

## SECTION 220010 - PLUMBING GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. This section describes the general provisions for the mechanical and electrical work included in Division 22. This section applies to all sections of Division 22.

#### 1.3 RESPONSIBILITY

- A. The General Contractor shall be responsible for all work included in the Plumbing Division and the delegation of work to Subcontractors shall not relieve him of this responsibility. Subcontractors who perform work under these Sections shall be responsible to the General Contractor. The term "Contractor" is used throughout this Division and shall mean the General Contractor, although the actual performance of the work may be by a Subcontractor.

#### 1.4 REFERENCES AND DEFINITIONS

- A. Following are definitions of terms and expressions used in the Plumbing Sections in addition to those included in Division 01 Sections:

1. Owner: Novant Health Scotts Hill Medical Center
2. Architects: LS3P Architects
3. Engineers: WSP USA Buildings, Inc.
4. Directed - "directed by the Architect"
5. Indicated - "indicated or in Contract Documents"
6. Concealed - "hidden from normal sight"; includes items in shafts, pipe and duct spaces, and above ceilings.
7. Exposed - "not concealed" - Work within Equipment Rooms and all visible (normal sight) work shall be considered exposed".
8. Piping - includes pipes, fittings, valves, hangers and accessories comprising a system.

#### 1.5 STANDARD SPECIFICATION

- A. References to catalogs, standards, codes, specifications, and regulations are the latest edition in effect at date of invitation to bid.

#### 1.6 CODES, REGULATIONS AND PERMITS

- A. Give all necessary notices and obtain all required permits. Pay all fees and other costs, including utility connections or extensions in connection with the work. File all necessary plans, prepare all documents, and obtain all necessary approvals of all governmental departments having jurisdiction. Obtain all required certificates of inspection and deliver same to the Architect before request for acceptance and final payment for the work.

- B. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following bodies:

North Carolina State Building Code (IBC - Based)  
North Carolina State Mechanical Code (IBC – Based)  
North Carolina State Plumbing Code (IBC – Based)  
North Carolina State Gas Code (IBC – Based)  
North Carolina State Fire Code  
National Electrical Code (NEC)  
National Fire Protection Association (NFPA)  
Duke Power

#### 1.7 MATERIALS LIST AND SHOP DRAWINGS

- A. Within 15 working days after the award of the contract, the contractor shall submit to the Architect for approval a list of Submittals to be included in the Submittal Schedule in accordance with Section 013300 Submittal Procedures. The list shall include the manufacturers of materials and equipment he proposes to provide. In the event any items of material or equipment contained in the list fail to comply with the specification requirements, such items will be rejected. Rejected items shall be resubmitted within 15 days. Substitution requests shall be submitted in accordance with specified procedure.
- B. After receiving approval of equipment manufacturers and prior to delivery of any material to job site and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval dimensioned drawings or cuts showing construction size, arrangement, operating clearances, performance characteristics and capacity of materials and equipment. Each item of equipment proposed shall be a standard catalog product of the approved manufacture.
- C. Samples, drawings, specifications, catalogs, etc., submitted for approval shall be properly labeled indicating specific services for which material or equipment is to be used, section and article number of specifications governing, and Contractor's name, name of job, and date.
- D. Catalogs, pamphlets or other documents submitted to describe items on which approval is being required shall be specific and identification in catalog, pamphlet, etc., of the item submitted shall be clearly made in ink. Data of a general nature will not be accepted. Any deviations or exceptions taken in the specification by the Contractor shall be so noted.
- E. Any deviations or exceptions taken in the specification by the Contractor shall be so noted.
- F. If material or equipment is installed prior to receipt by the Contractor of approved shop drawings, marked "Approved", "No Exception Taken" or "Make Corrections Noted", the Contractor shall be liable for its removal and replacement at no extra charge to the Owner.
- G. The acceptance of shop drawings shall not relieve the Contractor from his responsibility to furnish material, equipment and systems and to perform work required by the contract documents. Neither the Owner nor the Architect will be responsible for errors or omissions on shop drawings furnished by the Contractor even though such shop drawings containing errors or omissions are inadvertently accepted.
- H. The Contractor is further advised that the Architect will not act as coordinator between suppliers and subcontractors. All required coordination shall be the responsibility of the Contractor.

## 1.8 CONTRACTOR'S USE OF CAD/Revit FILES

- A. At the Contractor's written request, copies of the Engineer's CAD / Revit files may be made available for Contractor use in connection with the project, subject to following conditions:
1. Submit written request to the Architect Listing the specific drawings the Contractor intends to use. Provide a specific list of submittals that the files will be used in preparing, and the list of names of subcontractors or suppliers.
  2. The Contractor shall request in writing the electronic transfer agreement. Prior to transfer of files, the Contractor shall prepare a separate electronic transfer agreement for each subcontractor or supplier who will be using the electronic files.
  3. Data contained on the electronic files is part of Leach Wallace Associates (WSP) instruments of service and shall not be used for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. Any other use or reuse will be at the Contractor's sole risk and without liability or legal exposure to WSP.
  4. The electronic files and corresponding hard copy contract documents. Because of the possibility the information and data delivered in machine readable form may be altered, whether inadvertently or otherwise, WSP reserves the right to retain hard copy originals of the electronic documentation delivered to the contractor, in machine readable form, which the original shall be referred to and shall govern in the event of any inconsistency between the two.
  5. The use of the electronic files, does not relieve the Contractor of their duty to fully comply with the contract documents, including and without limitation, the need to check confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate work with that of other Contractors for the project.
  6. All "internal" calculations integral to / performed by the Revit model shall not be utilized for any purpose by the Contractor. This includes, but shall not be limited to, voltage drop calculations, duct static pressure calculations, air system airflow summary calculations, piping system pressure drop calculations, etc.
  7. All Revit "families" are the property of WSP and shall not be re-used on any other project for any purpose by the Contractor.

## 1.9 GUARANTEE

- A. The Contractor guarantees by his acceptance of the Contract that all work provided shall be free from defects in workmanship and materials for a period of one year after date of certification of completion and acceptance of work. Any defects in workmanship, materials or performance which appear within the guarantee period shall be corrected by the Contractor without cost to the Owner within a reasonable time to be specified in notice from the Architect. In default thereof, Owner may have such work done and charge the cost of same to the Contractor.

## 1.10 SITE VISIT

- A. Prior to preparing the bid, the plumbing subcontractors shall visit the site and familiarize themselves with all existing conditions. Make all necessary investigations as to locations of existing equipment, ductwork, piping, utilities, etc., work to be removed, and all other matters which can affect the work under the Contract. No additional compensation will be made to the contractor as result of his failure to familiarize himself with the existing conditions under which the work must be performed.
- B. Refer to Section 002113 Instructions to Bidders, and Section 002213 Supplementary Instructions to Bidders.

## 1.11 DRAWINGS

- A. The contract drawings are diagrammatic and indicate the general arrangements of systems and work included in the Contract. Do not scale the drawings. Consult the architectural and structural drawings

and details for exact location of structure and equipment; where same are not definitely located, obtain this information from the Architect.

#### 1.12 RECORD DRAWINGS

- A. The Contractor shall keep accurate records of all deviations in work are actually installed from work indicated. One complete set of contract documents shall be available at the construction site for indicating said deviations.
- B. When work is complete, make one (1) complete “As-Built” set of PDF files, certifying the accuracy of each drawing by endorsement and signature thereon and deliver to the Architect who will, after approval, deliver the record drawings to the Owner. Provide record copy of BIM model to Owner in accordance with Novant Health standards.

#### 1.13 OPERATING AND MAINTENACE INSTRUCTIONS:

- A. Contractor shall furnish to the Architect three (3) complete bound sets of typewritten or blueprinted instructions for operating and maintaining all systems and equipment included in this Contract. Each set of instructions shall be contained in a hard-back ring binder properly indexed and labeled. Also provide two complete bound sets of approved shop drawings for all items of equipment utilized on the project. All instructions shall be submitted in draft for approval prior to the final issue. Manufacturers' advertising literature or catalogs will not be acceptable for operating and maintenance instructions.
- B. Contractor shall prepare Operation and Maintenance Data and submit in accordance with the requirements of Section 017823 Operation and Maintenance Data.
- C. Instructions shall include a general description of each system together with specific instructions describing routine and emergency procedures required of the building maintenance personnel for operating and maintaining each system. The instructions shall include the name or label, location, and function of all operating equipment and controls, and the location of the electrical service and breaker I.D. numbers. Operating modes and the procedures for indexing each mode shall be clearly described. Include lubrication charts and schedules of frequency of lubrication for all equipment designating each point of lubrication and type of lubricant to be used. A listing of names, addresses, and phone numbers of the service organizations for each item of equipment and a typewritten maintenance schedule for same shall be included.
- D. Upon completion of all work and of all tests at a minimum the Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a minimum period of two (2) days of four hours each, or as otherwise specified. Instruct the Owner's representative fully in the operating, adjustment and maintenance of all equipment furnished. Instruction shall be divided into two (2) sessions of four hours each, each at a time directed by
- E. The instructors shall be thoroughly familiar with all parts of the installation on which he is to give instruction and shall be trained in operating theory as well as practical operation and maintenance work. Employ factory trained instructors wherever necessary as determined by the Architect.
- F. During the guarantee period, the Contractor shall service all major equipment items provided under this contract, including Domestic water heaters, domestic booster pumps, medical air compressors, vacuum pumps, etc. which require outside service agencies. Service shall not include filter replacement, lubrication of motors and bearings or continuation of water and special system chemical treatment after formal acceptance of the systems by the Architect. Prior to the start of guarantee period, the Contractor shall provide the Architect with a schedule of required maintenance operations for each item of equipment. Submit schedule to the Architect for approval. Thereafter, monthly reports shall be submitted to the Owner for describing actual service provided. Forty-eight (48) hours advance notice shall be given to Owner prior to work required under this Section.

1.14 ELECTRICAL WORK:

- A. Under Division 22 Plumbing, provide the following items of electrical work which shall conform with the applicable requirements of the Electrical Division:
  - 1. Control wiring.
  - 2. Interlock wiring for plumbing equipment.
- B. Under Division 26, 27 or 28, provide:
  - 1. Power wiring complete from source to motor or equipment junction box, including power wiring through motor starters.
  - 2. All miscellaneous individual motor starters, local wall mounted control devices, unless noted or specified otherwise.
  - 3. All fire alarm interface wiring including smoke detectors located in mechanical systems.

1.15 EQUIPMENT STARTUP AND INITIAL OPERATION

- A. No equipment shall be operated for testing or trial use except after full compliance with the equipment manufacturers' specifications and instructions of the lubrication, alignment direction of rotation, balance, and other applicable considerations.
- B. Particular care shall be taken to see that all equipment is completely assembled and properly lubricated, and all grease and oil cases and reservoirs have been filled to the correct level with the recommended lubricant.
- C. It is the Contractor's responsibility to place each item of equipment installed by him in operating condition, including all auxiliaries, piping, wiring, etc., and to start up each unit and check it for performance.

1.16 FIRE PROTECTION:

- A. As minimum, one five-pound CO2 extinguisher shall be provided with each work crew at all times when working within the building.

1.17 SCHEDULE OF WORK:

- A. Refer to project schedule. Specific phasing requirements are to be incorporated in to the project schedule, contractor shall coordinate all work included in this division. This includes minimizing outages of plumbing systems throughout the duration of construction. Coordinate any utility outage with the facility in advance.

1.18 SERVICE AGENCIES:

- A. All plumbing equipment suppliers shall have an established authorized service agency located within the Wilmington Metropolitan area. Within 30 days after award of the Contract, the Contractor shall submit to the Architect for approval a list of manufacturers' material and equipment names, including their respective service agency, he proposes to use. In the event any service agency in the list fails to comply with the specification requirement, such service agency will be rejected.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be new, the best of their respective kinds, suitable for the conditions and duties imposed on them at the building and shall be of reputable manufacturers'. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the sections following.
- B. Refer to Division 01 for General Requirements.
- C. All component parts of each item of equipment or device shall bear the manufacturers' name plate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc, in order to facilitate the maintenance or replacement. The name plate of a subcontractor or distributor will not be acceptable. All equipment requiring electrical service shall be U.L. labeled, or if a U.L. label is not available from the manufacturer, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Owner. Submit data indicating compliance with standards prior to installation.
- D. In specifying materials, four general procedures are used. The four classifications are as follows:
1. GROUP 1: When the material or equipment is specified by name of the identifying information and one name brand only is used, it is considered that the use of that particular item is essential to the project, and the Contractor shall base his proposal on the uses of that item.
  2. GROUP 2: When a material or equipment is specified by brand name and other identifying information and two or more brand names are named, it is considered that any one of the brands so named will be performed as desired, and the Contractor shall base his proposal on one of the named brands.
  3. GROUP 3: When the material or equipment is specified with the phrase "...or equal..." after a brand name and other identifying information, it is intended that the brand name is used for the purpose of establishing a minimum acceptable standard of quality and performance and Contractor may base his bid proposal on any item which is in all respects equal to that specified and presents essentially the same appearance, size, operation and performance. The Contractor shall be responsible for coordination of the equal product.
  4. GROUP 4: When material is specified as complying with the requirements of published "Standard Specification" of trade associations, American Society for Testing and Material, government specifications, etc., the Contractor shall base his proposal on any item which can be shown to comply in all respects to the referred to "Standard Specification".
- E. All substitutions shall be submitted in accordance with Section 012500 Substitution Procedures. It is distinctly understood: (1) that the Architect will use his own judgment in determining whether or not any materials, equipment or methods offered in substitution are equal to those specified and will fit within the space available; (2) that the decision of the Architect on all such questions of equality is final; and (3) that all substitutions will be made at no increases in cost to the Owner.
- F. Upon receipt of written approval from Architect, Contractor may proceed with substitution providing the Contractor assumes full responsibility for and makes, at his expense, any change or adjustment in construction or connection with any work that may be required by the substitution of such materials, equipment or methods. In the event of any adverse decisions by the Architect, no claim of any sort shall be made or allowed against the Owner.

## 2.2 PIPING SUPPORTS, GENERALLY

- A. Piping shall be run parallel with the lines of the building unless otherwise shown or noted on drawings. The different service pipes, valves, and fittings shall be so installed that after the covering is applied there will not be less than 1/2-inch clear space between the finished covering of parallel adjacent pipes. Hangers on different service lines running parallel with each other and nearly together shall be in line with each other and parallel to the lines of the building. Exact location of electric outlets, piping, ducts,

and conduits shall be coordinated among the trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.

- B. In general, hangers shall be spaced so as to prevent sag and permit proper drainage and shall not be spaced more than 10 feet apart unless otherwise indicated herein, Section 220050, or on the drawings. Hangers shall be placed within one foot of each horizontal elbow.
- C. Vertical runs of pipe and conduit not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs. Vertical runs of pipe and conduit over 15 feet long but not over 60 feet long and not over 6 inches in size shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and conduits and shall rest securely on the building structure without blocking.
- D. Hangers shall be of manufacturers hereinafter specified in Section 220050. Unless otherwise specified, pipe and conduit hangers and hanger supports shall conform with the following Anvil International figures:
1. Hangers generally shall be Fig. 69, 104, 212, 260 and 300.
  2. Hangers Figs. 295 and 212 shall be provided with turnbuckles and eye rods or rods with eye nuts.
  3. Turnbuckles shall be Fig. 230 and 114, shall have not less than 1-1/2 inch adjustment, and shall be provided with lockouts.
  4. Clamps shall be Fig. 261 or CT-121.
  5. Wherever the movement of pipe due to expansion exceeds 3/4 inch per foot of hanger rod length, hangers shall be Figs. 171, 174 and 181.
  6. Roller supports shall be adjustable.
  7. Concrete inserts shall be Fig. 282 or 281.
- E. On copper pipes, hangers in contact with pipe shall be copper plated.
- F. In lieu of individual hangers, multiple (trapeze) hangers may be used for water pipes having same elevation and slope and for electrical conduits as specified hereinafter:
1. Horizontal members shall consist of 1-1/2 inch by 1-1/2 inch No. 12 gauge, cold formed electro-galvanized dipped channels designed to accept special springheld hardened steel nuts for securing hanger rods and other attachments. Provide metal framing system with applicable fasteners, brackets, fittings, clamps, etc. Two or more such channels may be welded together forming horizontal members of greater strength than single channels. Members shall be Kindorf Series B-995, Unistrut, or approved equal.
  2. Each multiple hanger shall be designed to support a load equal to the sum of the weights of the pipes and liquid, the weight of the hanger rods shall be such that the stress at the root of the thread will not be over 10,000 psi at design load, except that no rod shall be smaller than 3/8 inch. The size of the horizontal members shall be such that the maximum stress will not be over 15,000 psi at design load.
  3. Horizontal runs of piping along walls, 4 inch and smaller, exposed or concealed, shall be secured to metal framing system as specified herein. Provide appropriate clamps, brackets and similar attachments to secure piping to vertical members in accordance with applicable sections of the specification.
  4. On copper pipes in contact with horizontal member, provide rubber strip (Vibra Strip or equal) between hanger attachment and copper pipe.
- G. Hanger attachments shall be suitable for each type of hanger and shall be compatible with the building material to which it is secured. Under no circumstances shall pipe support be secured to any other mechanical, electrical or fire protection equipment. Support shall be suspended from building structure only. The type of attachments which shall be used for the various types of building construction encountered are as follows:

1. Steel beams - Fig. 226, or 66 attachments.
  2. Bar joists - Fig. 225, or 60.
  3. Brick or block walls - Fig. 194, 195, 199 or 202 fastened as follows: For light duty, self-drilling anchors in brick and toggle bolts in block; for heavy duty, through bolts with backing plates.
  4. Concrete (Existing) - Phillips "Redhead" or Rawl self-drilling anchors or expansion bolts.
  5. Concrete (New) - Inserts, Fig. 281 or 282. Power driver fasteners may be used for light loading as hereinafter specified.
- H. Welded attachments for securing hangers to piping or to structural steel may be provided in lieu of other attachments specified if prior approval is obtained in the field from the Architect. Welded attachments shall be designed so that the fiber stress at any point in the weld or attachment will not exceed the fiber stress in the hanger rod. Generally, welding shall not be permitted in finished spaces.
- I. On insulated piping at hangers, provide calcium silicate inserts and shields, or piping saddles at each point of support, see Section 220050 and Section 220700.
- J. In no case shall wire or perforated strap be used for pipe or conduit support.
- K. Secure all hangers for piping and ductwork to joist and beams. In no case shall supports be secured to underside of metal or wood deck unless otherwise directed in the field by the Architect. Contractor shall submit details of method of attachments for approval to the Architect.
- L. Refer to Section 220050 for vibration hanger requirements. Refer to Section 230548 for Seismic hanger and support requirements.
- M. Hangers and materials within MRI shielding shall be made of non-ferrous material and shall be dielectrically isolated from any supports outside of the shielding in accordance with the shielding vendor details.
- N. Rooftop supports for mechanical piping and equipment shall be constructed of heavy gauge galvanized steel with counter flashing, mitered and welded corner seams, integral base plate and 2x4 pressure treated wood nailer. Supports shall be model es-1, es-2, or es-5 as applicable, manufactured by the PATE Company or approved equal.
- O. Pipe curb assemblies shall have heavy gauge galvanized steel curb, cap of acrylic clad abs thermoplastic graduated step PVC boots, adjustable stainless-steel clamps and cap fastening screws. Pipe curb shall be model PCA 1, 2, 5 as applicable, manufactured by the Pate Company or approved equal. Contactor shall coordinate exact number and size of openings for piping and conduit penetrations of cap.
- P. Roof curbs shall be box section design heavy gauge galvanized steel, mitered and welded corner seams, integral base plate, pressure treated wood nailer, insulated with 1 ½" thick rigid fiberglass board insulation. Curbs shall be model pc-1, pc-2, or pc-5, as applicable, manufactured by the Pate Company or approved equal].
- 2.3 SLEEVES AND PLATES
- A. Pipe sleeves through concrete and masonry construction shall be Schedule 40 galvanized steel pipes unless otherwise indicated on the drawings. Openings that cannot be sleeved before slab or wall is poured shall be core drilled. Pipe sleeves through drywall and similar construction shall be sized to pass both pipe and insulation, and where permitted by code, may be Schedule 40 PVC.
- B. Sleeves in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant. Caulk the annular space of pipe sleeves with an elastic caulk compound to make installation air and watertight.



