examination and Reporting: Installer of vibration isolation work shall observe the installation of other work related to and connected to vibration isolation work. After completion of other related work (but before equipment start-up), he shall furnish a written report to the Contractor, with a copy to VPTC Management Partners, LLC, listing observed inadequacies for proper operation and performance of vibration isolation work.
- B. Correction and Start-up: Do not start-up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation Installer.

3.02 Equal Loading:

- A. General: All isolation devices shall be selected for uniform static deflections according to distribution of weight. Equipment installed on vibration isolating mountings shall be level after

load is applied. Spring isolators with coils touching during equipment start-up or operation will not be acceptable.

3.03 Installation:

- K. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units.
- L. Remove space blocks and similar devices intended for temporary support during installation.
- M. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points.
- N. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.
- O. All piping and equipment shall be installed and ready for operation (i.e. filled with water, etc.) prior to installation of flexible piping connection. Alignment of piping and equipment shall be such that flexible connections are not over extended and compressed from weight of piping, fittings, etc.

END OF SECTION 15240

Section 15250 – System Insulation

Part 61 General

1.01 Description:

- A. Furnish and install thermal insulation materials, coverings and accessories for mechanical piping, equipment and ductwork systems as specified herein. Extent of mechanical insulation

work required by this Section shall be as indicated on drawings, schedules and by requirements of this Section.

1.02 Insulation Schedule:

A. Piping:

1. Type A – Fiberglass with white kraft paper fire retardant. (See Part 2 – Products)
 - a. Heating hot water
 - b. Domestic cold water, hot water and hot water return
 - c. Storm drain lines at roof deck from drain body to vertical riser
2. Type B – Black, closed cell flexible foam insulation. (See Part 2 – Products)
 - a. Refrigerant piping
 - b. Condensate drain lines
 - c. Note: Type B insulation shall not be used for domestic cold and hot water piping.
3. Type C – (Exterior Piping Applications) Polyisocyanurate with glass fiber wrap and PVC or metal jacket. (See Part 2 – Products)
 - a. Chilled water
 - b. Condensing water systems when used for waterside system economizing or in geothermal applications
 - c. Exterior domestic hot and cold water piping
 - d. Exterior make up water piping

B. Equipment:

1. Type D(H) - Semi-rigid fibrous glass board. (See Part 2 – Products)
 - a. Hot water tanks not factory insulated
 - b. Heating hot water air separators
2. Type D(C) - Closed cell flexible foam insulation. (See Part 2 – Products)
 - a. Roof drain bodies
 - 1) Insulate all roof drain bodies at the roof deck.
 - b. Chilled water air separators or condenser water separators when used for waterside system economizer
 - c. Chilled water pump bodies or condenser water pump bodies when used for waterside system economizer
3. Type E - Calcium silicate block insulation. (See Part 2 – Products)
 - a. Emergency generator exhaust piping and muffler; 4" thickness

C. Ductwork Systems:

1. Type F – Fiberglass wrap with aluminum foil jacket. (See Part 2 – Products)
 - a. High, medium and low pressure ductwork
2. Type G – Duct liner – Glass fiber coated with black fire resistant and microbial resistant coating. (See Part 2 – Products)
 - a. High, medium and low pressure ductwork when used for sound attenuation or if ductwork is exposed.

- b. Low pressure return boot
- c. Transfer ducts

D. Insulation Installation Exceptions:

1. Exhaust ductwork, stairwell pressurization and dedicated smoke evacuation ductwork shall not be insulated, unless otherwise noted.
2. Exposed ductwork shall be internally lined.
3. The first 25 feet of supply ductwork downstream of rooftop or floor mounted air handling units shall be internally lined with Type G insulation for high frequency acoustical attenuation purposes.
4. The first 10 feet of supply ductwork (low pressure) downstream of heat pumps, VAV terminals and fan-powered terminals shall be internally lined with Type G insulation for acoustical attenuation purposes.
5. Return ductwork within 25 feet of floor-mounted air handling units or rooftop units shall be internally lined with Type G for high frequency acoustical attenuation purposes.
6. At the contractor's option and with the approval of VPTC Management Partners, LLC Construction, medium and low pressure supply ductwork insulation may be omitted in return air plenums if not required by local codes (including energy codes). If accepted, a

minimum of 2°F of duct temperature rise shall be applied in calculating supply airflows to the space.

7. Selection of insulation thickness shall be in compliance with all local codes and local energy codes.
8. All piping exposed to outdoors shall be insulated. Coordinate insulation with heat trace cable and controls.

1.03 Quality Assurance:

- A. All insulation, jacket and adhesive shall have a fire and smoke hazard ratings as tested under ASTM E-84, NFPA 255, and UL 723 not exceeding:
 1. Flame Spread: 25
 2. Fuel Contributed: 50
 3. Smoke Developed: 50

1.04 Submittals:

- A. Provide submittal data on all insulation types to be installed in accordance with Section 15010.

1.05 Definitions:

- A. The term "plenum" shall mean a ceiling space or mechanical room used for the transfer of conditioned return and/or outside air.

1.06 Manufacturers:

- A. The model numbers listed in the Specification establishes a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications:
 1. armacell engineered foams
 2. CertainTeed Corporation
 3. Dow Building Materials
 4. Knauf Insulation
 5. Johns-Manville
 6. Owens-Corning Fiberglass Corporation
 7. Pittsburgh Corning
 8. Rubatex International, LLC

Part 62 Products

2.01 Piping Insulation:

- A. Type A (Fiberglass, indoor):
 1. One piece glass fiber, rigid molded sectional pipe covering with factory applied aluminum foil and white craft paper flame retardant vapor barrier jacket, conforming to ASTM C547, Class II, Mineral Fiber Preformed Pipe Insulation.
 2. Conductivity (k) equals approximately 0.23 (BTU/HR., SF., Degree F, IN) at 75 °F mean temperature.
 3. Encase pipe fittings with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.

- a. Under pre-molded PVC fitting coverings, wrap two separate layers of blanket insulation to provide same thickness and density as adjacent pipe covering.
 - b. Mitered segments of pipe insulation are also acceptable under PVC fitting covers when installing fiberglass insulation.
4. Approved manufacturer's trade names:
- a. Johns-Manville Corp. - "Micro-Lok 650-AP-T"
 - b. Owens Corning Fiberglass Corp. - "One Piece" 25 ASJ/SSL"
 - c. Other equal by listed manufacturer
- B. Type B (Closed Cell, indoor):
- 1. Closed cell, flexible foamed plastic conforming to ASTM C534, "Preformed Flexible Elastomeric Cellular Thermal Insulation in Tubular Form." Insulation shall be 6 lb/sf density suitable for a temperature range from -40 degrees F to 220 degrees F.
 - 2. Conductivity (k) equals approximately 0.28 (BTUHR., SF., Degree F, IN) at 75 °F mean temperature.
 - 3. Pipe insulation shall be applied in a continuous length and shall not be longitudinally slit.
 - 4. Approved manufacturers and trade names:
 - a. armacell engineered foams "Armaflex".
 - b. Rubatex
 - c. Other equal by listed manufacturer
- C. Type C (Polyisocyanurate, outdoor):
- 1. Prefabricated 2 lb./cu.ft. density polyisocyanurate insulation with waterproof mastic and glass fiber jacket finished with an aluminum jacket with waterproof silicone caulk joints.
 - 2. Conductivity (k) equals approximately 0.14 (BTUHR., SF., degrees F, IN) at 75 °F.
 - 3. Insulation shall be applied per manufacturer's recommendations. Joint sealants and coatings shall be as approved by the insulation manufacturer for the intended application and service temperature range.
 - 4. Jacketing shall be an all service jacket with 1 mil. aluminum foil on pipe insulation and FSK jacket on board stock applied by the manufacturer to ASTM C-1136. Jacket shall have integral flap for sealing joint.
 - 5. Approved manufacturers and trade names:
 - a. Dow Building Materials Trymer 9501
 - b. Other equal by listed manufacturer

2.02 Equipment Insulation:

- A. Type D (Hot) (Fiberglass board for Hot Equipment):
- 1. Semi-rigid intermediate service fibrous glass board for operating temperatures greater than 850 degrees F.
 - 2. Conductivity (k) equals approximately 0.23 (BTU/HR., SF., degrees F, IN) at 75 °F mean temperature. Minimum density of 2.75 lb / cu ft.
 - 3. Approved manufacturers and trade names:
 - a. CertainTeed - " 850 Fiberglass Insulation Board"

- b. Johns-Manville Corp. - "1000 series Spin Glass"
- c. Owens Corning - "Intermediate Service Board"
- d. Other equal by listed manufacturer

B. Type D (Cold) (Foamed Plastic for Cold Equipment):

1. Foamed plastic sheet suitable for operating temperatures between –40 degrees F and 22-degrees F.
2. Density shall be 6 lb/sf Conductivity (k) equals approximately 0.287 (BTU/HR., SF., Degree F, IN) at 75 °F mean temperature.
3. Approved manufacturers and trade names:
 - a. armacell engineered foams "Armaflex"
 - b. Rubatex
 - c. Other equal by listed manufacturer