- C. Escutcheon plates shall be provided for all exposed pipes and conduits passing through walls, floors, and ceilings in finished areas. Plates shall be chrome plated brass of the split ring type, of size to match the pipe or insulation where installed. Where plates are provided for pipes passing through sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.
- D. At all sleeves where noise can be transmitted (Mechanical and Electrical Rooms), smoke barriers, walls above ceiling to underside of the structure of floor above, or at fire rated separations, seal openings between pipes and ducts and corresponding sleeve to prevent sound transmissions and maintain fire rating. Utilize U.L. approved resilient sealant for penetration seals. Submit method of sealing for approval.
- E. Where watertight sleeves are indicated or required to suit the installation, provide Link Seal rubber seals, as manufactured by Thunderline Corporation, between pipes and sleeves

## 2.4 MOTORS

- A. Provide motors of a size adequate to drive the equipment but in no case less than the size shown or specified. If a motor larger than that specified is required, the Contractor shall bear the expense of changes in foundations, support, wire and conduit connections, circuit protective devices, variable frequency drives, or other affected elements of the system. Each motor shall have sufficient capacity to start and operate the machine it drives without exceeding the motor nameplate rating at the speed specified or at the load which may be obtained by the drive actually provided. Motors shall be rated for continuous duty at 115 percent of rated capacity; base temperature rise on an ambient temperature of 40°C.
- B. Motors for use with variable frequency controllers shall be “Inverter Ready”, suitable for variable speed / variable torque applications, designed to withstand a rise time of 0.10 microseconds and a peak voltage of 1600 per NEMA MG1 Section 31.40.4.2.
- C. Motors 1/2 hp and larger shall be 3 phase, Class B, general purpose, squirrel cage, open type, high efficiency, induction motors. The rated nominal full load efficiency shall be in accordance with the following schedule when tested in accordance with NEMA test standards when wound for 208 or 480 volts, 60 Hertz, alternating current. Motors smaller than 1/2 hp shall be single phase, open capacitor type in accordance with NEMA standards wound for 115 volts, 60 Hertz, alternating current. Motors 1/6 hp and under may be split phase type.
- D. Motor efficiencies shall comply with the United States Energy and Independence and Security Act (EISA) of 2007 and the latest revision of NEMA Standard MG1 Table 12-2.
- E. Unless otherwise indicated each motor (5 HP or larger) or motor driven equipment (5 HP or larger) shall have a composite power factor (PF) rating of a minimum of 90% when the motor is operating at the design duty defined on the drawings. Power factor correction devices shall be provided to meet the stated criteria.
- F. Devices (such as: capacitors) or equipment (such as: solid state power factor controllers) when required for power factor correction shall be provided with the motors or item or motor driven equipment. The device shall be mounted and wired to the motor by the project electrical contractor.
- G. For a motor or motor driven equipment requiring other than across-the-line starting PF correcting capacitors (or other equipment) shall be connected to motor terminals via a contactor (controller) with a 120 VAC coil. The 120 VAC coil shall be energized via an auxiliary contact on the contactor (controller) used to establish the "run" operating mode for the motor or motor driven equipment.
- H. All motors for use with variable frequency controllers shall include a maintenance free, circumferential, conductive micro fiber bearing protection ring to discharge shaft currents to ground. Bearing protection

rings shall be Aegis, model SGR, or approved equal. Bearing protection shall be installed and tested in accordance with the manufacturer's recommendations.

## 2.5 DRIP PANS

- A. Do not route piping in the dedicated space above electrical equipment. Where sanitary, water, or storm piping is routed above equipment sensitive to moisture, provide drip pans under mechanical piping, sufficient to protect equipment from leakage. Locate pan immediately below piping, and extend a minimum of 6" on each side of piping and lengthwise 12" beyond equipment protected. Fabricate pans 2" deep of reinforced metal with rolled edges and soldered or welded seams; 16 gauge steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged, to nearest floor drain, service sink, or as directed in the field.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP:

- A. Each subcontractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work.
- B. The quality of workmanship required for each trade in the execution of its work shall be the finest and highest obtainable in that trade working with the materials specified. Workmanship shall be satisfactory to the Architect and his decision as to acceptable quality if final.

### 3.2 EQUIPMENT CONNECTIONS

- A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

### 3.3 COMMISSIONING RESPONSIBILITIES

- A. The Contractor, and all the sub-contractors and suppliers within Division 22, shall cooperate with the commissioning agency (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.
- B. The contractor shall assign a representative to the commissioning team, and submit the person's name to the commissioning agency, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of plumbing commissioning. The representative shall ensure communications between Division 22 contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to proceed on schedule.
- C. The Contractor, and all sub-contractors and suppliers, shall cooperate with the Commissioning Agency in carrying out the plumbing commissioning process. In this context, the Contractor shall:
  - 1. Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.
  - 2. Ensure the automatic temperature controls (ATC) contractor performs plumbing commissioning responsibilities as listed in 230900.
  - 3. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

4. Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.
5. Ensure cooperation and participation of specialty sub-contractors.
6. Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.
7. Attend commissioning meetings scheduled by the CA.
8. Notify the CA a minimum of two weeks in advance of scheduled equipment and system start-ups, so that the CA may witness system verifications, and equipment and system startups.
9. Provide sufficient personnel to assist the CA as required during system verification and functional performance testing.
10. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the commissioning plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe startup.
11. Notify the CA a minimum of two weeks in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
12. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before re-scheduling a new startup. Those responsible for deficient or incomplete work will be responsible for the costs associated with rescheduling.
13. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the CA to witness formal functional performance tests (FPTs).
14. Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning agency. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs associated with rescheduling. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the ATC contractor and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.
15. Prepare preliminary schedule for plumbing system orientation and inspections, O&M manual submission, training sessions, pipe system testing, flushing and cleaning, equipment startup, TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.
16. Attend initial O&M staff training session.
17. Conduct plumbing system orientation and inspection at the equipment placement completion stage.
18. Update drawings to as-built condition and review with the CA.
19. Prepare O&M manuals as specified herein.
20. Participate in the O&M staff training sessions with vendors and contractors.
21. Provide written notification to the general contractor or construction manager and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.
  - a. Plumbing equipment including all domestic water heaters, medical air compressors, fixtures, vacuum pumps, etc.
  - b. Pumping systems.
  - c. Fire stopping in the fire rated construction, caulking, gasketing and sealing of smoke barriers.
  - d. Seismic restraints installation to specification; a certification from the seismic restraint engineer meets this requirement.
  - e. That the building control system is functioning to control plumbing equipment as specified.
22. Provide a complete set of as-built drawings and O&M manuals to the CA for review.

23. Integrate installation and programming scheduling with construction and commissioning schedules.
24. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
25. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.
26. In conjunction with the contractor, demonstrate system performance to the CA including all modes of system operation (e.g., emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for rescheduling costs.
27. Provide control system technician to assist during system verification and functional performance testing.
28. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.

#### 3.4 WATERPROOFING

- A. Under no circumstances shall waterproofing be damaged or penetrated. Should conditions arise which indicate such necessity, notify the Architect.

#### 3.5 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed in a neat and workmanlike manner. Existing surfaces which are damaged by the Contractor shall be repaired or provided with new materials and methods similar to existing adjacent work, subject to approval of the Architect. Structural members shall not be cut or penetrated unless otherwise indicated on the drawings. Verify in the field with the Architect. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary non-percussive methods. Existing masonry block walls shall be patched with new masonry or gypsum board attached and sealed to both block faces.

#### 3.6 SURVEYS AND MEASUREMENTS

- A. Base all measurements (both horizontal and vertical) from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check correctness of same as related to the work. Verify locations of existing utilities and inverts of same prior to the start of any systems shown connecting to utilities.
- B. Should the Contractor discover any discrepancy between actual measurements or conditions and those indicated which prevent following good practice or the intent of the drawings and specifications, he shall notify the Architect and shall not proceed with his work until he has received instruction from the Architect.

#### 3.7 WELDING

- A. Welding shall conform to current standards and recommendations of the National Certified Pipe Welding Bureau, with all North Carolina Occupational Safety and Health Acts, State, County and City Fire Prevention Code Requirements, Fire and Safety Regulations, and NFPA Standard 241 including provision of appropriate portable fire extinguisher.
- B. Before assigning any welders to work covered by this specification, the Contractor shall provide the Architect with the names of pipe welders to be employed for the work, together with each welder's

assigned number, letter, or symbol which shall be used to identify the work of that welder and which shall be affixed immediately upon completion of the work, copies of each welder's certified qualification tests prescribed by the National Certified Welding Bureau or by other reputable testing laboratory using procedures covered in the American Society of Mechanical Engineers Building Construction Code, Section IX, "Qualification Standard for Welding and Brazing Procedures Welders, Brazers and Welding and Brazing Operators." Welders must be certified for all positions.

- C. If requested by the Architect, the Contractor shall submit identifying stenciled test coupons made by any operator in question. The Contractor shall require any welder to retake the tests when, in the opinion of the Architect, the work of the welder creates a reasonable doubt as to his proficiency. Tests, when required, shall be conducted at no additional expense to the Owner; and the welder in question shall not be permitted to work as a welder on this project until he has been recertified. Recertification of the welder shall be made to the Architect only after the welder has taken and passed the required test; welder must pass the test without benefit or retests in order to resume work as a welder on the project.
- D. Welding for pressurization piping systems shall conform to American National Standards Institute (ANSI) American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". The Contractor shall be responsible for the quality of welding and shall repair or replace any work not in accordance with these specifications. Contractor shall, without cost to the Owner, check welds by radiograph, ultrasonic testing, sectioning or a combination of these methods wherever there is a question raised by the Architect as to the quality of a weld; examination of the questionable weld shall be in addition to other system tests specified. Welds shall have penetration complete to the inside diameter of the pipe and the recommended spacing and bevels between ends of pipe prior to welding shall be used in all cases to assure full penetration.

### 3.8 HANDLING AND STORAGE OF MATERIALS

- A. Proper and suitable tools, equipment and appliances for the safe and convenient handling and placing of all materials and equipment shall be used. During loading, unloading, and placing, care shall be taken in handling the equipment and materials so that no equipment or materials, including Owner furnished, are damaged.
- B. All plumbing equipment delivered to the job site shall be stored under roof or other approved covering, on pedestals above the ground. All enclosures for equipment shall be weatherproof. Any motors which are not totally enclosed, that are involved in the work, shall be stored in a heated area with a minimum temperature of 50 degrees Fahrenheit. All valves shall be stored under roof on wood pedestals above ground. All insulation shall be stored under roof or in trailers, adequately protected from the weather. The Contractor shall follow all written instructions and recommendations of the manufacturer and all requirements of the Architect in oiling, protection and maintenance of equipment during storage. It shall be the Contractor's complete responsibility for the storage and care of the equipment and materials.
- C. If any materials and/or equipment are found to be in poor condition at the time of being installed, the Architect may, at his discretion, order the Contractor to furnish and install new equipment at no cost to the Owner.

### 3.9 COOPERATION WITH OTHER TRADES

- A. Exact location of fixtures, clear outs, access ports, piping and valves shall be coordinated with all other trades so that there will be no interference between lighting fixtures, piping, ducts, and conduits. Where conflicts between the trades result, they shall be resolved by the Contractor to the Architect's satisfaction and at no expense to the Owner.
- B. Plumbing trades shall give full cooperation to other trades and shall furnish in writing, with copies to Architect all information necessary to permit the work of all trades to be installed satisfactorily and with

the least possible interference or delay. Exact location of all plumbing equipment in finished spaces shall be coordinated with shop drawings and with elevations indicated on the architectural drawings.

### 3.10 CLEANING AND PAINTING

- A. Thoroughly clean all exposed surfaces of equipment and material and leave in a neat, clean condition ready for painting. Restore and touch-up factory finishes which have been damaged during construction. Finished painting will be performed under another Division.
- B. Miscellaneous requirements include:
  - 1. Provide complete new finish if, in the opinion of the Architect, the factory finishes are severely damaged.
  - 2. Touch up threads of zinc coated screwed pipe with Rustoleum primer and one coat of enamel conforming to painting specification.
  - 3. All exposed hangers, steel supports and miscellaneous components, and cast iron pipe hangers shall be field painted with Rustoleum primer and one coat of enamel conforming to painting specification.
  - 4. All steel support and miscellaneous components shall be painted with Rustoleum primer and one coat of enamel conforming to the painting specification.

### 3.11 ACCESSIBILITY:

- A. Locate all equipment which must be serviced, operated or maintained, in fully accessible positions including control valves, balancing valves and isolation valves. Where required and where directed, provide 14 gauge steel access panels, Milcor or equal, to suit material in which installed. Doors installed in fire rated walls or shafts shall be labeled and shall match rating of the construction. Door shall be of sufficient size to allow access to all components, except minimum size shall be 24" x 24".
- B. Equipment deemed inaccessible by the Architect shall be reworked by the Contractor at no expense to the Owner. All doors shall have cylinder locks operable from same key. Submit shop drawings for approval.

### 3.12 EQUIPMENT BASES SUPPORTS

- A. Under this Division provide all equipment supports required for the plumbing work.
- B. Provide structural members and related materials, inertia pads, platforms, and gratings.
- C. All concrete bases, curbs, and supports shall be furnished under this Division unless otherwise indicated.
- D. The Contractor shall furnish all required foundation sizes, bolts, washers, sleeves, plates and templates for equipment.
- E. The size of the foundation bolts shall be as recommended by the manufacturer.
- F. The type and size of the supporting channels and supplementary steel shall be determined by the Contractor and shall be of sufficient strength and size to allow only a minimum, deflection in conformance with manufacturer's requirements for loading. Contractor shall submit details for approval to the Architect.

### 3.13 EXCAVATION AND BACKFILL

- A. Excavation:

1. Trenches shall be excavated to the necessary width and depth as shown on the drawings. The trench subgrade shall be such as to allow the bedding of the utility with a uniform and continuous bearing on solid, undisturbed earth for the full length of each pipe, except for that portion at the bell ends. The subgrade shall be graded with sufficient accuracy to assure this minimum. The bottom portion of all trenches from the subgrade to a point two feet (2') above the crown or top of the utility shall be as nearly vertical as practicable and at the minimum width.
2. Trenches in fill areas shall not be excavated until embankment construction has been completed to a point at least two feet (2') above the crown or top of the utility being placed.
3. Any part of the bottom of the trench excavated below the specified subgrade shall be back filled, at the Contractor's expense, with bedding materials as hereinafter specified. Whenever wet, or otherwise unstable, subgrade is encountered below the elevation of the original ground surface which existed prior to the time of construction, such soil shall be removed to the depth and extent directed by the Architect and the trench backfilled to the proper grade with bedding material as hereinafter specified. Reimbursement for extra work performed by the Contractor shall be in accordance with General Conditions. Whenever the Architect requires the removal of wet or otherwise unstable subgrade from the fill material previously placed by the Contractor, the cost of all removal of unstable soil, together with backfilling of the trench as herein specified shall be borne by the Contractor.
4. Excavation for manholes and similar structures shall be of sufficient size to leave a minimum of twelve inches (12") and a maximum of twenty four inches (24") clearance on all sides. Any over-depth excavation shall be filled with concrete as directed and at the expense of the Contractor.
5. Provide shoring and sheet piling necessary for excavation and for the safety of personnel and property as directed. Unless otherwise directed, the sides of all excavations over four feet (4') deep must be braced. All shoring, bracing, sheet piling, etc., must be solidly installed heavy timber suitable for the purpose. No lumber shall be buried when excavations are backfilled, except by authority of the Architect.

B. Backfill:

1. No backfill and/or bedding and backfill shall be placed until the construction adjacent or the utility to be backfilled has been inspected, tested and approved. Notify the Architect when inspections are required.
2. Backfill material shall be earth materials only, free from perceptible amounts of wood, debris, or topsoil and shall not contain marble or other elements which tend to keep it in a plastic state. The material shall be free of frost at the time of placement. Backfill for plastic pipes shall be clean sand, free of foreign materials.
3. Bedding materials, for use where trench subgrade is excavated below specified depth or for use at Contractor's option, shall be crushed stone or gravel, meeting the requirements of a S.R.C. No. 6 aggregate or crusher run S.R.C. CR-6 and shall be free of frost at the time of placing.
4. Work broken or ruptured by improperly placed backfill shall be removed and replaced by the Contractor at no additional cost to the Owner.
5. Following inspection as specified above, approved backfill material shall be deposited in the trench with hand shovels, not be means of wheelbarrows, carts, trucks, bulldozers, or similar equipment, in four inch (4") layers and compacted by mechanical tampers until the pipe has a cover of not less than two feet (2'). The remainder of the backfill material shall then be deposited in the trench in eight inch (8") layers and compacted. Any trenches improperly backfilled shall be reopened, then refilled and compacted to the required grade and smoothed off. Backfill shall be placed and tamped to achieve ninety five percent (95%) (Percent of dry weight) compaction.
6. Field density tests may be required by the Architect in areas where, in his opinion, a question exists with respect to compliance with compaction requirements. These tests will be paid for at standard rates by the Owner, where the test results indicate compliance with the compaction requirements, and by the Contractor where the test results indicate non-compliance with compaction requirements. Density tests shall be performed by the methods specified in A.A.S.H.O. Designation T-147, the Field Determination of Density of Soil-In-Place.

3.14 SLEEVES AND PLATES

- A. Sleeves shall be provided by the trade installing the pipe or duct. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. Provide all cutting and patching necessary to set sleeves which are not placed prior to construction. All cutting and patching necessary to set sleeves which are not placed prior to construction shall be the responsibility of the trade providing the sleeves.
- B. Sleeves shall be provided for all piping and ductwork passing through concrete, masonry, plaster and gypsum wallboard construction. Caulk the annular space of pipe sleeves with an elastic caulking compound to make installation, air, and watertight.
- C. Fasten sleeves securely in the construction so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into space between pipe and sleeve during construction.
- D. Sleeves required in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant.
- E. At all sleeves where objectionable noise can be transmitted, at smoke barriers, at walls above ceilings that extend to underside of the structure of floor above, or at fire rated separations, seal all openings between pipes and corresponding sleeves to prevent sound transmission and to maintain fire rating. Use U.L. approved resilient sealant for penetration seals. Submit method of sealing for approval. Where watertight sleeves are indicated or required to suit the installation, provide Link Seal rubber seals as manufactured by Thunderline Corporation, between pipe and sleeves.
- F. Where pipe motion due to expansion and contraction will occur, provide sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe and the insulation. Check construction to determine proper length for various locations; make actual lengths to suit the following:
  - 1. Terminate sleeves flush with walls, partitions and ceilings.
  - 2. Terminate sleeves 2 inches above finished floor in equipment rooms, kitchen and wet floor areas.
  - 3. In all other areas, terminate sleeves 1/2 inch above finished floor unless otherwise noted on the drawings or directed in the field.

### 3.15 ALTERATIONS AND DEMOLITION

- A. All existing piping, equipment and materials which are required to be removed shall be removed. All existing materials and equipment which are removed and are desired by the Owner, or are indicated to remain as the property of the Owner, shall be delivered to him on the premises by the Contractor where directed by the Architect. All other materials and equipment which are removed shall become the property of the Contractor and shall be promptly removed by him from the premises.
- B. Remove all indicated mechanical work by hand as far as possible. Power-driven equipment shall be used as a last resort, and shall not be employed without consent of the Owner. Schedule all demolition work to the satisfaction of the Owner. The Contractor shall execute the removal work as quietly as practicable to avoid unnecessary disturbances to occupied areas.
- C. Existing conditions, i.e. ductwork, piping, equipment, etc, may be obtained from available record drawings and are not warranted to be complete or correct. Contractor shall verify exact location of all ductwork, piping, etc, in the field prior to starting any work.
- D. Existing pipe sizes noted on the available record drawings are for the convenience of the Contractor only. Contractor shall verify sizes in the field.



- E. Existing piping no longer required to remain in service shall be disconnected and removed back to service mains, including existing piping hangers and supports. Existing pipe indicated or required to remain in service shall be capped.
- F. Existing piping that remains concealed, buried, or otherwise contained in or below the remaining slabs and walls shall be capped, plugged, or otherwise sealed. All pipes shall be cut so that their capped or plugged ends will be far enough behind finished surfaces to allow for the installation of the normal thickness of finished material.
- G. When existing plumbing work is removed, all related pipes, valves, and materials shall also be removed.
- H. When the work specified herein connects to existing piping, the Contractor shall perform all necessary alterations, cutting, or fitting of the existing work as may be necessary or required to make satisfactory connections between the new and existing work and to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect.
- I. When the work specified herein or under other divisions of the contract necessitates relocation of existing plumbing equipment, or piping, the Contractor shall perform all work and make all necessary changes to existing work as may be required to leave the completed work in a finished and workmanlike condition, to the entire satisfaction of the Architect, and at no additional cost to the Owner.
- J. Existing mechanical equipment, piping and ductwork affected by removal or new work installation and required to remain in service shall be reinstalled or supported as required in accordance with new work specification. All work shall be completed to the Architect's satisfaction and at no additional cost to the Owner.
- K. Valve off or disconnect live services as required for removal work.
- L. Refer to drawings for additional requirements.

### 3.16 FLASHING

- A. Openings for pipes through waterproofed floors and roof areas shall be flashed. Vent pipes shall be flashed with 4 lb. sheet lead 24 inches square. Flashing shall be extended up around vents, which shall terminate not less than 12 inches above roof, and shall be fastened under vent caps.
- B. Refer to Architectural drawings and specification for additional roof flashing requirements.

### 3.17 COORDINATED DRAWINGS

- A. Prior to installation of plumbing work in all areas of the building including exposed areas (spaces without ceilings); the Contractor shall prepare completely coordinated layout drawings, utilizing 3-dimensional software, indicating the coordinated work of all trades involved. The drawings shall be a sheet size similar to the contract drawings. All work shall be to scale minimum  $\frac{1}{4}'' = 1' - 0''$ . The drawings shall include all work shown on the drawings, including equipment (chillers, boilers, air handling units, pumps, water heaters, storage tanks, etc.), variable frequency controllers, ATC control panels, terminal units, ductwork, air devices, dampers, piping including sprinkler and plumbing, valves, light fixtures, cable trays, raceways and conduits 2" and larger.
- B. All trades shall be responsible for the preparation of the coordinated layout drawings. Each trade shall provide written certification that the coordinated drawings have accurately incorporated their work and that all conflicts are resolved or a solution is proposed on the drawings. The Contractor shall schedule the trades accordingly and shall provide final certification that all coordination has been completed.