C. Type E:

1. Calcium silicate block conforming to ASTM C 553, Type I (1200 degrees F. max), asbestos free.
2. Conductivity (k) equals approximately 0.42 (BTU-IN/HR., SF., degree F) per inch thickness at 200 °F.
3. Approved manufacturers and trade names:
 - a. Calislite
 - b. Pabco Insulation - "Super Caltemp"
 - c. Other equal by listed manufacturer

2.03 Ductwork Insulation:

A. Type F:

1. Duct insulation shall be minimum 2" thick, minimum 3/4 lb. density fiberglass
 - a. At locations with the International Energy Code, refer to Tables 6.8.2A and B for minimum duct insulation thickness.
2. Conductivity (k) equals approximately 0.24 (BTUHR., SF., degrees F, IN) at 75 °F mean temperature.
3. Integral UL rated vapor barrier of:
 - a. Aluminum foil reinforced with fiberglass scrim laminated to 30-lb. kraft paper.
 - b. Class I white vinyl 0.004 inch thick, where specified.
4. Approved Manufacturers and Trade Names
 - a. Certain Standard - "Universal"
 - b. Manville Corp. - "Microlite"
 - c. Owens Corning - "All Service Duct Wrap"
 - d. Other equal by listed manufacturer

2.04 Type G - Duct Liner:

1. ASTM C1071, Type II, Grade 2, R-6, 1" thickness, 1.5 lb. density for low pressure ductwork and 3.0 lb density for medium pressure ductwork, bonded mat of glass fiber coated with black fire resistant and microbial resistant coating, complying with TIMS AHC-101. Moisture adsorption shall not be greater than 0.5% moisture by volume when exposed to moisture-laden air at 120°F and 96% RH, per ASTM C553. Insulation shall be Schuller "Permacote Linacoustic" R-300, "Aeroflex Ductliner" as manufactured by Owens Corning Fiberglass Corp. or "Ultralite with Certa-Edge" by CertainTeed Corp. or equal by Knauf Fiberglass.
2. Duct liner adhesive shall comply with ASTM C916 "Specifications for Adhesives for Duct Thermal Insulation".
3. Liner Fasteners: Mechanical or weld secured fasteners for duct liner where finish of duct is not exposed. For exposed ductwork, except in mechanical rooms, provide adhesively secured fasteners. Position fasteners are recommended by SMACNA. The interior duct insulation shall be applied as recommended by the manufacturer including proper adhesive and adhered clips. Clip spacing shall not exceed 8" on center perpendicular to air flow and shall not exceed 12" on center in the direction of air flow.
4. All joints of the insulation shall have edges buttered with sealant, and shall be tightly buffed. Apply a brush coat of sealant at all joints on the surface of the duct liner extending at least 1" on each side of joint. Provide metal nosing on all exposed edges of duct liner at fire dampers, control dampers, fan discharges, etc.
5. Minimum Sound Absorption coefficients shall be per ASTM-E 477:

2.05 Exterior Protection:

A. Metal Jacket:

1. Smooth aluminum jacket 0.016 inch thick with integral polykraft or poly-surlyn moisture barrier. Provide banded locking joints with field applied silicone weatherproof sealant.
2. Approved manufacturers:
 - a. RPR Products, Inc.
 - b. Childers Products Co.
 - c. Manville Corp.
 - d. Pabco Division of A.J. Gerrard & Company

B. Foil/Film Facing for ductwork

1. Jacketing shall be a five-ply laminated foil/film facing for exterior applications. Product shall be a five-ply laminate alternating layers of aluminum foil (core and outer layers) with two

layers of polyester film. Substrate thickness shall be not less than 3.0 mils and the adhesive thickness shall be not less than 2.0 mils.

2. Product shall be coated with Venture Tape's cold weather acrylic, pressure sensitive adhesive system suitable for application in below freezing temperatures.
3. Laminate construction shall be highly puncture, tear resistant and flame retardant. Product shall be suitable for application between -10°F and 248°F. Product shall be suitable for use at temperatures up to 300°F.
4. All joints shall be sealed with manufacturer's recommended joint tape.
5. Product shall carry a ten year warranty

Part 3 - Execution

3.01 Piping Insulation General Requirements:

A. Preparation:

1. Do not apply insulation until piping has been leak tested.
2. All surfaces to be insulated shall be dry and free of loose scale, rust, dirt, oil or water.