- C. No work shall be installed prior to the Architect's approval of the drawings. The Contractor shall submit for approval of the Architect within 15 days after the award of the contract a schedule of proposed building areas to be grouped for coordination. Upon approval of the schedule, work may commence in areas of the building upon approval of that area's coordinated drawings prior to approval of another area.

3.18 CLOSE OUT PROCEDURES

- A. Refer to Section 017700 close out procedures for specific requirements.

END OF SECTION 220010

## SECTION 220050 - PLUMBING BASIC MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. This section includes requirements for plumbing equipment, materials and procedures which are common to more than one section of Division 22 and which are general in nature and use. This section applies to all sections of Division 22.
- B. The requirements of Section 220010, Plumbing General Provisions, shall apply to all work specified under this section.

#### 1.3 LEAD CONTENT

- A. All plumbing products, materials of construction, and joining methods used in the installation or repair of plumbing intended to dispense water for human consumption shall be in compliance with the United States Safe Drinking Water Act and shall meet the limit of weighted average lead content as set forth in NSF/ANSI 372. All such products shall also meet the lead leaching requirements of NSF/ANSI 372.

#### 1.4 SUBMITTALS

- A. Submit shop drawings for all items of materials specified in this section in accordance with Section 220010.
- B. At a minimum Manufacturer's product data shall include specifications, installation instructions and general recommendations for each type of material required. Include substantiating that proposed materials comply with specified requirements for each type.

#### 1.5 TESTS AND ADJUSTMENTS

- A. The Contractor shall furnish labor, instruments, equipment, and materials required to perform tests prescribed in the sections describing the various systems.
- B. Replace or repair defects found during inspection or test with new materials. Caulking of welded joints, screwed joints, cracks, or holes is not acceptable. Correct leaks in screwed fittings by remaking joints. In welded systems leaks in joints shall be cutout and re-welded. Repeat tests after defects have been eliminated.
- C. Where reasonable doubt exists as to a system's ability to comply with contract requirements, perform any reasonable test required by the Architect.
- D. Make static pressure tests and prove to the satisfaction of the Architect that the piping is tight before pipes are concealed or insulated. Tests shall be provided as hereinafter specified.
- E. Use test instruments for accuracy by an approved laboratory or by the instrument manufacturer and furnish certificates showing degree of accuracy to the Architect when requested. Make calibration histories for each instrument available for examination.

- F. Where gauges, thermometers and other instruments which are to be left permanently installed are used for tests, do not install until just prior to the tests to avoid possible changes in calibration.

## PART 2 - PRODUCTS

### 2.1 HANGERS

- A. Refer to Section 220010.
- B. Hangers and accessories shall be Anvil International, Fee and Mason, Modern, National, or B-Line of the types specified in Section 220010.
- C. It shall be the responsibility of the Contractor to provide an adequate pipe suspension system in accordance with recognized engineering practices, using standard, commercially accepted pipe hangers and suspension equipment.
- D. The design of all hangers and support shall be in accordance with the provision of the current issue of MSS-SP-58 document developed as a standard by the Manufacturers' Standardization Society.
- E. Hangers for steel pipe, except as noted otherwise shall be spaced at least every ten (10') feet. Hangers for cast iron pipe shall be provided at each joint. Hangers for copper pipe shall be placed at least every eight (8') feet, except pipes 1¼ inch and smaller and shall have hangers at six (6') foot intervals. Polyvinyl chloride pipe (PVC) shall have hangers at four (4) foot intervals.
- F. Where concentrated loads of valves, fittings and similar items occur, or if recommended by the piping manufacturer, closer hanger spacing will be necessary.
- G. Generally, hangers shall be clevis type, standard weight.
- H. Vibration hangers shall be provided as specified.
- I. On insulated piping systems, provide Pipe Shields, Inc., Model CS-CW or approved equal hanger shields at each point of support. Diameter of hanger shield shall match thickness of the insulation. In lieu of, provide wood dowel insert and minimum twenty-gauge protection shield at each point of support. Diameter of insert and shield shall match thickness of the insulation and encompass 50% of insulation surface. On cold systems seal insert vapor tight with appropriate coating.
- J. Diameter of hanger shield shall match thickness of the insulation.
- K. Hangers in direct contact with copper piping systems shall be copper plated.

### 2.2 IDENTIFICATION AND EQUIPMENT TAGS

- A. All control devices, i.e. panels, switches, starters, push button stations, controls etc., shall be clearly identified as to their function and the equipment controlled.
- B. All equipment such as pumps, water heaters, compressors, etc., shall be marked to clearly identify said equipment and space or duty they serve.
- C. Plumbing equipment herein specified shall be identified using engraved laminated black and white phenolic legend plates. Letters shall be minimum, 3/4" high white on surrounding black. Plates shall be mounted by means of sheet metal screws. Submit nameplate list to Architect for approval.

- D. Plumbing equipment, valves, etc., concealed above ceiling shall be identified as to location using clear plastic self-adhesive tape with black lettering, applied to ceiling tile "T" bars. Submit nameplate list to Architect for approval.
- E. Piping shall be identified with colored, pre-rolled, semirigid plastic labels as manufactured by Seton, Marking Services, Inc., or approved equal. Labels shall be Seton "set mark" system and shall be set around pipes with a field installed high strength cement around pipes with a field installed high strength cement compound applied along their longitudinal edge. Labels shall be placed around the piping or insulation every forty feet (40) and with one (1) label on each pipe in rooms smaller than fifteen feet (15). Medical gas and vacuum piping shall be labeled every twenty (20) feet. A label shall be placed at every major valve and at least six feet (6) from exit or entrance to an item of equipment. At Contractor's option, piping concealed above suspended ceilings only, may be identified by stenciling with black paint and taped color bands in accordance with the coding system herein specified. At Contractor's option, where labels are not subject to physical damage, preprinted plastic plastics with contact-type permanent adhesive backing may be provided in lieu of semirigid labels.
  - 1. Labels shall be provided in accordance with the following table with color coding and stencil designations as indicated:

SIZE OF LEGEND LETTERS

Outside Diameter of Pipe (Inches)	Length of Color Field (Inches)	Size of Letters (Inches)
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

- F. In addition to labeling as specified hereinbefore, all piping exposed within Central Utility Plant, mechanical rooms, and exposed within mechanical and electrical equipment spaces shall have full color coding, painted in a color identifying system type. Paint colors shall conform to the colors as schedule on the plans.
- G. All valves, except as specified below, shall be provided with colored plastic or brass valve tags with stamped-in numbers. Tags shall be secured to valve wheels with metal chain. Stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent, need not be so equipped. Care shall be exercised in selecting valve numbers to be prepared on tracing linen showing locations, details of arrangements, etc., of all service and control valves indicating identity and function. One black line print of each drawing shall be mounted under glass where directed. Valve tags shall be Seton or approved equal minimum 1-1/2" round tags with white characters describing system and valve designation. Submit valve number list for approval.

2.3 PIPE, FITTINGS, AND JOINTS

A. General

- 1. Piping materials shall conform to state and local code requirements. Pressurized piping systems shall conform to American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) B31.9, "Code for Pressure Piping, Building Services Piping". High-pressure piping shall conform to ANSI/ASME Section I, B31.1, "Code for Pressure Piping, Power Piping".
- 2. Quality and weight of materials shall comply with requirements of applicable American Society of Testing Materials (ASTM), ANSI, ASME, and Cast Iron Soil Pipe Institute (CISPI) standards. ASTM number and wall thickness shall be indicated on each pipe length

3. Provide pipe and fittings for systems as hereinafter specified. All references to codes shall apply to the latest year. Grooved products may be as manufactured by Victaulic or Grinnell. All piping and fittings shall be made in America.

B. Pipe Materials

1. Sanitary Drainage

- a. Underground sanitary piping serving fixtures in the Sterile Processing Department, Kitchen, Central Utility Plant, and any other areas subject to discharge greater than 140°F.

- 1) Cast Iron Soil Pipe

- a) All sizes - extra-heavy weight ASTM A74-98, fittings shall be cast iron extra-heavy weight ASTM A74-98 fitting joints shall be neoprene compression gaskets. Tyler Pipe Industries, Ty-Seal Or Multiple Seal, polyvinyl chloride gaskets manufactured in accordance with ASTM C 564.

- b. Underground sanitary piping serving all other areas:

- 1) Polyvinyl Chloride Pipe

- a) All sizes - Polyvinyl chloride pipe (PVC) DWV, Schedule 80 with PVC Schedule 80 DWV socket fittings, joints made with PVC solvent cement with primer.

- c. Above ground, within the building

- 1) No-hub Cast Iron Soil Pipe

- a) All sizes - service weight, ASTM A888-98 fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, four band, Anaco-Husky series 2000 meeting ASTM C 1540, C564, and CISPI 310.

- d. Sanitary piping from lab sinks (including sanitary piping from supply and waste box) to mains or risers shall be Enfield or Charlotte Chemdrain.

2. Sanitary Piping Above Operating Rooms, Procedure Rooms, Endoscopy Rooms, Catheterization labs, Clean Pharmacies, and Food Preparation areas:

- a. Copper drainage tubing

- 1) All sizes - DWV, ASTM B306, fittings shall be wrought copper and bronze drainage fittings ANSI B16.29 with soldered joints: Taramet Sterling “lead free” solder or equivalent.

3. Vent Piping:

- a. No-hub cast iron soil pipe

- a) All sizes - service weight, fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Anaco-Husky series 2000 meeting ASTM C 1540, C564, and CISPI 310.
4. Storm Water Drainage
- a. Underground
    - 1) Polyvinyl Chloride Pipe
      - a) All sizes - Polyvinyl chloride pipe (PVC) DWV, Schedule 80 with PVC Schedule 80 DWV socket fittings, joints made with PVC solvent cement with primer.
  - b. Above ground, within the building
    - 1) No-hub cast iron soil-pipe
      - a) All sizes - service weight, fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Anaco-Husky series 2000 meeting ASTM C 1540, C564, and CISPI 310.
5. Foundation Drains
- a. Foundation drainage piping shall be slotted corrugated polyethylene (PE) tubing according to ASTM F-405 with maximum 1/8" slot width for at least the lower 120 degree sector with similar fittings.
  - b. Geotextile requirements are as follows:

Grab strength lbs. (ASTM D4632)	120 lbs. (min.)
Elongation (%) (ASTM 4833)	N/A
Puncture Strength (ASTM 3786)	60 lbs. (min.)
Burst Strength (ASTM 3786)	225 PSI (min.)
Trapezoidal tear (ASTM D-5741)	50 lbs. (min.)
Apparent opening size	<#70 US Standard Sieve Minimum
Permittivity (ASTM D4491)	1.01/sec. (min.)
Ultraviolet degradation at 150 hrs (ASTM D4355)	70% strength retained
6. Air Conditioning Condensate and Equipment Drainage:
- a. Copper drainage tubing

- 1) All sizes - DWV, ASTM B306 with wrought copper and bronze drainage fittings, ANSI B16-29 with soldered joints: Taramet Sterling “lead free” solder or equivalent.
7. Domestic Cold Water:
- a. Domestic cold water above ground, 2-1/2” and larger
    - 1) Seamless copper water tube
      - a) All sizes - ASTM B88, Type L hard tempered with wrought copper solder joint fittings, rated for 150 lbs. (water) ANSI B16.22.
      - b) Alternate Fitting - Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path).
    - 2) Stainless steel pipe
      - a) ASTM A312, ANSI schedule 10S, fittings shall be grooved end stainless steel conforming to ASTM A403 or factory-manufactured from ASTM A312 stainless steel pipe. Adjoining couplings include two blue-enamel ductile iron housing segments, center-leg Fluoroelastomer gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth, and ASTM A449 compliant bolts and nuts. Victaulic Style 807N (rigid) and Style 877 (flexible).
      - b) UL classified in accordance with NSF-61 for potable water service. The system shall meet the low-lead requirements of NSF-372.
  - b. Domestic cold water above ground, 2" and smaller
    - 1) Seamless copper water tube
      - a) All sizes - ASTM B88, Type L hard tempered with wrought copper solder joint fittings, rated for 150 lbs. (water) ANSI B16.22 with soldered joints Taramet Sterling “lead free” solder or equivalent.
      - b) Alternate fitting - Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path).
    - 2) Stainless steel pipe
      - a) All sizes - Vic-Press 304™ Type 304/304L stainless steel, Schedule 10S ASTM A312 with precision cold drawn stainless steel fittings with EPDM O rings, rated to 500 psig maximum (water). O rings shall be UL classified in accordance with ANSI/NSF61 for potable water service.



8. Domestic Hot Water and Hot Water Recirculation:
  - a. Seamless copper water tube
    - 1) All sizes - ASTM B88, Type L hard tempered with wrought copper solder joint fittings, 150 lbs. (water) ANSI B16.22 with soldered joints: Taramet Sterling “lead free” solder or equivalent. Galvanized steel pipe is not permitted.
      - a) Alternate fitting - Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path).
  - b. Stainless steel pipe
    - 1) 2” and smaller - Vic-Press 304™ Type 304/304L stainless steel, Schedule 10S ASTM A312 with precision cold drawn stainless steel fittings with EPDM O rings, rated to 500 psig maximum (water). O rings shall be UL classified in accordance with ANSI/NSF61 for potable water service.
    - 2) 2-1/2” and larger - ASTM A312, ANSI schedule 10S, fittings shall be grooved end stainless steel conforming to ASTM A403 or factory-manufactured from ASTM A312 stainless steel pipe. Adjoining couplings include two blue-enamel ductile iron housing segments, center-leg Fluoroelastomer gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth, and ASTM A449 compliant bolts and nuts. Victaulic Style 807N (rigid) and Style 877 (flexible).
      - a) UL classified in accordance with NSF-61 for potable water service. The system shall meet the low-lead requirements of NSF-372.
9. Deionized/Reverse Osmosis Water
  - a. Copolymer polypropylene resin
    - 1) All sizes - materials in accordance with FDA, USDA, 3A, and USP XX Class VI Sanitary Standards. Pipe and fittings shall conform to the requirements of ASTM D 2837-85. All pipe, fittings, and valve joints shall be prepared using PP true union sanitary clamps and sealed by the use of silicon gaskets.
    - 2) Pipe, fittings, valves, gaskets, true union clamps, and flange forming equipment shall be provided by the same manufacturer.
10. Compressed Air:
  - a. Seamless copper water tube
    - 1) All sizes - ASTM B88, Type L, hard tempered with wrought copper solder joint fittings 200 lbs., ANSI B16.22. Joints soldered with ASTM B32 tin-antimony 95-5 or Taramet Sterling “lead free” solder or equivalent.
11. Medical Gas and Vacuum Piping:
  - a. Seamless copper tube

- 1) All sizes – ASTM B819 Type L copper tubing. All solder joint fitting used for connecting copper tubing shall be wrought copper. All copper-to-copper joints shall be made using a copper-phosphorous brazing filler alloy (BCup Series) without flux. Dissimilar metals such as copper and brass shall be joined using an appropriate flux with either a copper-phosphorous (BCup Series) or a silver (BAg Series) brazing filler alloy. Tubing shall be joined by brazing or silver soldering, without flux, by a compound having a melting point exceeding 1,050oF. A low flow (0.5 scfm) nitrogen purge should be continuously conducted through the tubing during brazing to prevent the formation of copper oxide scale on inner walls.

## 2.4 VALVES

### A. General

1. Valve shall include an integral means to lock valve open or closed.
2. Valves shall be provided where indicated on drawings and as herein specified.
3. Valves shall be placed in such a manner as to be easily accessible for handwheel operation and stuffing maintenance.
4. Valves in piping where shown and where listed herein:
  - a. To balance flows in plumbing piping systems.
  - b. To isolate all items of equipment.
  - c. To isolate motorized flow control valves.
  - d. To isolate branch lines and riser at mains.
5. Valve pipe connections shall be screw, solder, welded, flanged, press fit or Victaulic as required to be consistent with other parts of the piping system.
6. Where piping or equipment may subsequently need to be removed, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.
7. Valves over ten feet above standing level and above 4" in size shall have chain wheel with chain extending to within six feet of standing level. All wheel operated valves shall have an indicator to show the position of the disc or plug.
8. Install valves in accessible locations and adjust for smooth and easy operation.
9. Valves for equipment and controls shall be installed full size of pipe before reducing size to make connection.
10. Where there is no interference, shut-off valves shall be installed with handwheel down on horizontal runs of pipe to prevent accumulation of foreign matter in packer between seats at closing end of wedge.

### B. Balancing Valves

1. Provide balancing valves where indicated and required to balance water flow through the piping system. For pipe sizes 2 1/2" and larger provide separate balancing valve and flow meter fitting.
2. Balancing valve for system piping shall be DeZurik, Homestead or approved equal eccentric plug valve as follows: flanged 2-1/2" and larger, with Fluorinated Hydrocarbon filler in a PTFE U-ring (packing) and CIIR or EPDM plugs and Chloro-Isobutene Isoprene plug facing suitable for -20 to 250°F continuous operation. Valves shall have lever actuators with adjustable memory stop. For 2" and smaller, provide combination balancing and flow fitting with screwed ends as manufactured by Nexus, Tour & Anderson, or approved equal.

### C. Ball Valves

1. Ball valves shall be used in lieu of gate valves in all domestic water piping systems size 3" and smaller for shut-off service. Ball valves shall be Apollo, Red White Valve Corp, Jomar or approved equal.
2. For valves up to 2½" in size the body and bonnet shall be ASTM B62 bronze. For valves 3" body shall be bronze or brass. Ball shall be Type 316 stainless steel. Stem shall be stainless steel. Seats shall be TFE.
3. Stem shall be blowout proof and externally adjustable to compensate for wear. Valve shall be equipped with vinyl covered lever handle which shall indicate position of ball orifice and shall have stops for fully open and closed position. Construction shall be such that power actuator can be used. Ball opening shall be full pipe size.
4. Valve shall be suitable for flow in either direction and shall be rated 150 psig SWP and 600 psi non-shock WOG.
5. Valve shall be so constructed with two piece cast bronze bodies, full port design, with adjustable stem packing. Valves used for domestic service shall be lead free.
6. Ball valves used for balancing shall have adjustable memory stop. For use in insulated piping systems provide 2" extended handles of non-thermal conductive material.
7. Vic-Press Ball Valves 2" and Smaller:
  - a. Stainless Steel Body: CF8M stainless steel body, ball, and stem, PTFE seats, 304 stainless steel handle, nut, and stem washer, with Schedule 10S stainless steel type 316 Vic-Press™ and/or grooved ends. Rated for services to 400 psi (2750 kPa), Victaulic Series P569.

D. Drain Valves

1. Drain valves shall be ball valves with hose end connections and shall be provided at low points of all piping system and where indicated or required, 3/4" minimum. Provide Nibco Series 585-70-HC or approved equal. Valve shall be rated for 200 lbs.

E. Valve Schedule

1. Unless otherwise specified, valves shall be Grinnell, Stockham, Crane, Jenkins, or Nibco equal to the Nibco figure numbers indicated herein:
2. Domestic Hot and Cold Water Systems:
  - a. Check - Solder end                      S-413

F. Check valves at pump discharge shall be in line spring loaded or swing design with weight or lever and spring. Deionized Water Valves

1. Valves shall be Sani-Tech true union design ball valves, manufactured from unpigmented polypropylene. The valves shall have a stainless steel reinforced them with double o-ring stem seals. The ball shall be true union mounted within the body. The valves shall have factory installed sanitary end connections to match with Sani-Tech pipe and Sani-Flex tubing end connections. Valves shall be supplied with Teflon seats with Viton backups and Viton stem and carrier seals.

## 2.5 PIPE ANCHORS

- A. All pipe lines shall be anchored where specified herein, indicated on drawings and where required to prevent uncontrolled movement. Anchors shall be constructed of steel and plates, assembled by bolting or welding and secured to the building structure by means of clamps or welding. Structural members shall not be cut or drilled. Anchors shall prevent both axial and lateral movement of the lines. Anchor vertical pipes by means of clamps welded to pipe and secured to wall or floor construction. Submit details of anchors to Architect for approval.

- B. Provide thrust restraints in accordance with the cast iron soil institute manual at all horizontal and vertical changes in direction for sanitary and storm drainage systems. Couplings and thrust restraints shall be rated to withstand a minimum of 50 ft. water column head pressure.
- C. Anchor piping adjacent to flexible pipe connectors to prevent connector from expanding against its restraining bolts and also to keep the pipe on both sides of the connector in alignment.