B. Application:

1. Insulation shall be installed in a smooth, clean workmanlike manner. Joints shall be tight and finished smooth without fishmouths.
2. Insulation shall fit tightly against the surface to which it is applied to prevent air circulation between the insulation and the pipe or equipment to which it is applied.
3. Insulation applied to cold piping or equipment shall be completely vapor sealed, free of pinholes or other openings.
4. Do not use wet insulation materials.
5. All longitudinal joints on vertical pipe runs shall be staggered.
6. Apply insulation so as to permit expansion or contraction of pipelines without causing damage to insulation or surface finish.
7. Do not apply mastic or adhesive until all previous applications of mastic and adhesives have thoroughly dried.
8. No bands or staples shall be provided on covering.
9. The adhesive used in connection with all covering work shall contain an approved vermin and rodent-proof ingredient.
10. Provide 24-gauge sheetmetal saddle between the pipe hanger/support and the exterior of the insulation. Saddle length shall be the same as insulation inserts.

C. Application at Fittings:

1. Insulation of flanges and flanged fittings shall overlap adjacent pipe covering at least 1 inch. Valves shall be insulated up to the gland only.
2. Pipeline strainers shall be insulated in such a manner as to permit removal of strainer basket without disturbing insulation of the strainer body.
3. Insulation adjacent to uninsulated flanges shall be tapered back and neatly finished so as to allow access to and removal of bolts without injury to covering.

D. Insulation of valves and specialties (including PRVs and RPZs):

1. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation with disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
2. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings insulation that will allow passage of air to pipe surface.
3. At contractor's option, apply preformed covers manufactured of same material as pipe insulation. Attach per manufacturers installation instructions.

3.02 Type A Insulation Installation:

- A. Tightly butt together sections of insulation on pipe runs sealing longitudinal seams of jacket with a self-sealing adhesive. Seal end joints with 4-inch wide straps of matching vapor barrier tape. Seal off ends of insulation with vapor seal mastic at valves, fittings and flanges. No further finish required. Mastic shall extend onto the bare pipe and over the insulation O.D.
- B. PVC fitting jackets shall be used when they are available for the particular application. When molded or routed coverings are not available, the coverings shall be fabricated in the field similar to equipment insulation. Molded or routed fitting covers are highly recommended. Order PVC pre-curved.
- C. Cold Piping:
 1. Cover valves, fittings and flanges with insulation having the same thickness as adjacent pipe covering, securing in place reforming tape up to 12" O.D. and 1/2" wide SST bands on larger O.D. Apply a PVC jacket and seal joints with PVC cement (solvent welding).
- D. Hot Piping:
 1. Covers shall overlap the pipe insulation by the thickness of the insulation or 2" min. Cover valves, fittings and flanges with insulation similar to the adjacent pipe covering, securing in place with reforming tape up to 12" O.D. and 1/2" wide SST bands on larger O.D. Apply a PVC jacket and tape end joints to adjacent pipe insulation.
 2. Do not use PVC fitting jackets where the surface of the insulation is above 150 degrees F.
- E. Exterior Piping:
 1. Exterior above grade water piping shall be finished with a weatherproof jacket and an aluminum jacket. Lap and seal joints as per manufacturer's instructions. Place laps to shed water.

3.03 Type B Insulation Installation:

- A. Type B insulation shall be slipped on the pipe prior to connection, and the butt joints shall be sealed.
- B. All joints shall be completely butt sealed with the manufacturer's recommended adhesive.
- C. Do not apply Type B insulation in multiple layers.
- D. Type B insulation shall not be used in plenums or firewall penetrations.
- E. This Contractor shall paint Type B insulation exterior to the building with two coats of a vinyl acrylic paint recommended by the insulation manufacturer for protection against ultraviolet

degradation and shall be flexible with no cracking. It is recommended in high humid areas to coat the insulation with vapor barrier mastic to .037 min. DFT.

3.04 Type C Insulation Installation:

A. Exterior:

1. Butter joints of insulation with non-setting adhesive. Secure with factory applied self-seal laps. Installation shall be as per manufacturer's guidelines.
2. Finish shall be factory applied all service Jackets. All fittings shall be finished with vapor seal mastic reinforced with white glass mesh. Minimum .037 thick DFT of mastic.
3. Piping exposed in machine rooms shall be finished with vapor seal mastic and open weave membrane 10 x 10.
4. Piping exposed to weather shall be finished with all service jacket and additional finish of 0.16 thick aluminum jacket. Aluminum jacket shall be secured with stainless bands located

on maximum centers of 12 inches and at the overlap. No screws or pop rivets shall be used.

5. Fittings and valves shall be finished with vapor seal mastic, reinforced with min. .037" DFT of mastic, glass mesh and aluminum preformed fitting covers.

3.05 Type D and E Insulation Installation:

A. Equipment Insulation Application:

1. Apply insulation to fit as closely as possible to equipment.
2. Stagger joints where possible.
3. Bevel insulation around nameplates, ASME stamp and access plates.
4. Insulation on equipment that must be opened periodically shall be constructed so insulation can be removed and replaced without damage.
5. Do not install Type E insulation on aluminum surfaces or with aluminum jacket.

B. Hot Equipment:

1. Install 3/4-inch expanded metal over equipment with standing ribs or seams prior to applying insulation to eliminate ribs or seams penetrating through the insulation.
2. Secure the insulation with steel bands spaced on 12-inch centers.
3. Where required, use welded studs, clips or angles as anchors for wire or bands on flat surfaces.
4. Seal joints with insulating cement.
5. Over the insulation stretch 1-inch hexagonal mesh wire and lace the edges together.
6. Apply a 1/4-inch thick coat of finishing cement and trowel smooth.
7. Smooth insulation with lagging adhesive, cover with glass cloth and a final coat of lagging adhesive.
8. On small equipment where it is not practical, omit the wire mesh and finishing cement on Type D insulation.

C. Cold Equipment:

1. Cover irregular surfaces with a smoothing coat of insulating cement.
2. Secure insulation with wire or with stainless bands spaced on 12-inch centers.
3. Seal joints with vapor seal mastic.
4. Embed a layer of glass into a 1/16-inch coating of vapor seal mastic. Then coat the outside of the glass cloth with a 1/16-inch coating of vapor seal mastic.

D. Roof Drain Bodies:

1. Insulate similar to cold equipment.
2. Insulated boxes around roof drain bodies are not acceptable.

3.06 Type F Insulation Installation:

A. Ductwork Insulation Application:

1. Apply insulation tightly and smoothly to duct.
2. Secure insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag and max 3" from any corner.

3. Impale insulation over pins or anchors located not more than 18 inches apart and hold in place with washers and clips.
4. Cut off protruding pin after clips are secured and seal with 2-mil. aluminum foil backed pressure sensitive tape.
5. Apply insulation with joints tightly butted.
6. Seal all ductwork joints, punctures and fittings with a mastic type sealant containing a vapor barrier.
7. Cover all breaks, joints, punctures and voids with a vapor seal mastic and cover with a vapor barrier material identical to vapor barrier on the insulation, where gaps exceed 2".
8. Bevel insulation around nameplates, access plates and doors.
9. Insulation shall be continuous through walls and floors except at fire dampers.

3.07 Type G Insulation Installation:

A. Internal Lining Insulation Application:

1. Apply where specified herein.
2. Apply liner in accordance with SMACNA Duct Liner Application Standard, later edition.

3.08 Metal Jacket Installation:

- A. Cover all piping insulation exposed to the exterior with metal jacket as specified herein.

3.09 Hangers:

- A. Continue insulation through pipe hangers. Provide either rigid insulation inserts or sheet metal inserts at all outside pipe hangers. Provide rigid insulation inserts for piping operating below 60 °F. and sheet metal inserts for piping above 60 °F.
- B. Provide rigid insulation (on non-insulated piping) or sheet metal inserts (on insulated piping) between the pipe and pipe hanger - shall be of a thickness equal to the adjoining insulation and

shall be provided with vapor barrier where required. Insulation insert shall not be less than the following lengths:

1/2" to 2-1/2" pipe size	10 Inches Long
3" to 6" pipe size	12 Inches Long
8" to 10" pipe size	16 Inches Long
12" and over	22 Inches Long

- C. Inserts for cold piping shall have a vapor barrier facing of the same material as the adjacent pipe insulation. Seal inserts into insulation with vapor seal mastic.
- D. Sheet metal inserts shall be of steel sheet. Gauge shall conform to manufacturer's recommendation for pipe size. Sheet metal inserts shall have insulation filler of the same material as the adjacent pipe insulation.

3.10 Pipe Sleeves:

- A. Pipe insulation and vapor barrier shall be continuous through sleeves in walls and floors.
- B. Type B insulation shall not be used in sleeves through firewalls or fire rated (2-hour) floor systems. Use Type A or Type C through the sleeve instead and vapor seal the joint between the two insulations.
- C. Provide 26 gauge galvanized steel or 0.020 inch aluminum jacket over insulation on pipe passing through sleeves where sealant is required.
- D. Where penetrating interior walls, extend the metal jacket 2 inches out either side of the wall and secure each end with a metal band compressing the insulation slightly.
- E. Where penetrating floors, extend the metal jacket 2 inches below the floor and 5 inches above the floor. Secure with metal bands.

END OF SECTION 15250