## 2.6 EXPANSION (WATER SYSTEMS)

- A. Where expansion joints are indicated or required, select joints with a traverse of 150 percent of the pipe expansion from the ambient 40 degrees F to the maximum system operating temperature.
- B. All expansion joints shall be suitable for minimum operating pressure and temperature of 150 psi and 300 degrees F, respectively. Expansion joints 2" and larger shall have flanged ends, except when installed in copper pipe systems.
- C. Submit for approval manufacturer's shop drawings of each expansion joint provided depicting length of pipe, location of anchors and guides, calculated expansion offset and type of joint employed.
- D. Expansion joints shall be as herein specified:
  - 1. Flexible Ball Type - Barco Type N of Series 600.
  - 2. Corrugated Type - Flexonics "Low-Corr" joints for pipes 3" and larger. Flexonics Model H or HB for pipes smaller than 3".
  - 3. Slip Type - Flexonics "Slip Pakt" with anchor base.
  - 4. Loop expansion joints
    - a. Provide flexible hose expansion loop(s) as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction or seismic movement of the piping system.
    - b. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal hose, compatible braid, 180 deg return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
    - c. Flexible loops shall be capable of movement in the  $\pm X$ ,  $\pm Y$ , and  $\pm Z$  planes.
    - d. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.
    - e. For flammable liquid or gas service up to 4", flexible expansion loops shall be CSA / AGA certified.
    - f. All flexible hose expansion loops shall be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record shall be used to document the execution of this procedure and shall follow the general "guidelines" of ASME Section IX. Each individual welder shall conform to the in-house procedure qualification record and be qualified prior to each production lot. The testing of each individual welder shall be documented in a welding procedure qualification record.
    - g. Flexible hose expansion loops to be Metraloop as manufactured by The Metraflex Company or approved equal.
    - h. Corrugated Hose shall be stainless steel with 304 stainless steel braid.
    - i. Fittings Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.
    - j. Flexible hose expansion loops shall have a factory supplied, hanger / support lug located at the bottom of the 180 degree return.
    - k. Flexible hose expansion loop(s) shall be furnished with a plugged FPT to be used for a drain or air release vent, and hanger lug at the bottom of the 180 degree return.

## 2.7 PIPE GUIDES

- A. Provide pipe guides where indicated on drawings or where required for proper installation of expansion loop. Limit use of guides with expansion loop to point shown or where required to prevent buckling of pipe whether indicated or not.
- B. Do not use pipe guides as pipe supports.
- C. Provide factory made cast semi-steel or other heavy fabricated steel consisting of bolted two-section outer cylinder and base with a two-section guiding spider welded or bolted tight to the pipe of sufficient size to clear pipe insulation and long enough to prevent over-travel of spider in cylinder. Furnish a guide sleeve of a length not less than the length of pipe expansion plus the spider length.

## 2.8 VIBRATION ISOLATION

- A. General:
  - 1. Plumbing equipment and associated piping shall be mounted on vibration isolators as specified and required to minimize transmission of vibrations and structure-borne noise to building structure or spaces.
  - 2. Select vibration isolating units for the lowest operating speed of equipment so designed that natural frequency of equipment and base mass is not less than 1.5 times the lowest operating frequency of the moving equipment but not a multiple or harmonic of the base frequency. Furnish vibration isolation producing a uniform loading and deflection even when equipment weight is not evenly distributed, and be stable during starting and stopping of equipment without excessive traverse and eccentric movement of equipment.
  - 3. Concrete pads under the isolation units shall be reinforced. Use concrete having a minimum compressive strength of 2500 psi and structural reinforcing bars conforming at ASTM A-615 Grade 60.
  - 4. The installed vibration isolation system for each floor or ceiling mounted item of equipment shall have a maximum lateral motion under equipment start up and shut down conditions of 1/4". Motions in excess shall be restrained by approved spring type mountings.
  - 5. All electrical connections, drain connections, etc., made to equipment which rests on vibration isolators, shall be sufficiently flexible to permit the equipment to be properly isolated.
  - 6. The type of isolation, base, and minimum static deflection shall be as required for each specific equipment application, but no case less than that specified herein when supported on a solid concrete structural slab having a thickness of not less than 4". If vibration isolators with a deflection greater than the minimum specified are required to meet the noise criteria for the adjacent spaces, suitable isolation systems shall be submitted. Should vibration isolators installed for the equipment prove inadequate to prevent transmission of equipment vibrations to the building structure or limit equipment vibration originated noises in the building spaces to acceptable levels, the isolators shall be replaced with units having the largest deflection that can be practicably installed.
  - 7. Spring and combination rail and spring isolation supports where designated in the schedule are indicated for equipment structurally built or supported on a rigid structural steel frame suitable for these types of isolation. Where these types of isolation are not suitable for the equipment construction or operation, the equipment shall be mounted on a structural steel base as herein specified.
  - 8. Equipment affected by wind pressure or with operating weight different from installed weight shall have built-in adjustable vertical stops to prevent rising of equipment when weight is removed. Equipment containing liquid shall have vertical stops.
  - 9. Inertia bases shall consist of a steel reinforced concrete slab cast into a welded structural steel channel frame. Frame shall be fabricated of sufficient strength to prevent distortion of any type during construction, and when the equipment is in operation. Equipment anchor bolts with bottom plates and pipe sleeves shall be preset. One-half inch steel reinforcing bars shall be placed on 6"

center both ways in a layer 1-1/2" above the bottom of the base; bars shall extend inside channel frame flanges not less than 1".

10. Where required due to equipment configuration, the inertia block construction shall change and the concrete thickness shall increase as necessary for the proper mounting of the equipment. The weight of the inertia base shall be equal to or greater than the weight of the equipment supported. Additional weight necessary to reduce vibration or motion caused by the equipment's unbalanced forces to less the 1/32" movement shall be provided when necessary.
11. Concrete sub-bases not less the 4" shall be provided for all floor mounted mechanical equipment under another Division. Sub-bases shall rest on a structural floor and shall be reinforced with steel rods and interconnected with floor. A minimum clearance of 2" shall be provided between sub-bases and all inertia blocks, steel bases, and steel saddles with equipment in operation.
12. Each electric motor shall be mounted on the same foundation as the driven machine. Piping connections including strainers at pumps shall be supported on the same foundation as the pumps.
13. All exterior vibration isolation shall be hot dip galvanized.

B. Vibration Isolation Equipment

1. All isolation equipment shall be Mason Industries, Vibration Eliminator, Amber/Booth, or Korfund equal to the following Mason Industries products:
  - a. Type I Mounting - double deflection neoprene units with .35" minimum static deflection. Mason Type ND units and Type NDR rails.
  - b. Type II Mounting - Stable Springs. Mason Type SLF.
  - c. Type IV Hanger - combination spring and double deflection neoprene element. Mason Type 30N.
  - d. Type V Hanger - similar to Type IV with elevation holding device. Mason Type PC30N.
  - e. Type VII Hose - Flexible pipe connector. Mason Type SFEJ or approved equal, with control rods.
  - f. Type IX Base - structural steel base form for floating concrete base. Provide base of sufficient length to support pipes as indicated. Mason Type K.
  - g. Type XI Hose - Flexible stainless steel hose. Mason Type BSS.
  - h. Type XII Pad - Neoprene cross ribbed or waffle pattern, 5/16" thick. Imprint durometer on material. Provide hot dipped galvanized steel bearing plates where necessary to spread loads. Mason Type W.

C. Application of Isolation Equipment:

Item	Type	Deflection
Pumps – base-mounted (5 hp and larger)	II & IX	0.75"
Pumps – based-mounted (below 5 hp)	I	0.75"
Piping – hangers within 50 ft. of isolated equipment	V	1.50"
Piping – First two hangers near non-isolated equipment	IV	0.75"
Flexible Pump Connectors	VII	---
Air Compressors	II & IX	0.75"
Suction and Discharge connections at	XI	---

vacuum pumps

## 2.9 PRESSURIZED DIAPHRAGM TYPE EXPANSION TANKS

- A. Provide for the domestic water heating systems where indicated on the drawings pressurized diaphragm type expansion tanks as manufactured by Amtrol, Armstrong, B&G, or Taco equal to Taco Series CA or CAX, or as scheduled on plans. Capacities shall be indicated. Submit selection calculations for approval.
- B. Each tank and system shall be air pre-charged to the initial fill pressure of its respective system, suitable for a maximum working pressure of 150 psig and furnished with ASME stamp and certification papers. Tanks shall have replaceable elastomer diaphragm suitable for an operating temperature of 240 degrees F. Provide air charger tank connection.

## 2.10 TEST PLUGS

- A. Pressure and temperature test plugs where indicated or required shall be 1/4" npt fittings, suitable to receive either a 1/8" OD temperature or pressure probe. Fittings shall be solid brass with Nardel valve core, fitted with a color-coded marked cap with gasket. The entire assembly shall be rated at 1000 psig. Provide two (2) pressure gauge adapters and two (2) 5" stem thermometers, 0 to 220 degrees F and 20 to 130 degrees F range. Plugs shall be as manufactured by Peterson Equipment Company, Inc., Richardson, Texas or Sisco plugs.

## PART 3 - EXECUTION

### 3.1 CLEANING

- A. After completion of installation, thoroughly clean dirt, rust, loose scale, oils and grease, and other foreign matter from metal and insulated surfaces, painted or unpainted, specified under Division 22 of the specification.
- B. Clean all systems piping thoroughly of grease, metal shavings, welding beads, or other refuse. Flush piping by use of portable pump or separate water supply to prevent damage to existing or new system pumps. Before cleaning closed systems, all equipment shall be isolated by closing inlet and outlet valves and opening the by-pass valves. The system shall be filled with sufficient detergent and dispersant added to remove all dirt, oil, and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. Bleeding shall continue until water runs clear and all detergent is removed. A sample of the water shall be tested and, if PH exceeds the PH of the make-up water, draining shall be resumed. After flushing, clean strainers of debris, open coils and close by-passes. Remove dirty water filters and install new water filters. Turn over replacement bag filters to Owner. Refill and vent water systems being sure to add water after venting to completely fill system.

### 3.2 PIPING INSTALLATION

- A. Install piping without undue stress or strain in locations shown and run parallel to the lines of the building, except to grade them as specified in a neat and workmanlike manner using a minimum of fittings. Provide such fittings, valves, and accessories as may be required to meet the conditions of the installation. Contractor shall inform himself fully regarding any peculiarities and limitations of space available for installation of material under each section of specifications. Install piping to suit necessities of clearance with ducts, conduits, structure, and other work, and so as not to interfere with any passages or doorways and allow sufficient head room at all places. Use proper reducing fittings for changing piping sizes.
- B. Do not install piping through transformer vaults, elevator equipment rooms or other electrical or electronic equipment spaces. Do not route piping over electrical-distribution panels.

- C. Cut pipes accurately to measurements established in the field in a neat and workmanlike manner without damage or without forcing or springing. Perform cutting by means of an approved type of mechanical cutter of the wheel type where practicable. Ream pipe after cutting to remove all burrs.
- D. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Carefully investigate the architectural, structural, and existing conditions affecting the work, and arrange such work accordingly, providing such fittings, and accessories as may be required to meet such conditions.
- E. Install unions and flanges where shown and on each side of all pieces of equipment and other similar items, and in such a manner that the unions or flanges can be readily disconnected. Do not place any union or flange in a location which will be inaccessible after completion of the project.
- F. Unions in steel pipe 2-1/2" and smaller for water service, shall be 250 lb. malleable iron brass, seat type. Use 150 lb. forged steel flanges for piping 3" and larger. Gaskets shall be 1/8" thick rated for 150 psi service at 250 degrees F. Unions in copper pipe 2" and smaller shall be wrought copper with red bronze ring nut. Use 150 lb. ASME copper flanges for piping 2-1/2" and larger. Flanges and gaskets for use in steam and condensate systems shall be rated for system operating pressures.
- G. Use dielectric unions or couplings at all junctions of copper or brass piping and fittings with ferrous material to prevent electrolysis and galvanic corrosion.
- H. Joints between dissimilar piping material shall be made with appropriate adapters in accordance with the respective manufacturer's printed instruction and recommendations.
- I. Use reducing fittings, eccentric where required to prevent pocketing of air and water or both, to make changes in pipe sizes.
- J. Prefabricated piping installed on prefabricated multi-trade racks may be installed level provided drain points are installed periodically to allow for blow out and draining (1 drain per 50 linear feet). Where piping is individually supported and not part of a multi-trade rack, grade pipe minimum 1" in 40 feet to low points, unless otherwise specified or indicated. Provide drain valves at all low points.
- K. Install wells in domestic heating hot water systems for automatic temperature control sensors. Exact locations and number of wells required shall be determined through coordination with the work required under Section "Automatic Temperature Control."
- L. All piping shall be so installed so that it will in no way be distorted or strained by expansion or contraction. Except as noted, all expansion and contraction shall be taken up by means of swing joints, loops, bends or long offsets. Swing joints made up with at least three fittings shall be provided in branches from mains to runouts. Size loops for the total pipe expansion without cold springing, but field cold spring one-half the pipe expansion corrected for ambient temperature.
- M. Provide a fitting restraint system at the base of each no hub storm water piping riser 4" and larger in size, and extending vertically 3 floors or greater, with all base ells 45° to 90°. Fitting restraint system shall be Holdrite No Hub Series 117, or approved equal.
- N. Coat all uninsulated piping underground (except cast or ductile iron piping or polymer) with two layers of asphaltic paint, one layer of six-mil polyethylene film, one layer of 15-pound asphaltic felt. Spirally wrap all pipe lines embedded in concrete with two layers of 30-pound asphaltic felt.
- O. Underground piping shall be installed in a continuous enclosure to protect the pipe from damage during backfilling. The enclosure shall be split or otherwise provide access at the joints during visual inspection and leak testing. Backfill shall be clean and compacted so as to protect and uniformly support the piping. A continuous tape or marker placed immediately above the enclosure shall clearly identify the pipeline by



specific name. In addition, a continuous warning means shall be provided above the pipeline at approximately one-half the depth of bury. Where underground piping is installed through a wall sleeve, the ends of sleeve shall be sealed to prevent the entrance of ground water. Piping underground within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit.

### 3.3 LOOP EXPANSION JOINTS

### 3.4 WORKMANSHIP

- A. Cut pipes accurately to measurement established at structure. Install pipes without springing or forcing.
- B. Clear windows, doors, and other openings with all pipes. Arrange pipes to permit expansion and contractions without misalignment or damage.
- C. During construction all openings in piping and equipment shall be closed with caps or plugs to keep out all foreign matter indicated.
- D. All piping in finished spaces shall be run concealed unless otherwise indicated.

### 3.5 PHASING

- A. The contractor shall schedule phasing to minimize the disruption of existing patient services. This phasing is essential to ensure a safe environment in patient care areas. Phasing shall include assurance for clean to dirty airflow, emergency procedures, criteria for interruption of protection, construction of roof surfaces, written notification of interruptions, and communication authority. Procedures must be developed for noise and vibration that will affect patients, and planned accordingly. The renovation areas shall be isolated from the occupied areas during construction using airtight barriers, and exhaust airflow shall be sufficient to maintain negative air pressure in the construction zone.

### 3.6 WELDING

- A. Refer to Section 220010.

### 3.7 SLEEVES AND PLATES

- A. Refer to Section 220010.

### 3.8 FLOW METER FITTINGS

- A. Locate and arrange piping, both upstream and downstream of fitting to conform to the manufacturer's published literature.
- B. When flow is measured in horizontal pipe, locate the connection nipples at or slightly above the horizontal centerline of the pipe to minimize the entrance of gases and impurities.
- C. Provide each fitting with an integral tab, or a metal tag or a stainless steel wire, extending outside the pipe covering, and stamp or print in a plainly visible position the manufacturer's name and address; the model number of the meter to which it is to be connected; the name, number or location of the equipment served; the specified rate of flow and the multiplier (including unity, where applicable) to be applied to the meter reading.
- D. Provide fittings with shut-off valves and with quick connecting hose fittings for portable meters.

### 3.9 TESTS

- A. The following tests shall be conducted by the Contractor and all piping shall be proven tight in the presence of the Architect or his representative. Notify Architect prior to tests. These tests shall be conducted before any insulation is installed and any insulation installed prior to test shall be removed. Provide all equipment and labor required. Tests shall be at least four hours in duration. Piping may be tested in sections as approved by the Architect. Tests shall be specified herein.
- B. Domestic water piping shall be hydrostatically tested to actual operating pressure (as recorded at the time of testing at the ground floor domestic water booster pump), and in no case less than 100 psig. All openings in the water piping shall be plugged throughout the system, or portion thereof, filled with water, and tested with a pump to the above noted pressure.
- C. Sterilization
1. Domestic water system piping shall be disinfected after tests in accordance with State or District Health Department requirements. Before placing the systems in service, contractor shall engage a qualified service organization to sterilize the new water lines in accordance with the following procedure:
  2. Through a 3/4" hose connection in the main entering the building, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 PPM. Plumbing contractor shall provide plumbing connections and power for pumping chlorine into the system.
  3. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.
  4. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 PPM chlorine, retain this water in the system for three (3) hours. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system.
  5. At the end of the retention period, no less than 100 PPM of chlorine shall be present at the extreme end of the system.
  6. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 PPM.
  7. Obtain representative water sample from the system for analysis by a recognized bacteriological laboratory.
  8. If the sample tested for coliform organisms is negative, a letter and laboratory report shall be submitted by the service organization to the contractor, certifying successful completion of the sterilization.
  9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.
- D. The sanitary, storm water, condensate drain and miscellaneous drain systems shall be hydrostatically tested. Tests shall be as required by code and as a minimum shall comprise the plugging of all openings in the line, filling the system (or portion thereof) with water until all joints are proven tight. Piping shall be tested with a minimum head of 10 feet of water.
- E. All pressure piping systems, unless otherwise specified herein, shall be filled with water and thoroughly flushed clean of foreign matter after erection and before connection of equipment.
- F. Testing and verification of medical gas and vacuum systems shall be required for all new work and modifications to existing medical gas and vacuum piping as indicated on the documents. Testing and verification of medical gas and vacuum system shall be as follows:
1. The medical gas and vacuum systems, including all source equipment, valving, alarms and station outlets shall be evaluated and certified for mechanical and therapeutic function as defined in the National Fire Protection Assn. (NFPA) ii, Compressed Gas Assn. (CGA) and The Facility Guidelines Institute: "Guidelines For Design and Construction of Health Care Facilities", 2018 Edition. This testing shall be performed by an agency independent of the facility, contractor, or

- their suppliers. The Agency shall specialize in medical facilities and shall be able to demonstrate experience and expertise in medical gas and vacuum installations and meet the requirements of ASSE 6030.
2. The Agency shall provide to the facility full documentation of the following:
  3. That all medical gas and vacuum systems as constructed follow the guidelines of the NFPA 99, regarding the placement and applicability of valves, alarms, and source equipment. The Agency shall not be responsible for evaluation of Contractor's technique in such elements as routing and hangers except as per paragraphs 3.8.G.4, 3.8.G.5, 3.8.G.6, and 3.8.G.7 below.
  4. That no cross connections exist in the pipeline as constructed. Documentation shall include examination of the outflow of each station outlet, following a mechanical cross connection procedure as specified by NFPA 99. Additionally, each system outflow shall be examined with an appropriate analyzer and the concentrations shall be documented. All medical gas and vacuum systems shall be included in the mechanical examination.
  5. Where laboratory systems are tested as separate systems, cross connection tests will be performed to document their separation from medical systems as required by NFPA 99.
  6. That all station outlets are delivering gas at a pressure and flow consistent with anticipated needs, as these shall be defined by responsible authorities within the facility, but in no case to be below CGA or NFPA guidelines.
  7. That the pipeline is free of debris, including liquid.
  8. That all station outlets are functional.
  9. That delivered gas is as pure as required by applicable CGA/USP requirements for breathing gas. Samples shall be taken from such station outlets as shall be agreed by the facility and the verification agency. In no case in testing for hydrocarbons shall the number of samplings be fewer than two (2), one from source and one from such station outlets as will provide the gas has traversed the greatest length of pipeline. Samples shall be evaluated against CGA/USP requirements for human use and compared to one another.
  10. That all reserve source equipment and its control equipment is in place and is operational.
  11. That all valves are functional. The control zones shall be documented without regard to plans. This documentation shall be compared to the as-built plans, and all discrepancies between the actual installation and the plans shall be reported to the facility.
  12. That all alarms are functioning and are set in accordance with NFPA 99. The surveillance areas of each shall be documented and compared as in paragraph 3.8.G.11 above.
  13. That medical air is dry. The examination shall consist of a dewpoint taken at source and most distant station outlet of each lateral branch. Temperatures and pressures affecting the dryness shall be documented.
  14. Where separate waste anesthetic gas disposal station outlets are provided, the evacuation system shall be included in all mechanical examinations as per paragraphs 3.8.G.4, 3.8.G.6, 3.8.G.8, 3.8.G.10, 3.8.G.11, and 3.8.G.12.
  15. The documentation shall be provided by an independent testing agency approved by the Engineer, and shall contain all of the above information as well as the verification. These documents shall become part of the permanent records of the facility. Verification shall be issued upon successful completion of all specified tests. The Contractor shall not be released from his contractual obligation until verification is obtained.

END OF SECTION 220050



SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE SUPPRESSION PLUMBING AND HVAC

PART 1 - GENERAL

1.1 Related Documents:

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this section.

1.2 References:

- A. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following:
- B. SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) "Seismic Restraint Manual: Guidelines for Mechanical Systems"
- C. North Carolina Building Code 2018

1.3 System Description:

A. General Requirements

- 1. The requirements for seismic protection measures described in this section shall be applied to mechanical piping equipment. Structural requirements shall be in accordance with Division 13.

B. Equipment

- 1. Mechanical equipment shall be seismically protected shall include the following items to the extent required on the drawings or in other sections of these specifications:
  - a. Boilers
  - b. Domestic Water Heaters
  - c. Expansion Tanks
  - d. Air Separators
  - e. Air Cooled Chillers
  - f. Pumps
  - g. Medical Gas Source Equipment and Compressors
  - h. Refrigerant Piping
  - i. Pumps with motors
  - j. Fuel Oil Storage Tanks
  - k. Water and Gas Piping
  - l. Valves and Fittings for Piping
  - m. Air and Refrigerant Compressors
  - n. Air Handling Units
  - o. Ductwork
  - p. Unit Heaters
  - q. Exhaust and Return Fans
  - r. Dry sprinkler systems
  - s. Medical gas manifolds and equipment

- t. Fire Protection Equipment
- C. Systems
- 1. The following mechanical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:
    - a. All piping inside the building except where noted (including plumbing and fire suppression piping)
    - b. All piping outside of the building installed above ground by the mechanical, plumbing, or fire protection contractor (early release mechanical, fire protection, plumbing piping).
    - c. All domestic water supply and recirc systems
    - d. Heating and cooling air and water distribution systems (supply & return)
    - e. Contractor designed bracing
    - f. Medical gases
- D. The contractor shall design and install the bracing and anchorage systems in accordance with the following requirements.
- 1. Seismic design criteria: provide bracing and anchoring for equipment, piping, ductwork, stacks and breeching designed, constructed, and installed to resist stresses produced by lateral forces specified under the NCBC (2018 year), for Seismic Design Category as noted on structural and architectural drawings and specifications.
  - 2. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 pounds or more and all suspended or wall mounted equipment weighing 20 pounds or more.
  - 3. The following components are exempt from the requirements of this section:
    - a. Mechanical components in structures assigned to Seismic Design Category C provided that the importance factor ( $I_p$ ) is equal to 1.0.
    - b. Mechanical components in Seismic Design Categories D, E, and F where  $I_p = 1.0$  and flexible connections between the components and associated ductwork and piping are provided and that are mounted at 4 ft (1.22 m) or less above a floor level and weigh 400 lbs (1780 N) or less.
    - c. Mechanical components in Seismic Design Categories D, E, and F weighing 20 lbs (95 N) or less where  $I_p = 1.0$  and flexible connections between the components and associated ductwork and piping are provided, or for distribution systems weighing 5 lbs/ft (7N/m) or less.
    - d. For this project, the following seismic coefficients shall be used in calculating the required later force:
      - 1) 1.  $S_{ps}$  = Refer to architectural and structural plans and specifications.
      - 2) 2.  $I_p$  = Refer to architectural and structural plans and specifications.
    - e. All lateral forces shall be presumed to act through the component's center of gravity.
    - f. Items Not Covered By This Section
      - 1) Items Requiring No Seismic Restraints
        - a) Seismic restraints are not required for the following items.
        - b) Gas piping less than 1-1/4" inside diameter
        - c) All other piping less than 2-1/2" inside diameter
        - d) Rectangular air handling ductwork less than 6 square feet in cross sectional area
        - e) Round air handling ductwork less than 28" in diameter
        - f) Piping suspended by individual hangers 12" or less in length from the top of the pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below
        - g) Ducts suspended by hangers 12" or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below
        - h) In exceptions above, all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall

be braced. Interior piping and ducts not listed above shall be seismically protected in accordance with the provisions of this specification.

1.4 System Description:

1. Shop drawings and calculations:
2. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
3. The specific detail for each type of brace or anchor must be referenced on a plan that identifies the required location. Supplying a book of details without referencing the proper detail to a specific location on a plan is not acceptable.
4. Structural calculations for required lateral force level for each component.
5. All submittals, including pre-approved systems, shall be signed and sealed by a licensed engineer, licensed in the state in which the project is located.
6. Product data:
  - a. Technical data on seismic control devices.

1.5 Commissioning:

- A. Contractor shall be responsible to coordinating with the commissioning agent.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Refer to architectural and structural plans and specifications.
2. Building Classification Category: Refer to architectural and structural plans and specifications.
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: Refer to architectural and structural plans and specifications.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: Refer to architectural and structural plans and specifications.
  - a. Component Importance Factor: Refer to architectural and structural plans and specifications.
  - b. Component Response Modification Factor: Refer to architectural and structural plans and specifications.
  - c. Component Amplification Factor: Refer to architectural and structural plans and specifications.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): Refer to architectural and structural plans and specifications.
4. Design Spectral Response Acceleration at 1.0-Second Period: Refer to architectural and structural plans and specifications.
5. Rated strengths, features, and applications shall be as defined in reports by agency acceptable to authorities having jurisdiction.

- a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

## 2.2 ELASTOMERIC ISOLATION PADS

### A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Ribbed pattern.
5. Load-bearing metal plates adhered to pads.
  - a. Surface Pattern: Ribbed pattern.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts:

1. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
  - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
  - b. Top plate with threaded mounting holes.
  - c. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.



3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.6 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
- 1.
  2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with non-adjustable snubbers to limit vertical movement.
    - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.7 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- (13-mm-) thick neoprene
1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  2. Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

## 2.8 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene
1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.9 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.11 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

## 2.12 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.13 RESTRAINT CABLES

- A. Restraint Cables: ASTM A 603 galvanized steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

## 2.14 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.15 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.16 VIBRATION ISOLATION EQUIPMENT BASES

- A. Steel Rails: Factory-fabricated, welded, structural-steel rails.
  - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
    - a. Include supports for suction and discharge elbows for pumps.
  - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
  - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
  - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Concrete Inertia Base: field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
  - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

#### 2.17 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- B. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- C. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
- E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind -control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

### 3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
  - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- J. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.
  8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION 220548





## SECTION 220700 – PLUMBING SYSTEMS INSULATION

### PART 1 - GENERAL

#### 1.1. RELATED DOCUMENTS

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

#### 1.2. SUMMARY

- A. Work included in this section consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to the following piping, equipment, and plumbing systems, in accordance with applicable project specifications and drawings:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Sanitary waste piping.
5. Storm-water piping.
6. Roof drains and rainwater leaders.
7. Supplies and drains for handicap-accessible lavatories and sinks.
8. Plumbing equipment.
9. Air conditioning condensate and equipment drain piping.

- B. The requirements of Section 22010, Plumbing General Provisions, shall apply to the work specified under this Section.

#### 1.3. DEFINITIONS

- A. The k factor means the number of British thermal units of heat transmitted per (sq. ft.) Fahrenheit temperature difference through a material with flat, parallel sides one inch (1") apart. The material shall be tested and rated according to ASTM Test Method C-177.
- B. The term "Mineral Fiber" as defined above specifications includes fibers manufactured of glass, rock or slag processed from a molten state, with or without binder.
- C. Unless otherwise specified, the term concealed, as used in this specification, shall include all furred spaces, accessible pipe and duct shafts, and spaces above suspended ceilings.
- D. Unless otherwise specified, the word exposed shall refer to all work other than "concealed" work.

#### 1.4. REFERENCES

- A. Thermal insulation materials shall meet the property requirements of one or more of the following American Society for Testing of Materials (ASTM) specifications as applicable to the specific product or use:
  1. ASTM C 533-07: "Specification for Calcium Silicate Block and Pipe Thermal Insulation"
  2. ASTM C547: "Standard Specification for Mineral Fiber Pipe Insulation"
  3. ASTM C534: "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form"

4. ASTM C553 “Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications”
5. ASTM C585 “Standard Practice for Inner and Outer Diameters or Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)”
6. ASTM C 612 “Standard Specification for Mineral Fiber Block and Board Thermal Insulation”
7. ASTM C 795 “Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel”
8. ASTM C 1126-04: “Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation”
9. ASTM C 1136 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”
10. ASTM C 1290 “Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts”
11. ASTM G-21 “Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi” (fungi resistance section only)
12. ASTM G 22 “Practice for Determining Resistance of Plastics to Bacterial (bacteria resistance section only)

#### 1.5. QUALITY ASSURANCE

- A. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.6. SYSTEM PERFORMANCE

- A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers’ Association (NAIMA) to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1 (2015), “Energy Standard for Buildings Except Low Rise Residential Buildings” of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. In no case shall the insulation thickness be less than that specified herein.
- B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirement of any one of the following specifications:
  1. American Society of Testing of Materials     ASTM E 84
  2. Underwriters’ Laboratories, Inc.             UL 723
  3. National Fire Protection Association         NFPA 255

#### 1.7. FIRE RESISTANCE

- A. Except for materials which are subsequently exempted, all materials used as part of the thermal insulation shall have a fire hazard rating not to exceed twenty-five (25) for flame spread and fifty (50) for fuel contributed and smoke developed.
- B. Test factory assembled materials as assemblies.
- C. Determine ratings by the Standard Method of Test for Surface Burning Characteristics of Building Materials, ASTM E-84 or NFPA No. 255.

- D. The following will be required to establish that fire hazard ratings for materials proposed for use do not exceed those specified: (1) label or listing by Underwriter's Laboratories, Inc., (2) certified test report from an approved testing laboratory.
- E. The following materials are exempt from the foregoing Fire Resistant Rating:
  - 1. Jackets of canvas, PVC and nylon.
  - 2. Polyurethane, polystyrene, cork and flexible, closed-cellular insulation.
  - 3. Nylon anchors for securing insulation to equipment.
  - 4. Factory pre-molded one (1) piece PVC fitting and valve covers

#### 1.8. QUALIFICATIONS

- A. Materials submitted shall be standard products of a manufacturer who has been engaged in the production of the products for not less than three (3) years.
- B. The installing sub-contractor shall have at least five (5) years of successful installation experience on projects with similar insulation products.

#### 1.9. QUALITY ASSURANCE

- A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.4 above.
- B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

#### 1.10. SUBMITTALS

- A. Provide shop drawings in accordance with Section 220010 and the General Requirements which shall include all insulation, jackets, finishes, corner beads, etc. Shop drawings shall additionally describe each system or component to be insulated, insulation type and thickness, and method of installation.

#### 1.11. DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

#### 1.12. COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220050 and Section 220010.

- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.13. SCHEDULING

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

### PART 2 - PRODUCTS

#### 2.1. GENERAL

- A. All insulating materials, including adhesives, jackets and coatings, to be used on the project must be delivered to the building in the manufacturer's unopened container and must bear the manufacturer, brand and description of material.
- B. After the necessary tests have been conducted to prove the water systems tight, all piping and equipment to be insulated shall be thoroughly cleaned and then covered. Insulation materials shall be the product of Owens Corning, Knouf, Manville, Armstrong or Armacell equal to the products specified herein.
- C. Molded pipe insulations shall be manufactured to meet ASTM C 585, ASTM C534 and ASTM C 547.

#### 2.2. TYPES OF INSULATION

- A. Refer to Insulation schedule on drawings.

#### 2.3. ADHESIVES, SEALERS AND COATINGS

- A. Provide all adhesives, sealers, vapor barrier coatings etc., compatible with the material to which they are applied. They shall not corrode, soften or otherwise attack such material in either the wet or dry state and must be suitable for the service temperatures.
- B. Any cement, sealer or coating used shall be resistant to vermin and mold and shall be durable. It shall not discolor on aging; and where applied on the final surface of the insulation, it shall be light in color and be capable of being painted.
- C. Adhesives, coatings and compounds shall be equal to the following:
- D. Vapor barrier adhesive for sealing joints on pipe insulation - Foster 85-75.
- E. Insulating cement - Owens Corning No. 110

#### 2.4. FITTINGS AND VALVE COVERS

- A. Pipe fittings and valves shall be insulated with Owens Corning PVC pre-molded one (1) piece PVC insulated fitting cover and factory precut insulation. Fittings shall have edges of one (1) piece cover sealed with Owens Corning vapor barrier pressure sensitive tape.

#### 2.5. PROTECTIVE SHIELDING GUARDS:

- A. Protective Shielding Pipe Covers

1. Plastic wraps for covering plumbing fixture. Hot- and cold-water supplies and trap and drain piping as manufactured by Truebro, McGuire Manufacturing, Zurn Industries or Insul-Tect. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures

1. Plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping as manufactured by Truebro, Zurn Industries or equal. Comply with ADA requirements.

2.6. METALLIC COMPONENTS

- A. Staples shall be outward clinching type of Type 304 or Type 316 stainless steel.

- B. Bands shall be galvanized steel, aluminum, brass, or nickel-copper alloy, of three-quarter inch (3/4") nominal width. The band thickness, exclusive of coating, shall be not less than five thousandths inch (0.005") for steel and nickel copper alloy, seven thousandths inch (0.007") for aluminum, and one hundredth inch (0.01") for brass.

- C. Wire shall be 14-gauge, nickel-copper alloy or copper clad steel, or 16-gauge, soft annealed, galvanized steel.

- D. Wire netting used for exposed surfaces of insulation that is to be cement finished shall be 22-gauge, one-inch (1") galvanized mesh, with continuous 26-gauge galvanized steel corner beads having two and one-half inch (2-1/2") wings.

- E. All exterior piping shall be additionally covered with a sixteen mil (16 mil) (0.4mm) embossed aluminum or stainless steel weatherproof jacket. Jacketing shall be Childers Lock-on type with factory applied poly kraft moisture barrier. Jackets are to be fabricated with continuous Z-lock on the longitudinal seam and sections shall be joined with factory fabricated butt strap and sealant. Fitting shall be insulated and weatherproofed using similar materials.

- F. Where indicated, all piping shall be covered with UV resistant Owens Corning PVC jacketing. Installation shall be in accordance with the manufacturer's limitation with regard to surface temperature and thermal expansion. Fittings shall be insulation as prescribed above, jacketed with pre-formed fittings covers matching the outer jacketing.

2.7. INSULATION SCHEDULE

- A. Refer to insulation schedule on drawings.

PART 3 - EXECUTION

3.1. EXAMINATION

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2. PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3. GENERAL

- A. All insulation shall be installed by skilled workmen regularly engaged in this type of work.
- B. Insulation shall be continuous at all hangers, sleeves and openings. Vapor seals shall be provided for all cold surfaces and shall be continuous.
- C. Arrange to permit expansion and contraction without causing damage to insulation or surface.
- D. Actual insulation thickness must be at least equal to the minimum specified in the schedule. Where the manufacturer's rated or nominal thickness is less than the minimum specified, a thicker material or more layers will be requested so that the stated minimum thickness will be attained or exceeded.
- E. Install insulation materials in a first class manner with smooth and even surfaces. Scrap pieces of insulation shall not be used where a full length section will fit.
- F. Unless otherwise specified herein, the application of all insulation materials, accessories and finishes shall be in accordance with the manufacturer's published recommendations.
- G. Insulation materials shall not be applied until all surfaces to be covered are clean and dry; all foreign material, such as rust, scale, dirt, etc., has been removed; and, where specified, surfaces have been painted. Insulation shall be clean and dry when installed and during the application of any finish. The insulation on pipe fittings, valves and pipe joints shall not be installed before the piping is tested and approved.
- H. Omit insulation on the following unless directed otherwise:
  - 1. Brass or copper pipe specified to be chrome plated.
  - 2. Traps and pressure reducing valves, relief piping from safety valves, and unions.
- I. Replace and repair insulation disturbed by testing and balancing procedures.

3.4. PIPE INSULATION

- A. High density pipe saddles shall be provided at all points of support as hereinbefore specified in Section 220010.
- B. Insulate all valves and strainers. Use pre-molded covers and factory precut insulation where applicable. Unions and flanges shall not be insulated except on cold service.
- C. Insulate valves up to and including bonnets, except for cold water valves which shall be insulated over packing nuts in a manner to permit removal for adjustment and repacking.

D. Insulate strainers in a manner to permit removal of the basket without disturbing the insulation of the strainer. Obtain Engineer's approval of installation method.

E. Application - Type I Insulation

1. Insulate all pipes in a neat and workmanlike manner. Seal all longitudinal laps of jackets and staple every six inches (6"). Where the piping operates below ambient temperature, the staples shall be coated with vapor barrier adhesive. All butt joints shall be wrapped with a three inch (3") minimum wide strip of jacketing material securely sealed in place.
2. Insulate valves and fittings with pre-cut blanket type fiberglass insulation and PVC covers as specified. Insulation shall be of the same thickness as that on adjoining pipe. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. The one (1) piece PVC fitting cover shall then be secured by stapling, tack fastening, banding or taping the ends to the adjacent pipe covering. Chilled water supply and return piping and cold-water systems piping shall be insulated as above and have all seam edges of the cover sealed with ZESTON vapor barrier adhesive mastic. The circumferential edges of cover shall be color matching tape. The tape shall extend over the adjacent pipe insulation and overlap itself at least two inches (2") on the downward side.
3. Where fittings are operating above ambient they may, in lieu of the preceding paragraph, be covered with a three hour (3 hr.), hydraulic setting, combination insulating and finishing cement having k factor not greater than 0.87 at a mean temperature of two hundred degrees Fahrenheit (200° F). The thickness of this cement shall be such that the surface is substantially flush with the pipe covering. Where the insulation terminates at a fitting that is not covered, the end of the insulation shall be beveled off with this same cement. All fittings insulated in this manner shall be covered by a fabric jacket as specified, which shall be cemented down with lagging adhesive.
4. Where expansion joints are required to be insulated, they shall be covered with readily removable sections of insulation of same composition and thickness as provided for adjacent piping.

F. Application - Type II Insulation

1. The material shall be slit lengthwise to permit installation or slipped over pipe before connections are made. Butt joints shall be secured to each other with adhesive suitable for the application.
2. All joints and seams must be thoroughly bonded, both mechanically and hermetically, by the adhesive recommended by the insulation manufacturer. Also, the manufacturer's recommendations shall be followed as to the adhesive to use where the insulation needs bonding to metal or other material used for any surface treatment where a finish coat of paint is required.
3. All penetrations of the insulation must be thoroughly sealed so that the insulation itself will form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the metal.

G. Application - Type V Insulation

1. The material shall be applied lengthwise by placing the slit tubing over pipe. Longitudinal joint is made by peeling release paper from adhesive surface and applying pressure along longitudinal joint. Butt ends shall be secured with Armaflex 520 adhesive.
2. All joints and seams must be thoroughly bonded, both mechanically and hermetically, by the adhesive recommended by the insulation manufacturer. Also, the manufacturer's recommendations shall be followed as to use where bonding to other materials or metal is required.
3. All penetrations of the insulation must be thoroughly sealed so that the insulation itself will form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the metal.

3.5. EQUIPMENT INSULATION

A. Cut or score insulation to fit shape and contour of equipment. Stagger all joints.

- B. Provide permanently fastened angles or plates, where required to support insulation.
- C. Do not cover nameplates. Cut back the insulation and line edges with 26-gauge galvanized steel.
- D. Application - Type III Insulation
  - 1. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be spaced on not over twelve-inch (12") centers. All joints and voids shall be filled with cement, well troweled into openings. Apply over the insulation surface one inch (1") galvanized wire netting laced together at all edges and wired to the steel bands with 16-gauge soft annealed wire. Over this shall be applied a one-half inch (1/2") thick layer of insulating cement applied in two (2) layers. Install metal corner beads at all corners and edges to provide a permanent installation.
- E. Application - Type IV Insulation
  - 1. Apply a brush coat of manufacturer's recommended adhesive to dry, clean metal surface covering an area equal to the size of one (1) sheet. Apply a brush coat of adhesive to the back of the sheet, except for a one-half (1/2") wide border around the edges. After adhesive on metal surface and sheet has dried to a non-tacky state, position sheet so that the edges overlap the previously installed sheets by one eighth inch (1/8"). Apply light pressure to adhere a spot in the center of the sheet only and compress butt edges into place. Spread joints and coat with adhesive.

### 3.6. FINISHES

- A. Canvas jacket shall be provided on all interior exposed piping, equipment, and ductwork herein specified to be insulated.
- B. Canvas jacket applied to insulated equipment: Onto the dry cement surface apply a brush coat of Foster Sealfas 30-35 at the rate of 60-70 square feet per gallon. Imbed into wet coating, all canvas jacket smoothed out to avoid wrinkles and lap all seams a minimum of 2 inches. Apply a second brush coat of Sealfas 30-36 to the entire surface at the rate of 60-70 square feet per gallon. Canvas jacket shall be 8 oz. ULC listed, flame spread 25 or less, smoke developed 50 or less.
- C. Where canvas jacket is to be installed on piping, apply Foster 30-36 adhesive to the canvas jacket by dipping to completely wet and saturate the canvas. While wet, position on the insulation and pull tight, bond lap and smooth out all wrinkles. Finish with a sealer coat of adhesive.
- D. Where PVC jacket is to be installed on piping, installation materials and procedures shall be in accordance with the manufacturer's recommendations.
- E. All pipes exposed to the weather shall be covered with aluminum jacket minimum 0.016 inch thick kept in place with aluminum bands 12 inches on center. Longitudinal seams shall be on underside of pipe and horizontal joints shall be lapped 3 inches with aluminum bands at edge of overlap.

END OF SECTION 220700



## SECTION 220810 – COMMISSIONING OF PLUMBING SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section and all other sections of Division 22.
- B. The OPR and BOD documentation are included by reference for information only.

#### 1.2 SUMMARY

- A. This section includes the requirements for commissioning the Plumbing systems, assemblies and equipment.

#### 1.3 DESCRIPTION

- A. Refer to Division 01 Section “General Commissioning Requirements” for the description of the commissioning process.
- B. The following equipment and/or accessories shall be commissioned as part of this project:
  - 1. Domestic hot water systems and equipment
  - 2. Sanitary water systems and equipment
  - 3. Storm water systems and equipment
  - 4. Interface connections with the BAS
  - 5. Medical and Laboratory Gas Systems

#### 1.4 SUBMITTALS

- A. Refer to Division 01 Specification Section “General Commissioning Requirements” for CxA’s role.
- B. Refer to Division 01 Specification Section “Submittal Procedures” for specific requirements.
- C. Refer to Division 01 Specification Section “General Commissioning Requirements” for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.
- D. Certificates of readiness.
- E. Certificates of completion of installation, prestart, and startup activities.
- F. O&M manuals
- G. Testing reports

#### 1.5 COORDINATION

- A. Refer to Division 01 Specification Section “General Commissioning Requirements” for requirements pertaining to coordination during the commissioning process.

#### 1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

#### 1.7 GENERAL DOCUMENTATION

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

### PART 2 - PRODUCTS

#### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the contractor for the equipment being tested. For example, the plumbing contractor of Division 22 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 22, except for equipment to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each subcontractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or – 0.1°F. Pressure sensors shall have an accuracy of + or – 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

### PART 3 - EXECUTION

#### 3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment and systems. These checklists shall be executed by the installing contractor.
- B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The

CxA will receive a copy of the final approved O&M literature once corrections have been made by the contractor.

- D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior to the training session.

### 3.2 TESTING PREPARATION

- A. Certify in writing to the CxA that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.3 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tasks at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Attend domestic water balancing review and coordination meetings.
- D. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- G. Prepare preliminary schedule for Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.
- H. Update schedule as required throughout the construction period.

- I. Assist the CxA in all verification and functional performance tests.
  - J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
  - K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
  - L. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
  - M. Notify the CxA a minimum of two weeks in advance of the time for the start of the balancing work. Attend the initial balancing meeting for review of the balancing procedures.
  - N. Participate in, and schedule vendors and contractors to participate in the training sessions.
  - O. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
    - 1. Plumbing equipment including domestic water heaters, pumps, plumbing fixtures, and all other equipment furnished under this Division.
  - P. The equipment supplier shall document the performance of their equipment.
  - Q. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
  - R. Test, Adjust, and Balance Contractor:
    - 1. Attend initial commissioning coordination meeting scheduled by the CxA.
    - 2. Submit the site specific balancing plan to the CxA and Design Professional for review and acceptance.
    - 3. Attend the balancing review meeting scheduled by the CxA. Be prepared to discuss the procedures that shall be followed in balancing the Plumbing system.
    - 4. At the completion of the balancing work, and the submittal of the final balancing report, notify the Plumbing contractor and the CM/GC.
    - 5. Participate in verification of the balancing report, which will consist of repeating measurements contained in the balancing reports. Assist in diagnostic purposes when directed.
  - S. Equipment Suppliers
    - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
    - 2. Assist in equipment testing per agreements with contractors.
    - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  - T. Refer to Division 01 Section “General Commissioning Requirements” for additional contractor responsibilities.
- 3.4 OWNER’S RESPONSIBILITIES
- A. Refer to Division 01 Section “General Commissioning Requirements” for Owner’s Responsibilities

### 3.5 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for Design Professional's Responsibilities.

### 3.6 CxA's RESPONSIBILITIES

- A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's Responsibilities.

### 3.7 DOMESTIC WATER BALANCING VERIFICATION

- A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least ten (10) days in advance of testing and balancing work and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.
  - 1. The CxA will coordinate with the CM and TAB contractor to determine the date of field verification. Notice will not include data points to be verified.
  - 2. The TAB subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 3. Failure of an item includes, other than sound, a deviation of more than +/- 10%.
  - 4. Failure of more than 10% of selected items shall result in rejection of final TAB report.
  - 5. TAB contractor shall remedy the deficiency and notify the CxA so verification of failed portions can be performed.

### 3.8 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include entire Plumbing installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Plumbing contractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

- I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.9 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 22 sections. Provide submittals, test data, inspector record, and certifications to CxA. If no procedures are prescribed by the manufacturer, proceed as follows:
  1. Plumbing Piping Distribution Systems: Includes domestic water, sanitary, drain, storm water, laboratory water, air, natural gas, laboratory gas and vacuum piping.
    - a. Verify that all valves and accessories have been installed correctly, are accessible and operate as intended.
    - b. Verify that specified tests of piping are complete.
  2. Plumbing Equipment: Includes pumps, backflow preventers, hot water heating equipment, RO/DI, compressed air and vacuum laboratory support equipment.
    - a. Verify that all equipment has been installed in accordance with the manufacturer's recommendations and all equipment can be easily accessed for maintenance.
    - b. Verify that all valves, trim, fittings, controls, and accessories have been installed correctly and operate as intended.
    - c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
    - d. Verify that all required interfaces with the BAS have been installed correctly and operate as intended.
    - e. Operate equipment as intended to ensure the design conditions can be obtained.
- B. Plumbing Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections. Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 22 Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA.
- D. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools and equipment to test performance of air, fuel, gas, sanitary waste and vent piping, storm drainage piping, sprinkler and domestic water distribution systems.
- E. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and subsystems. The following equipment and systems shall be evaluated:
  1. Plumbing Piping
  2. Domestic Hot Water Heaters
  3. Domestic Hot Water Pumps
  4. Domestic Water Booster Pumps

### 3.10 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.11 APPROVAL

- A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.12 DEFERRED TESTING

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.13 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.14 TRAINING OF OWNER’S PERSONNEL

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

END OF SECTION 220810





## SECTION 221100 - PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. In-line, close-coupled centrifugal pumps. (Type B).
  - 2. Domestic Hot Water Recirculation Pumps
  - 3. Domestic water booster pumps.
  - 4. Elevator sump pumps.

#### 1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 220050.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Include diagrams for power, signal, and control wiring.
  - 5. Operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Pump capacities shall be as scheduled on the drawings.
- B. Reference Motor Specification Section 220010 for efficiency and construction compliance. The motors shall be **ODP** or **TEFC** design as applicable.
- C. Data submitted for approval shall include pump speed and characteristic curves for performance of the impeller selected. Curves shall indicate capacity vs. head, NPSHR, efficiency and brake horsepower for the full range, from shut-off head to free delivery. Manufacturers' pumps may be considered only if pump efficiencies are equal or greater than the basis of design.
- D. Vibration isolation shall be provided as specified in Section 220050.
- E. Base ells or support shall be provided under piping risers from pump and risers shall further be supported by calibrated spring hangers. Where pump arrangement precludes the use of base elbows or comparable supports, piping shall be supported by means of spring-loaded hangers calibrated for the specific use. Pump isolation bases shall be sized to accommodate the support ells.



<u>Connection Type</u>	<u>Maximum Working Pressure</u>
1" or 1¼" Internal Thread (NPT)	232 psig
2" Internal Thread (NPT)	145 psig
ANSI Flange (Class 250)	362psig

2.3 ELEVATOR PIT SUMP PUMP (Type "E" Pump):

- A. Contractor shall furnish and install a Stancor Oil-Minder System Pump or approved equal and control to allow water to be automatically pumped from a sump basin without danger of ejecting potentially harmful oily substances into sewers or drainage system. The system consists of:
- B. Stancor Submersible Sump Pump rated as indicated on drawings with Double Mechanical Seal, Cast Iron Impeller and 3600 rpm, 115/60 Motor with Stainless Steel Housing and 16' long cables. A Stainless Steel Oil Sensor Probe shall be mounted on the Pump. Pump shall be UL Approved and with Thermal and Overload Protection.
- C. Junction Box shall be provided with NEMA 4X Enclosure, Factory Pre-Wired to the pump, oil probe and float switches via 16' long cables and with a 25' long Multipin Connector Cable to Remote Control Panel.
- D. Provide Control Panel in a UL, NEMA 4X Fiberglass Enclosure with Visual & Audible Alarms and Auxiliary Contact.
- E. Mechanical Float Switches, one for Normal On-Off operation and one for High Water Alarm, with 16' Cables.
- F. 24" diameter X 24" deep Fiberglass Basin with a Perforated Steel Cover.
- G. The Pump, Control Panel, Float and Sensor Probe shall be ENTELA tested & certified and Approved by the local governing jurisdiction.

2.4 DOMESTIC WATER BOOSTER PUMP PACKAGE (Type "G" Pump):

- A. Provide a factory fabricated and tested packaged variable speed domestic water pressure booster system. Package shall be complete, and shall include base frame, pumps, piping, valves, ANSI 125# flanged (175# WOG) fittings, supports, stainless steel or copper suction and discharge piping headers, variable frequency drives, and controls. Package shall be primed and finish painted with a painting system designed for wet environments. The controls provided with the package shall provide a constant system pressure with pump flow rates scheduled on the Contract Drawings.
- B. The package shall be complete, and in order for it to become fully functional, field connection requirements shall be limited to water piping to the system headers, over temperature drain tube, a single incoming power connection at the control panel, and ATC connections as indicated on the Contract Drawings.
- C. The entire package shall be third party certified by Underwriters Laboratories, Inc. in accordance with OSHA 29 CFR, with references to nationally recognized testing laboratories. Pumps and valves shall be classified for use by U.L., Inc. in accordance with ANSI/NSF Standard 61 for drinking water components. Provide a coating on the inside of the pump suction and discharge headers that shall conform to NSF standards for drinking water, and subject to the authority having jurisdiction.
- D. Submittal data for the booster pump package shall include but not be limited to:

1. System drawings at a scale of 1/2"=1'-0". As a minimum include dimensions in plan, end and side views, including all panels and appurtenances, pumps, piping, valves, fittings, etc. Identify all field connection locations for piping, controls, and electrical power. All pipe and valve sizes shall be indicated.
2. Individual computer data sheets for the system.
3. Pump speed and characteristic curves for performance of the pump/impeller selected. Curves shall indicate capacity vs. head, NPSHR, efficiency and brake horsepower for the full range, from shutoff head to free delivery. Pumps will be considered only if pump efficiencies are equal or greater than the basis of design.
4. Pump, motor, drive, valve, pipe, and fitting data.
5. Provide a complete description of control panel and VFC's, along with all functions and capabilities, sequencing data, instrumentation and alarms. Provide a wiring diagram for all panels and pump controllers.

E. Quality assurance

1. The Contract Drawings indicate the size and arrangement of the booster pump package. The Contractor shall note the space constraints and piping connections, and the Contractor and vendor shall verify all dimensions and arrangements before submitting shop drawings to ensure that the package is coordinated with the building access provisions and the utility arrangements shown.
2. The booster pump package shall be designed with sufficient clearances to enable the removal of an inboard motor or pump around the adjacent pump while keeping the adjacent pumps in operation.
3. Control panels and VFC's shall be readily accessible and shall meet code required clearances.
4. Any modifications made by the Contractor or factory to the pump package layout indicated on the contract drawings shall be indicated on the shop drawings, and shall be approved in writing by the Engineer. Package modifications shall be the responsibility of the Contractor for coordination, shall meet the minimum requirements of this specification, and shall be at no additional cost to the Owner.

F. Booster pumps

1. Pumps shall be vertical, inline, centrifugal, single stage or double suction type, radial split case design, split coupled motor assembly, with rigid spacer type coupling.
2. Select pumps so that the operating point on the selected impeller curve will be at or to the left of, and not more than 5% below, the point of maximum efficiency. Impeller size for specified duty shall not exceed 90% of volute diameter.
3. Provide pumps with premium efficiency motors designed for inverter duty that conform to Section 220010 of these specifications. Motors shall be of scheduled rpm. Pumps shall be non-overloading with respect to nameplate horsepower throughout the entire performance curve for the impeller selected.
4. Casing shall be cast iron for working pressures up to 175 psig at 150°F (125 psig ANSI flange rating) and ductile iron for working pressures to 375 psig at 150°F (250 psig ANSI flange rating). Suction and discharge connections shall be flanged with tappings for seal flush and gauge connections.
5. Impeller shall be of the enclosed type, vacuum cast in one piece and constructed of bronze, ASTM B584. Impeller shall be finished, the exterior being turned and the interior being finished smooth and cleaned. The impeller shall be dynamically balanced, and keyed to the shaft, fastened with a washer, gasket and capscrew.
6. Mechanical seals shall be John Crane stainless steel outside multi spring balanced type with Viton secondary mechanical seals rated for 125 psig minimum working pressure and a continuous water temperature of 225°F. Provide bronze gland plate with stainless steel hardware including a factory installed external flush line with manual vent. All pumps shall be provided with a lower seal chamber throttle bushing.
7. The pump shaft shall be ground and polished stainless steel, with stainless steel sleeve.
8. The coupling shall be a rigid spacer type of high tensile aluminum alloy. Couplings shall be split to allow removal from pump and motor shafts, leaving space between the shafts sufficient to

- replace all mechanical seal components without disturbing the pump or motor. Coupling shall be protected by a removable guard. Filed alignment shall not be required by the coupling design.
9. Pump suction and discharge piping ells shall be supported directly from the package structural base.

#### G. Valves

1. Each pump shall be provided with the valves specified below. Valves shall be approved for use with potable water:
  - a. High performance full port size butterfly or ball valve on the pump suction. Suction valve shall be upstream of the pump suction diffuser.
  - b. Pump suction diffuser, angle pattern, rated for 175 psig. Construction shall be cast iron body, end cap, and pump inlet fitting, with bronze startup and stainless steel permanent strainers; bronze or stainless steel straightening vanes; drain plug, and factory fabricated support to booster package structural base. Suction diffuser shall be Armstrong, Bell and Gossett, or approved equal.
  - c. Center guided silent check valve at the pump discharge, designed to eliminate water hammer and sized for a pressure drop no greater than 1 psig.
  - d. High performance full port size butterfly or ball valve on the pump discharge, downstream of the check valve.
2. High performance butterfly valves, ball valves, and silent check valve shall meet the requirements of Section 220100 of these specifications.

#### H. Pump sequencing

1. The discharge header pressure sensor and pump sequencing controls shall be provided with the booster pump package. The package shall include the necessary contacts for transmitting alarms as described in the controls sequence indicated on the Contract Drawings.
2. The booster pump package shall be configured to be manually operated through virtual H O A selector buttons provided on a touch screen operator interface panel provided with the package.

#### I. Power and control panel

1. Electrical components shall be provided in NEMA 12 enclosures with a touch screen operator interface. A single main disconnect shall be provided. Control panel shall be equipped with virtual Hand off Auto control switches on the display panel for user control of pump motors and variable frequency drives. Control panel shall be complete with 3 leg overload and short circuit protection, 120V control circuit transformer, and integral, fused 24V controller power supply.
2. Ambient environmental ratings for the controller shall be 0°C to 60°C and 5% to 95% relative humidity, non-condensing.
3. The control panel shall be complete with 3.5" by 4.5" liquid crystal, watertight touch screen operator interface with easy to read backlit display. The operator interface shall have password protected system parameters, onscreen display of pump system parameters such as system pressure (psi), supply pressure (psi), three phase voltages, three phase amperages, pump run status, and percentage of full speed. All system parameters shall be visible on a single screen without scrolling. Access to the inside of the controller shall not be required to change system parameter settings, alarm settings or to reset alarms.
4. The controller shall utilize a 0-10mV or 4-20 mA analog signal with discharge pressure as the control variable. Controls shall be arranged so that two pumps may be energized at any one time with the third pump as standby.
5. Controller design shall include provisions for low flow energy savings, best operating point sequencing, end of pump curve protection, automatic alternation of pumps, built in pump on delay and minimum run timers, resettable pump elapsed runtime meters, smooth pump starting and

- sequencing, onscreen field modifiable control and alarm parameters, no flow shutdown and other capabilities as described on the Contract Drawings.
6. Provide onscreen alarm display with alarm identification, with the following alarms included: low system pressure shutdown, high system pressure shutdown, low suction pressure shutdown, high suction pressure shutdown, pump failure, controller failure, drive fault, and suction or discharge pressure transmitter failure. The controller shall include onscreen fault description and possible cause information with alarm horn.
  7. Provide communication interface for remote EMCS indication, contacts: individual pump status, drive/motor failure, system pressure, and low suction pressure. ATC Contractor shall provide field wiring and sensors to implement the Input/Output points shown on the Contract Drawings.
  8. Nonvolatile factory set parameters shall be readily restored at any time in the field without requiring any programming device or connection to an external source. The controller shall hold software in EPROM memory storage to prevent accidental loss of data due to voltage surge or spike.
  9. All controls shall be factory prewired and tested in accordance with the provisions of the National Electrical Code. Control wires shall be individually numbered and each component shall be labeled accordingly. Internal wiring shall be copper stranded, A.W.G. with a minimum rating of 90°C. The controller shall bear the UL508 label for industrial controls.
  10. Provide surge protection for all controls.
- J. Instrumentation
1. Booster pump package shall be provided with manifold mounted liquid filled pressure gauges for indicating suction and discharge pressures. Provide gauges and gauge cocks that conform to Section 220010.
  2. Provide a factory prewired and pre-piped temperature probe to assure over temperature protection (continuously operating system).
- K. Variable speed drives
1. Provide one variable speed drive for each pump provided in this booster pump package. Variable speed drives shall conform to the requirements of this section.
- L. Factory Testing and Certification:
1. The entire booster pump system and its component parts shall be fully assembled and shall undergo a complete operational factory flow test from zero to 100% design flow rate under the specified pressure conditions.
  2. The system certification shall include copies of the test data as certified by a factory engineer. Performance test certifications shall be placed inside the control panel with copies in the installation manual.
  3. The entire package shall be third party certified by U.L., Inc.
- M. Startup Services:
1. Contractor shall provide the services of one factory trained service representative for the installed system to provide a minimum of eight (8) man hours of labor for system startup. As a minimum, manufacturer's representative shall inspect each pump, controller, valve, fitting, all controls, etc, and the entire package installation under this contract, and shall verify proper operation of the system and all its components and accessories, including all field connections made by the installing Contractor.
  2. Service representative shall provide written authorization for startup and shall witness startup and provide a factory formatted startup test report for submission to the Engineer.
  3. Service representative shall also provide a minimum of four (4) additional hours of field training to the Owner's maintenance personnel at startup for the proper operation and maintenance of the booster pump package. Schedule training with the Owner a minimum of 24 hours in advance.

4. Manufacturer of the booster pump package shall be Tigerflow with Aurora pumps, Armstrong, Systecon, or Syncroflow. All submittals shall be certified by an officer of the proposing company that their packaged system complies with these specifications.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

#### 3.2 PUMP INSTALLATION

- A. Install in-line, seal less centrifugal pumps with shaft horizontal unless otherwise indicated.
- B. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.
- C. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
- D. Install all floor mounted pumps and pump packages on concrete housekeeping pads.
  1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  3. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Install pressure switches in water supply piping.
- F. Install thermostats in hot-water return piping.
- G. Install time-delay relays in piping between water heaters and hot-water storage tanks.
- H. Install piping adjacent to pumps to allow service and maintenance.
- I. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
  1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
    - a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
    - b. Vertically mounted, in-line, close-coupled centrifugal pumps.
    - c. Comply with requirements for flexible connectors specified in Section 220050.
- J. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping.
  1. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- K. Connect thermostats to pumps that they control.

- L. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

### 3.3 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 220010.

### 3.4 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Set thermostats for automatic starting and stopping operation of pumps.
  - 5. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 6. Prime pump by opening suction valves and closing drains and prepare pump for operation.
  - 7. Start motor.
  - 8. Open discharge valve slowly.
  - 9. Adjust temperature settings on thermostats.
  - 10. Adjust timer settings.

### 3.5 ADJUSTING

- A. Adjust domestic water pumps to function smoothly and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221100



## SECTION 221300 - PLUMBING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cleanouts
  - 2. Drains
  - 3. Domestic water pressure reducing valves
  - 4. Master mixing valves
  - 5. Emergency fixture mixing valves
  - 6. Plumbing specialties
  - 7. Meters
  - 8. Grease interceptor
  - 9. Oil interceptor

#### 1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 220050.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Include diagrams for power, signal, and control wiring.
  - 5. Operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

- A. Cleanouts shall be placed in piping throughout the building, where noted and where required by code and at not greater than seventy five foot (75') intervals. Cleanouts on piping below floors, at ends of runs and changes of direction of piping shall consist of Y branches, the full size of pipes to which they are connected with cleanout plugs and covers as listed below or as detailed. Extend cleanouts on concealed piping to finished walls, floors and grade. Do not leave cleanouts above ceilings – they must be turned up to the floor or wall above. Cleanouts shall be Josam, Jay R. Smith, Watts, or Zurn equal to Josam numbers indicated below.
  - 1. In concrete floor on grade (generally) - Series 58370-2-20C cleanout with scoriated round satin bronze top, bronze cleanout plug with lead seal, and adjustable housing. In carpeted are, Josam Series 58370-2-14-20-C.

2. At base of vertical piping and in walls - Series 58510 cleanout tee with countersunk bronze threaded plug. Where risers are concealed, provide Series 58760-2-20 cleanout tee with plug and satin finish bronze access cover and frame.
3. Cleanouts on exposed horizontal piping shall be Series 58510-25 with bronze threaded plug.
4. Cleanouts in exterior underground piping shall be countersunk set in four inch (4") extra heavy cast iron pipe extension to grade. Provide Josam Series 58490-20 with taper thread bronze plug set in twelve inches by twelve inches by eight inches (12" x 12" x 8") concrete finished flush with grade.
5. Cleanouts in waterproofed equipment rooms - Series 58460A-20-20 with bronze plug.

## 2.2 DRAINS

- A. Provide traps for all drains. All sanitary traps shall be "deep seal" type.
- B. Where drains are subject to evaporation, provide trap primer or barrier type trap seals as required by the AHJ.
- C. Provide drains where indicated. Drains shall be Josam, Jay R. Smith or Zurn equal to Josam equipment as follows:

- |  |   |
|--|---|
| 1. Floor Drains – General, with Primer Tap                   | Type "A" 30000-6A-17-50 (Nikaloy Top)                   |
| 2. Floor Drains – General                                    | Type "B" 30000-6A-17 (Nikaloy Top)                      |
| 3. Floor Drains – Equipment, with Funnel<br>And Primer Tap   | Type "C" 30000-7E3-17 (Nikaloy Top)                     |
| Floor Drains - Mechanical Room,<br>Super Flow Large Capacity | Type "D" 32100-11-50 (Cast Iron Top)                    |
| 4. Trench drains   | Refer to drawing schedule                               |
| 5. Roof Drains   | Type "F" 21500-AE-3-4-22 (Cast Iron Dome)               |
| 6. Roof Drain (Overflow)                                     | Type "G" 21500-AE-3-4-16GLV-22 (Internal<br>Waterguard) |

## 2.3 DOMESTIC WATER PRESSURE REDUCING VALVES

- A. Provide for the domestic cold and hot water systems pressure reducing valves which shall reduce the hot system pressure to the value shown on the drawings. The cold system valve shall modulate to maintain the cold piping to within +/- 5 psig of the hot piping.
- B. The valve shall be provided in the cold water line and shall sense the pressures remote of that valve. A highh pressure line from the control shall be connected downstream of the main valve and shall sense the cold water pressure, with a low pressure line to be connected to the hot water line. As the pressure in the cold water side increases the differential between the cold and hot systems shall increase. The control shall begin to close and the main valve shall modulate closed to keep the cold pressure the same as the hot pressure.
- C. Provide valves with the following accessories:
  1. Self-cleaning strainer provided in the main valve inlet body to protect pilot system from foreign particles.
  2. Isolation valves to isolate pilot system from line pressure during servicing.
  3. Closing speed control to control closing speed of main valve.
  4. Opening speed control to control opening speed of main valve.
  5. Strainers in pilot lines.

- D. Valves shall be model 690G 01ABCSKc DB for piping 3” and larger and model CRD-L for piping 2-1/2” and smaller as manufactured by CLA VAL Company, or approved equal. Valves shall be ductile iron with epoxy coating, bronze trim and Buna N rubber. The pilot control shall be a bronze housing with stainless steel trim and Viton rubber, suitable for dead end domestic water service.

#### 2.4 MASTER MIXING VALVE

- A. Furnish and install where indicated master mixing valve assembly, as manufactured by Powers/Watts, Model LFIS200DVHFSLP or approved equal. It shall be sized for a minimum flow of 1 GPM and a maximum flow of 576 GPM at 5 PSI pressure drop..
- B. Master water mixing valve shall be of the thermostatic type with electronic actuator and integral controls. It shall have bronze body construction with replaceable corrosion resistant components. The assembly shall include integral check valves and manual shut off valves.
- C. The assembly shall be ASSE 1017 listed and shall control the discharge water temperature to +/-2 °F from set point.

#### 2.5 EMERGENCY FIXTURE MIXING VALVE

- A. Furnish and install where indicated emergency mixing valve, as manufactured by Powers or approved equal. Valves shall be sized for the capacity scheduled on the drawings and installed in accordance with manufacturers’ recommendations.
- B. Emergency water mixing valve shall be of the thermostatic type with liquid filled motor. It shall have bronze body construction with replaceable corrosion resistant components. Valve construction shall employ a sliding piston control mechanism. Piston and liner shall be of stainless steel material. Valve shall comply with ANSI Z358.1-2004 and provide positive hot water shut-off and integral cold water bypass.

#### 2.6 PIPE SPECIALTIES

- A. Backwater Valve:
  - 1. Swing type backwater valve suitable for use with sanitary systems. Josam 67400 or equal.
- B. Manual Air Vents:
  - 1. Manual air vents shall be key-operated type installed where indicated on the drawings or as required for proper venting of equipment. Vents at top of vent chambers or coils shall be 1/4" brass cocks, Crane #2190 H or approved equal.
- C. Pressure Regulating Valves:
  - 1. Pressure regulating valve on water fill lines serving hydronic systems shall be designed for 125 psig working pressure, set as required and shall be Watts Series U5B or approved equal. Relief valves shall be Watts Series 174A, ASME stamped or approved equal. Provide unions and pressure gauges upstream and downstream of pressure regulating valves.
- D. Backflow Preventors:
  - 1. Backflow preventors shall be Watts Series LF909 or approved equal, 3/4 inch size and larger, for piping systems. Elsewhere, vacuum breakers shall be Watts, or approved equal, Series 288A No. 9D for equipment and No. 8A for hose bibs.

E. Strainers:

1. Strainers shall be Mueller Steam Specialty Company, Inc., or approved equal, No. 351 for 2" and smaller and No. 758 for 2-1/2" and larger. Screens shall be stainless steel with 1/32" perforations for water. Provide valved blowdown connections on each strainer consisting of a gate valve set between two short nipples. Bush strainer outlet as required for 3/4" maximum connection. Provide a fine mesh start-up screen to be removed after system cleaning.

F. Flowmeter Fittings:

1. Flowmeter fittings shall be Barco or approved equal Venturi type, or Dieterich Annubar type, or approved equal, brass or cast steel construction suitable for 150 psig working pressure and 250 degrees F operating temperature and shall be equipped with brass quick-disconnect valves for connecting flowmeter. The fitting shall have a maximum head loss of one foot water gauge at design rate and shall have an accuracy of plus or minus 5 percent for water temperatures from 40 degrees F to 215 degrees F. Maximum meter reading shall be 50 inches water gauge.

G. Pressure Gauges:

1. Gauges shall be Terice, Ashcroft, Weiss, Winters, Crosby or Marsh equal to Terice No. 450 series, liquid filled, 4-1/2" diameter case, bottom connected for easy reading. Dial shall have black letters on white background.
2. Pressure gauges shall be suitable for field calibration.
3. Each gauge shall be mounted within six feet of the floor on background or pipe mounted. Submit gauge locations and scale ranges for approval.
4. Provide Apollo or approved equal 1/4" ball valve where "gauge cocks" are indicated or required.
5. Select gauge such that at normal service the gauge pointer is at the middle of the scale range.

H. Thermometers:

1. Thermometers shall be Moeller, Terice, Weiss, Taylor, or approved equal. Thermometers shall be bi-metal type with adjustable angle, self-powered (no battery), 3/8" LCD digits display, Hi-impact ABS case, dual F&C switchable, temperature range -40°F-300°F (-40°C-150°C), accuracy +/- 1% or 1°, whichever is greater. Unit shall be complete with brass socket with extension necks for insulated pipes.
2. Thermometer (remote indicating type) shall be Weksler Series X, or approved equal, stainless steel casing, 4-1/2" dial, 0 degrees F to 120 degrees F reading, with Class 5A fully compensating capillary tubing (maximum length 25 feet), air temperature bulb and mounting bracket.

## 2.7 OTHER SPECIALTIES

- A. Hose connections inside of building shall include an integral vacuum breaker and 3/4" hose thread outlet lock shield cap and removable tee handle equal to the Woodford Model 19.
- B. Where exterior wall hydrants or hose bibbs are noted, provide a freezeless wall hydrant with keyed box as manufactured by Josam Series 71300-SS or approved equal.
- C. Provide Zurn or Josam shock absorbers equal to Josam Series No. 75000 on the cold water connection to all fixtures with flush valves and where indicated on the plans. Size in accordance with PDI Standard WH 201.
- D. Mechanical trap seals:

1. Provide mechanical trap seals on all traps subject to evaporation including: floor drains, floor sinks, hub drains, wall boxes, etc. Mechanical trap seals shall be ASSE 1072 listed by Sure Seal or equivalent.

E. Downspout Nozzle:

1. Provide bronze downspout nozzle with wall flange, threaded inlet, and ½” wire mesh. Josam 25010-24 or equal.

2.8 GREASE INTERCEPTOR

1. Refer to specification section 221323.
2. Unit shall have a minimum 30 year warranty.

2.9 OIL INTERCEPTOR

1. Furnish and install acid resistant coated interior and exterior fabricated steel oil interceptor with bronze cleanout plug and visible double wall trap seal, removable combination pressure equalizing/flow diffusing baffle and sediment bucket, horizontal baffle, adjustable oil draw-off and vent connections either side, secured gasketed non-skid cover, complete with flow control fitting.
2. Interceptor shall be Zurn type, Z1186, or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  1. Size same as drainage piping up to 4”. Use 4” for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 45 degrees.
  3. Locate at minimum intervals of 50 feet for piping 4” and smaller and 100 feet for larger piping.
  4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  1. Position floor drains for easy access and maintenance.
  2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

- a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
  - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
  - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- G. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- I. Assemble open drain fittings and install with top of hub 2 inches above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
  2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
  3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
- N. Install wood-blocking reinforcement for wall-mounting-type specialties.
- O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- P. Install piping adjacent to equipment to allow service and maintenance.

### 3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
  2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### 3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Pumps

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221300





## SECTION 22 1323 - SANITARY GREASE INTERCEPTORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Grease interceptors.

#### 1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. PDI: Plumbing and Drainage Institute
- C. GREASE INTERCEPTOR: Elliptical fiberglass (FRP) tank system designed with built-in inlet piping and baffle penetration that introduces wastewater in a tangential laminar flow to reduce disruption of collected grease and solids. Tank system is designed to capture and hold grease and solids to maximize waste retention and optimize Stokes Law separation. System backed by 30 year manufacturer warranty.
  - 1. GRAVITY GREASE INTERCEPTOR: Elliptical fiberglass (FRP) interceptor that is certified to meet IAPMO/ANSI Z1001-2007 and applicable sections of the latest editions of the Uniform Plumbing Code or the International Plumbing Code. Interceptor is designed to deliver 100 PPM non-emulsified free-floating oil and grease and 350 PPM Total Suspended Solids effluent quality based on inlet peak fixture flow.
  - 2. HYDROMECHANICAL OR PDI CERTIFIED GREASE INTERCEPTOR: Elliptical fiberglass (FRP) interceptor that is certified to meet PDI G-101 Standard rated at 100 GPM flow.
  - 3. CSA CERTIFIED GREASE INTERCEPTOR: Elliptical fiberglass (FRP) interceptor that is certified to meet CSA B481 Standard rated at either 50 GPM or 100 GPM flow.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of plastic interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of interceptor indicated.
  - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from Installers of the items involved:

1. Interceptors.
2. Piping connections. Include size, location, and elevation of each.
3. Interface with underground structures and utility services.

## PART 2 - PRODUCTS

### 2.1 GREASE INTERCEPTORS

- A. Basis of Design: Elliptical Fiberglass (FRP) grease interceptor construction, as supplied by Zurn Green Turtle Inc., with inlet piping and baffle penetration designed to introduce wastewater in a tangential laminar flow pattern, to be appropriately sized based on anticipated usage and flow rates to meet applicable sanitary sewer discharge limits, incl. municipal by-laws.

1. Include accessways, tanks, and piping and baffle openings to retain grease and solids and to permit tangential laminar wastewater flow.
2. Factory installed Schedule 40 PVC cement welded type socket ports, or straight pipe, fitted into interceptor walls for each pipe connection.
3. Accessway Extension Collar:
  - a. Fiberglass risers (EC2), 36-inch optional alternate.
4. Accessway Frames and Covers: Round cover with non slip cover finish, gasketed and non vented top design.
  - a. Cast Iron: AASHTO M306 Traffic load rated. 36-inch diameter cover with 0.25" gasket. Two closed pickholes. Non Bolted or Bolted option. ASTM A48 CL35B.
  - b. Include indented top design with lettering cast into cover, using wording equivalent to the following: Grease Interceptors in Sanitary Sewerage System: "GREASE INTERCEPTOR"
5. Watertight Flexible Caulking: Sikaflex 255 or Sikaflex 221 or approved alternate to provide watertight seal at extension collar joints.

- B. Capacities and Characteristics:

1. Number of Compartments: 2 cells
2. Total Capacity: 2000 USG
3. Grease Retention Capacity: 1154 USG
4. Solids Retention Capacity: 589 USG
5. Inlet and Outlet Schedule 40 PVC Pipe Size: 6"
  - a. Centerline of Inlet to Grade: Coordinate with civil division
  - b. Centerline of Outlet to Grade: Coordinate with civil division
6. Vent Pipe Size: 3".
7. Installation Position: Underground with accessway collar riser to grade.
8. Green Turtle Proceptor Model: GMC 2000(2).

### 2.2 FIBERGLASS ACCESSWAY RISERS

- A. Fiberglass accessway extensions: Fiberglass wound pipe.

1. Length: From top of underground tank to underside of access frame at grade.
2. Extension Sections: 0.25-inch minimum thickness and 36-inch I.D. as a single continuous piece, without joints unless approved by the manufacturer.
  - a. Sealant: Watertight Flexible Caulking, Sikaflex 255 or Sikaflex 221 or approved alternate to provide watertight seal at extension collar joining to tank on bottom and access frame at top.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

#### 3.2 INSTALLATION

- A. Install fiberglass interceptors according to manufacturer's installation instructions.

#### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 22010 and 22050. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

#### 3.4 IDENTIFICATION

- A. Identification materials and installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
  1. Use warning tapes or detectable warning tape over ferrous piping.
  2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 22 1323



## SECTION 222923 – VARIABLE FREQUENCY MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

#### 1.3 COMMISSIONING

- A. Division 22 will be responsible to carry out the commissioning requirements specified in Section 220010.

#### 1.4 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with Section 220050:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field installation, and location and size of each field connection.
  - 4. Include diagrams for power, signal, and control wiring.
  - 5. Operation and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

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

#### 1.6 WARRANTY

- A. General Warranty: Manufacturer's standard form in which manufacturer agrees to provide labor and materials to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period shall be 2 years from date of Substantial Completion not to exceed 30 months from date of shipment.

### PART 2 - PRODUCTS

#### 2.1 VARIABLE TORQUE AC VARIABLE FREQUENCY CONTROLLER: PULSE WIDTH MODULATION TYPE

- A. AC Variable Frequency Controllers shall be provided for equipment as scheduled on the plans. The variable frequency controller (VFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, AC power for stepless motor control from 10% to 110% of base speed. The

- VFC shall be as manufactured by ABB, GE, Yaskawa, Danfoss, Eaton, Rockwell Automation (Allen-Bradley), or Toshiba.
- B. The VFC shall be a voltage source type with a PWM output utilizing IGBT transistor semi-conductors. The base VFD shall be UL Listed for 100 KAIC without the need for input fuses.
- C. The VFC shall meet EMI/RFI Product Standard EN61800-3 for First Environment Restricted Level.
- D. Seismic qualifications: By manufacturer, from qualified testing agency, shall comply with International Building Code.
- E. The VFC together with all options and modifications shall be mounted within a standard NEMA 12 enclosure suitable for continuous operation at an ambient temperature of 0o to 40o C with relative humidity to 95% non condensing. All high voltage components within the enclosure shall be isolated with steel covers. The complete unit shall carry UL or ETL listing under standards UL508A and UL 61800-5-1; enclosures shall comply with NEMA 250.
- F. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. VFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:
1. 110% of controller maximum sine wave current rating is exceeded.
  2. Output phase to phase and phase to ground short circuit condition.
  3. High input line voltage.
  4. Low input line voltage.
  5. Loss of input phase.
  6. External fault. This protective circuit shall permit, by means of the terminal strip, wiring of remote NC safety contacts such as high static, firestat, etc., to de-energize the AFC.
- G. The following adjustments shall be available in the controller and retained in non-volatile memory:
1. Maximum frequency (15 to 500 hz) factory set at 60 hz.
  2. Minimum frequency (3 to 60 hz) factory set at 6 hz.
  3. Acceleration (.1 to 360 seconds) factory set at 20 seconds.
  4. Deceleration (.1 to 360 seconds) factory set at 20 seconds.
  5. Volts/Hertz ratio factory set for 460V at 60 hz.
  6. Voltage offset or boost factory set at 100% torque.
  7. Current limit (50% to 110% sine wave current rating) factory set at 100% current.
- H. The VFC shall have the following basic features:
1. Door mounted operator controls consisting of membrane command center which will enable manual hand-off-auto and speed control, local/remote indication and manual/or automatic speed control selection. In addition, the command center will serve as a means to configure controller parameters such as minimum speed, maximum speed, acceleration and deceleration times, volts/hz ratio, and torque boost.
  2. Main input disconnect to provide a possible disconnect of all phases of the incoming AC line to both the controller and the bypass circuitry. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.
  3. Input fuses, or circuit breaker overcurrent protective device.
  4. Electronic motor overload relay.
  5. Automatic restart after power outage, drive fault or external fault, with drive in its automatic mode. The circuit shall enable the user to select up to five (5) restart attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center.
  6. Door-mounted LED display for digital indication of:
    - a. Frequency output.

- b. Voltage output.
  - c. Current output.
  - d. First fault indication.
7. Relay for remote indication of drive fault and motor running.
  8. Smoke purge circuit to enable acceptance from a contact closure from the building control and monitoring system (BCMS), that will start the controller regardless of mode and operate the motor at a preset adjustable speed.
  9. A minimum of two critical frequency avoidance bands, field programmable via the membrane command center. Each critical frequency avoidance band shall have a bandwidth adjustable via the keypad of up to 10 Hz.
  10. The drive shall be equipped with a direct interface device utilized to provide communication to the building BCMS system, [name BCMS manufacturer] [or] [BACNET PROTOCOL], and a USB port for communication with a PC.
  11. Isolated process follower to enable VFC to follow a 4-20 MADC or 0-10VDC grounded or ungrounded signal.
  12. The VFC shall have the capability to ride through power dips or outages up to 16.66 milliseconds without a controller trip.
  13. AC line reactor 5% impedance to minimize line surges, line notching, and voltage distortions, or DC bus choke with 5% impedance (equivalent).
  14. Manual bypass-to-line with magnetic contactors to transfer motor from the VFC to line speed operation on utility supplied input power while the motor is at any speed. Two motor contactors, electrically interlocked shall be utilized, one contactor between the controller output and the motor, and the other between the by pass power line and the motor, providing across the line starting.
  15. Motor protection per the NEC shall be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. The 24-volt DC relay control logic, allowing common start/stop commands in the "controller" mode and the "bypass" mode shall also be included within the enclosure.
  16. In addition to the door interlocked, main power input disconnect providing positive shutdown of all power to both the bypass circuitry and the VFC. The bypass circuit shall provide a service switch to safely trouble shoot and test the controller, both energized and de-energized, while operating the bypass mode. Terminal connectors for over pressurization switches shall be provided, to protect the ductwork in the bypass mode.
  17. Control power transformer, 120VAC secondary, with primary and secondary fuses, sized to operate connected control burden plus 50VA.
- I. For single drive, multiple fan or pump operations, the VFC shall be provided with fuses and overload protection for each fan or pump separately. Termination points shall be provided for final wiring connections by Division 16. Provide means of disconnect for each pump or fan on enclosure.
  - J. Output Filtering: Provide DV/DT output filtering to limit standing waves as required for installed output circuit lead lengths, based on drive manufacturer's guidance.
  - K. The manufacturer shall have service and parts suppliers located within a two hour driving distance. Start-up service shall be provided by a factory authorized technician.
  - L. The VFC shall carry a full parts and labor warranty for two years from date of start-up.
  - M. Provide schematic single line diagrams of the VFC showing all power and control circuits as part of the shop drawing submittal.
- 2.2 LINE CONDITIONING AND FILTERING
- A. Input Line Conditioning: Passive harmonic filter, selected to limit input Voltage and Current Total Harmonic Distortion (THD%) to IEEE 519 (2014 Revision) Table 2 limits when the point of common coupling is defined as the input terminals to the VFD. Filter shall also provide minimum 5% reactive line

impedance. Filter package shall be MTE Matrix AP or equal and shall be incorporated into the bypass cabinet or supplied in a separate NEMA 3R enclosure.

- B. Output Filtering: For distances between VFD and Motor over 50 feet, and as indicated on the Drawings, provide dV/dT output filter.
- C. EMI/RFI Filtering: CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking.

## 2.3 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
  - 1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
  - 2. The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.
  - 3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
  - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
  - 1. Elapsed-time meter.
  - 2. Kilowatt meter.
  - 3. Kilowatt-hour meter.
- F. Cooling Fan and Exhaust System: For NEMA 250, UL Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.
- G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

## 2.4 SOURCE QUALITY CONTROL

- A. Testing: VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, (NEMA rated enclosures are not acceptable) completely assembled and tested by the manufacturer in an ISO9001 facility.
  - 1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
  - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.



- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 HARMONIC ANALYSIS STUDY

- A. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at the defined PCC per IEEE 519 to specified levels

#### 3.2 INSTALLATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks.
- C. Floor-Mounting Controllers: Install VFCs on 4-inchnominal thickness concrete base.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Install fuses in each fusible-switch VFC.
- E. Install fuses in control circuits if not factory installed.
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

#### 3.3 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified.
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFC with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### 3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
  - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
  - 5. Test each motor for proper phase rotation.
  - 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 7. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges.
- F. Set field-adjustable pressure switches.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 222923



## SECTION 223400 – DOMESTIC WATER HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Commercial, indirect-fired, domestic-water heaters.

#### 1.3 SUBMITTALS

- A. Submit Shop Drawings for all materials specified in this section in accordance with Section 220050.
  - 1. Include construction details, materials descriptions, dimensions of individual components and profiles, and finishes for the product.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
  - 3. Include details of equipment assemblies, indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Include diagrams for power signal and control wiring.
  - 5. Operation and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
  - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

#### 1.5 WARRANTY

- A. Manufacturer will repair or replace any part of the equipment we manufacture that is found to be defective in workmanship or material within 18 months of shipment from the factory or 12 months from start-up (whichever comes first). Manufacturer should be notified in writing as soon as the defect becomes apparent.

- B. Each boiler shall be completely tested before leaving the manufacturing factory. This includes a hydrostatic pressure test prior to final assembly and factory test fired prior to shipment. Combustion must be set on all fuels and all firing rates. A factory test fire report and wiring diagram shall be provided with each boiler.
- C. The pressure vessel shall be guaranteed against thermal shock for 10 years (non-prorated) when utilized in a closed loop hydronic heating system with a maximum temperature differential rating of up to:
  - 1. Carbon Steel Units: 170 degrees Fahrenheit
  - 2. Duplex Alloy Steel Units: 100 degrees Fahrenheit.
- D. The boiler pressure vessel shall be guaranteed accordingly without a minimum return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure a minimum flow through the boiler.
- E. The pressure vessel shall carry a 10-year warranty against material and workmanship defects. This warranty shall be non-prorated for the first 7 years and years 8-10 shall be pro-rated as per schedule posted on the current product warranty.
- F. The combustor and exhaust pipes (heat exchanger) shall be guaranteed against flue gas corrosion for a period of 10 years on carbon steel boilers or duplex alloy steel boilers. This warranty shall be non-prorated for the first 7 years and years 8-10 shall be pro-rated as per schedule posted on the current product warranty.
- G. All parts not covered by the above warranty shall carry a one-year warranty. This shall include all electrical and burner components.

## PART 2 - PRODUCTS

### 2.1 INDIRECT FIRED DOMESTIC HOT WATER HEATER:

- A. Indirect fired domestic water heater shall be Hubbell Model BWXP-SS-2400-PFD-XX, or approved equal.
- B. Water heater shall be plate and frame, double wall, instantaneous water to water heat exchanger.
- C. Water heater shall have flanges or unions at boiler water connection points. Entire Assembly shall be ASME rated for domestic water working pressure of 150 psig and boiler water working pressure of 150 psig. Heat exchanger shall be insulated and include a painted steel jacket. Entire assembly shall be mounted on a structural steel frame.
- D. Material in contact with domestic water, including fittings, and piping, shall be non-ferrous. Heat exchanger shall be 316L stainless steel.
- E. Water temperature control shall be provided by 2-way, normally closed, modulating control valve. Outlet water temperature shall be controlled to within +/-4°F of set point over flow range of 3-100% of rated flow. High temperature limit system with automatic reset shall be provided to close control valve on over-temperature condition. Wiring to be factory packaged enclosed in conduit and control enclosure.
- F. Water heater shall come packaged with an ASME temperature and pressure relief valve, inlet and outlet water thermometers on both domestic and boiler water, painted structural steel support frame, copper water piping, and Schedule 40 black steel or copper boiler water piping.
- G. Basis of design water heater is Hubbell model BWXP-SS-PFD-XX, capable of 50 gpm recovery at a 40-140°F temperature rise with 150°F temperature boiler water supplied. Heat Exchanger must be sized to

reduce design boiler water return temperature to 100F or below to increase condensing boiler plant efficiency and reduce HWS pump flow and electric consumption. Domestic water heaters that return higher than 100F boiler water at design will not be acceptable

- H. Water heater should incorporate a BACnet compatible communication card to report points to BAS system.

### PART 3 - EXECUTION

#### 3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Install domestic-water heaters on concrete base.
  - 1. Maintain manufacturer's recommended clearances.
  - 2. Arrange units so controls and devices that require servicing are accessible.
  - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 6. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 7. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
  - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.
- E. Install thermometer on outlet piping of domestic-water heaters.
- F. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet.
- G. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill domestic-water heaters with water.
- I. Charge domestic-water compression tanks with air.

- J. Where installing piping adjacent to domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.
- K. Initial start-up and balancing services shall be provided by representative of manufacturer.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 223400



## SECTION 224213 – PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This section includes all plumbing fixtures to be provided for the project.
- B. The requirements of Section 220010 Plumbing General Provisions shall apply to all work specified under this section.

#### 1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 220050.
  - 1. Include construction details, material descriptions, dimensions of individual components and finishes for the product.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
  - 4. Include diagrams of power, signal and control wiring.
  - 5. Operation and maintenance manuals.

#### 1.4 CODES

- A. All plumbing products, materials of construction, and joining methods used in the installation or repair of plumbing intended to dispense water for human consumption shall be in compliance with the United States Safe Drinking Water Act and shall meet the limit of weighted average lead content as set forth in NSF/ANSI 372. All such products shall also meet the lead leaching requirements of NSF/ANSI 372.
- B. Provide all plumbing connections required by fixtures and equipment which are provided on this project. Certain items of equipment shall be provided under this section and certain items will be furnished and set under other sections of the specifications. In all cases, provide valved water supplies, waste and vent lines, and, unless noted otherwise, make final connections after the fixtures and equipment are in place.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Refer to schedule on contract drawings for description and composite for all plumbing fixtures.
- B. Fixtures shall be American Standard, Aquarius, Aqua Bath, Bradley, Crane, Eljer, Elkay, Fiat, Guardian, Just, Kohler, Speakman, Stern-Williams or Zurn equal to the composite models specified on the drawings.
- C. Trim shall be Chicago, McGuire, Omni, Powers, Speakman, Truebro, or T&S Brass and Bronze Works, equal to the composite models specified on the drawings.

- D. Flush valves shall be Sloan, Zurn or Delany. Flush valve handles shall be located on the "wide side" of the toilet areas for handicapped use.
- E. Toilet seats shall be Church or Olsonite, equal to the composite models specified on the drawings.
- F. Carriers shall be Josam, Jay R. Smith, Watts or Zurn, equal to the composite models specified on the drawings.
- G. Water coolers shall be Haws, Oasis, or Sunroc, equal to the composite models specified herein.
- H. Floor sinks shall be Josam, Jay R. Smith, Watts, or Zurn, equal to the composite models specified herein.
- I. Emergency fixtures shall be Bradley or Speakman, equal to the composite models specified herein.
- J. Hospital equipment will be furnished by owner for installation by contractor unless specified otherwise.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted fixtures.
  - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install floor-mounted water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.
- D. Install counter-mounted fixtures in and attached to casework.
- E. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- F. Each fixture and piece of equipment connected to the sanitary system shall be equipped with a trap. Provide traps for storm water lines where required by code. Each trap shall be placed as close to the fixture as possible and no fixture shall be double trapped. All traps on bell and spigot pipe shall be service weight cast iron and all traps on threaded pipe shall be galvanized cast iron recessed drainage type.
- G. Install flushometer valves on water closets.

- H. Install flushometer valves for accessible water closets, with lever handle mounted on wide side of compartment.
- I. Install toilet seats on water closets.
- J. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts. Include adapters if required.
- K. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.
- L. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- M. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
- N. Set showers pans in leveling bed of cement grout.
- O. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220700 Plumbing systems insulation.
- P. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.
- Q. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

### 3.4 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.5 CLEANING AND PROTECTION

- A. After installing plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213



## SECTION 226100 – MEDICAL GAS EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  1. Dry claw vacuum pump units.
  2. Skid mounted medical compressed air units.
  3. Central compressed air units.
  4. Instrument air compressor.
  5. Medical gas valves and boxes.
  6. Alarm panels
  7. Medical gas outlets.
  8. Medical gas manifolds.

#### 1.3 SUBMITTALS

- A. Submit shop drawings for all materials specified in this section in accordance with section 220050.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Include plans, elevations, sections, and mounting or attachment details.
  3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  4. Include diagrams for power, signal, and control wiring.
  5. Operation and maintenance manuals.

#### 1.4 EQUIPMENT CONNECTION

- A. Provide all connections required by medical gas equipment and devices equipment which is provided on this project. Certain items of equipment shall be provided under this section and certain items may be furnished and set under other sections of the specifications. In all cases, make final connections in accordance with manufacturers recommendations after equipment is in place.

### PART 2 - PRODUCTS

#### 2.1 PIPE, VALVES AND FITTINGS

- A. Provide materials as hereinbefore specified in Section 220050.

#### 2.2 VACUUM PUMP UNIT (DRY-CLAW TYPE)

- A. Provide a complete medical vacuum source, complying with NFPA 99 5.1.3.7 in all respects, as specified and scheduled on the drawings. Provide BeaconMedaes model VHS08Q-240V-Q\_V or preapproved equal. System shall be rated for 210 SCFM at 19” HgV with one unit on standby.
- B. All components shall be at least duplexed and valved (or check valved as provided in NFPA-99) to permit service to any component without interrupting vacuum supply to the facility during any maintenance

- operation or any condition of single fault failure. Each pump exhaust shall be isolated by a ball valve for service isolation.
- C. Furnish complete plant consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service. All capacities shall be indicated in SCFM at 19 inches HG.
  - D. Furnish medical vacuum filter assembly rated for the full capacity of the vacuum system. Medical vacuum filter assembly shall be of modular construction and ship separately of the medical vacuum system.
  - E. System shall be entirely on a single base or a base which can be separated in the field for rigging. If separable, bases are prepared for separation from the factory. System or system sections shall fit through a standard 36 inch door frame.
  - F. System piping shall utilize o-ring sealed flanges and SAE O ring or flare fittings for minimum leakage and easy repair. Valves shall be butterfly or ball type, positive seal with three piece disassembly.
  - G. System shall be completely factory assembled. Field connections to be (1) inlet line (from facility), (1) outlet, and (1) electrical conduit and power. Systems requiring site assembly are not acceptable (except reattachment of sections separated on site at contractor's convenience).
  - H. System base, frames, control cabinet, piping and receiver shall be powder coated for durable and attractive finish.
  - I. Each pump shall include corrugated metal inlet and outlet flex connectors factory installed by the MGEM. Systems employing plastic or rubber hoses for flex connectors shall not be acceptable.
  - J. Provide non contacting claw style rotary pumps. Internal construction shall be friction free and rotors are to be non-contacting. Air end shall be oil free and shall require no sealants. Each pump shall be air cooled and continuous duty rated. Pumps shall be provided with single lubricated gearboxes requiring oil change not more often than annually. MGEM shall offer a testing service for pump oil to allow less frequent changes. System shall be provided with an exhaust silencer which shall ship loose for field installation in the vent piping. Pumps shall be equipped with high vacuum shutdown and high temperature shutdown.
  - K. Each pump shall be direct or close coupled to a NEMA rated Premium Efficiency TEFC motor with a service factor of 1.15.
  - L. Control system shall be contained in a cabinet factory prepunched for conduit connections. Provide three punches: for power in sized per NFPA 70 Article 310 and based on total system amperes, for communications, and for master alarm wiring, each sized for ½" EMT conduit. The control system is to be built and labeled in a UL approved panel shop operating under ISO 13485 (Medical Device) registration. Provide in the control system door:
    - 1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control.
    - 2. Separate 16 bit, full color half VGA resolution touch screens for display of pump functions and pump control. These controls shall provide selector control of Automatic, Manual (continuous run) or Off for each pump.
    - 3. Screens shall turn off when not in use to preserve screen life.

4. A separate disconnect handle with door interlock for each pump (note for systems greater than triplex, only two disconnect handles are required, but individual disconnect means shall be provided inside the cabinet).
5. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
6. Power on lamp illuminated whenever any disconnect is On.
7. Means for deactivating the screen saving function.

M. Provide in the control cabinet interior:

1. Full voltage motor starters with overload protection, one per pump.
2. Circuit breaker disconnects, one for each pump operated by the through the door disconnect handle.
3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
4. Power distribution terminal block convenient for main power entry.
5. All internal circuit boards and components needed for operation of the control system as described below.
6. Volt free contacts for connection to master alarms.
7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

N. The control system shall provide for the following functionality:

1. Display of vacuum level on a single display for at a glance checking
2. Automatic lead/lag sequencing and alternation. Display shall clearly show status of each pump including running unit, next-unit-in-sequence, and units unavailable to run.
3. Runtime hour-meters for each pump.
4. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.
5. When H-O-A selectors are in Hand mode, system shall operate on a vacuum switch and pump will not run if lead switch is satisfied.
6. Visual and audible alarm indication and isolated contacts for remote alarm for at least Lag Pump in Use.
7. Continuous monitoring of ambient temperature.
8. Automatic indication of major maintenance intervals and details of required maintenance kits.
9. Distinct separate indication on the control screens of alarms which shutdown the pump vs. alarms which do not shut down the pump vs. maintenance notifications.

10. Isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, A condition which does not shut down the system, and A maintenance required event.
  11. Control system shall permit individual test of lag in use, high temperature, and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local, and connected master (source) alarms.
  12. Controls shall facilitate one-person “bumping” of the pumps to test rotation.
  13. Control system shall log and allow review of all alarm and shutdown events.
  14. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to make vacuum. Control systems which can lose any single component and fail to make vacuum are not acceptable.
  15. An integral webserver using standard Ethernet which facilitates observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special software are not acceptable.
  16. Controls shall provide autodiscovery from and of any Total Alert alarm on the same network allowing for system wide linking and inspection of any networked component through any single connection.
  17. BACnet capability. MGEM shall also be a registered BACnet vendor.
- O. Provide one (1) ASME galvanized vacuum control tank, 240 gallons, fitted for vertical installation. The tank shall be fitted with a pressure gauge, safety valve, and gauge glass. The tank shall be pre-piped by the manufacturer to provide continuous draining of liquid and debris. The vessel shall not be installed as a dirt trap. Piping must allow vacuum pump operation simultaneously with full tank bypassing per NFPA 99C to allow venting and maintenance while pumps are under operation providing central vacuum.
- P. The complete medical vacuum system and all electrical components shall be factory pre-tested prior to shipment by the MGEM.
- Q. Provide separately for installation at site in vacuum inlet piping, one (1) vacuum switch together with vacuum gauge and demand check. The switch shall be wired at site by others to Master Alarm Panels.
- R. The manufacturer shall supply the services of a factory-authorized technical representative to check the installation, start-up the vacuum system, and instruct Owner's personnel in the operation and maintenance of the unit. A written report confirming that equipment was started and left in satisfactory operating condition shall be provided.
- S. The supplier shall have a fully staffed factory-authorized service organization available 24 hours a day, 7 days a week, year-round.
- T. Refer to schedule on drawings for required capacities.
- U. The entire system shall be covered by factory warranty for 30 months from shipment.
- 2.3 MEDICAL AIR COMPRESSOR – SCROLL TYPE
- A. Provide a complete medical air source, complying with all relevant requirements of NFPA 99 5.1.3.5 and supplying medical air continuously for the life of the equipment. Provide BeaconMedaes model



SAS20Q-240V-Q or preapproved equal. The unit shall be rated for 192 SCFM at 55 PSIG regulated delivery pressure with one unit on standby.

- B. Furnish a complete plant consisting of compressors, receiver, air treatment system and controls capable of providing scheduled capacity with one compressor out of service and complying with requirements below.
- C. System shall be entirely on a single base or a base which can be separated in the field for rigging. If separable, bases shall be prepared for separation from the factory. System or system sections fit through a standard 36 inch door frame.
- D. System shall be completely factory assembled. Systems requiring site assembly are not acceptable (except reattachment of sections separated on site at contractor's convenience).
- E. System base, frames, control cabinet and receiver shall be powder coated for durable and attractive finish.
- F. The compressor modules and motors shall be fully isolated from the main compressor base by means of a four point, heavy-duty isolation system for a minimum of 95% isolation efficiency. System shall be engineered for equal weight distribution between four isolation points.
- G. Flexible connections between compressor units and the structure shall be provided for all inlets and outlets. Vibration flexes to be all metal and of sufficient length to achieve full isolation. Systems using rubber or plastic tubing flex connectors are not acceptable. Systems with short flex connections providing only nominal isolation are not acceptable. Inlet flexes shall be corrugated metal with outer stainless braid. Outlet flexes shall be metal and double wall with thermal isolation.
- H. Any piping or connection which may exceed 150 degrees F. shall be guarded to prevent contact burns. Belt and fans shall be guarded to prevent worker injury. Hazard labeling alone is not acceptable.
- I. The compressors shall be a continuous duty rated scroll type. The design shall be single stage, air-cooled, consisting of one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves and rated for 828 kPa (120 PSIG) discharge pressure. Orbiting bearings shall be grease filled. Compressors shall be field serviceable for tip seal change and bearing lubrication. Non-field serviceable scroll compressors are not acceptable. Noise level shall not exceed 75 dB(A) for duplex system, 78 dB(A) for triplex system, and 80 dB(A) for quad system with pumps running at peak demand. Belt tensioning shall be achieved with a sliding motor mounting base adjustable with two tensioning screws. Each compressor unit shall be equipped with a distinct after cooler with separate cooling fan designed for a maximum approach temperature of 7°C (15°F) at 37.8°C (100°F) ambient and complete with electronic drain valve. Designs using compressor cooling air for the aftercooler are not acceptable. The discharge of piping of each compressor shall incorporate an electronic solenoid valve to prevent reverse rotation of the scroll at shutdown.
- J. Each compressor airend or element shall be protected by an intake filter of quality no less than 2 micron for particulate. Designs that utilize a common intake filter for multiple elements or airends shall not be accepted.
- K. Control system shall be contained in a cabinet factory prepunched for conduit connections. Provide three punches: for power in sized per NFPA 70 Article 310 and based on total system amperes, for communications and for master alarm wiring, each sized for ½" EMT conduit. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 Medical Device registration. Provide in the control system door.
  - 1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control.

2. Separate 16 bit, full color half VGA resolution touch screen for display of compressor unit functions and compressor unit control. These controls provide selector control of Automatic, Manual (continuous run) or Off for each compressor unit.
  3. Screens turn off when not in use to preserve screen life.
  4. A separate disconnect handle with door interlock for each compressor unit (note: for multiplex units greater than triplex, only two disconnect handles shall be required).
  5. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
  6. Power on lamp illuminated whenever any disconnect is On.
  7. Means for automatically deactivating the screen saving function.
- L. Provide in the control cabinet interior:
1. Full voltage motor starters with overload protection, one per compressor unit.
  2. Circuit breaker disconnects, one for each compressor unit (note: for multiplex units greater than triplex, only two circuit breakers are required) operated by the through the door disconnect handle.
  3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
  4. Power distribution terminal block convenient for main power entry.
  5. All internal circuit boards and components needed for operation of the control system as described below.
  6. Volt free contacts for connection to master alarms.
  7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.
- M. The control system shall provide for the following functionality:
1. Display of pressure, dew point and carbon monoxide level on a single display for at a glance checking.
  2. Automatic lead/lag sequencing and alternation. Display clearly shows status of each compressor unit including running unit, next-unit-in-sequence, and units unavailable to run.
  3. Runtime hour-meters for each compressor unit.
  4. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.
  5. When H-O-A selectors are in Hand mode, system will operate on pressure switch and compressor units will not run if lead switch is satisfied.
  6. Visual and audible alarm indication and isolated contacts for remote alarm for at least Dew Point High, CO High, Lag Compressor in Use, and High Temperature (for each compressor unit alone or system together).

7. Continuous monitoring of ambient temperature.
  8. Automatic indication of major maintenance intervals and details of required maintenance kits.
  9. Distinct separate indication on the control screens of alarms which shutdown the compressor vs. alarms which do not shut down the compressor vs. maintenance notifications.
  10. Control and observation of dryer operation from control panel with controls integral to touchscreen system. System includes maintenance alerts and diagnostics for dryers.
  11. Isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, A condition which does not shut down the system and a maintenance alert.
  12. Permit individual test of Dew point, CO, lag in use, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local and connected master (source) alarms.
  13. One-person “bumping” of the compressors to test rotation.
  14. Logs and allows review of all alarm and shutdown events.
  15. Logs and allows review of all maintenance events.
- N. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to make air. Control systems which can lose any single component and fail to make air are not acceptable.
- O. Controls shall include an integral webserver using standard Ethernet allowing observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special software are not acceptable.
- P. Autodiscovery from and of any Total Alert alarm on the same network allowing for system wide linking and inspection of any networked component through any single connection.
- Q. Compressor motors shall be NEMA Premium Efficiency rated, open drip proof unit with 1.15 service factor suitable for 208 or 230/460 volt, three phase, 60hz.
- R. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.
- S. A temperature sensor at the outlet of each compressor cylinder or air-end to provide high temperature alarm and shutdown that compressor. Systems employing a single switch for multiple cylinders or air-ends are not acceptable.
- T. Provide redundant medical air treatment systems including desiccant dryers, filters, and purifiers sized for NFPA system output. Include dew point and carbon monoxide monitoring. Medical air treatment shall include:
1. Desiccant dryers producing a 10°F (-12°C) pressure dew point. Refrigerant dryers are not acceptable.
  2. Dryer purge flow control through an integral dew point based purge control system. Purge controllers using desiccant temperature are not acceptable.

3. 441 transfer valve utilizing two ceramic slide plates. Units utilizing multiple solenoids or diaphragm type switching are not acceptable. Valve shall require no periodic service and be covered by a 5 year factory warranty.
  4. Mounted coalescing pre-filter rated for 0.01 micron with automatic drain and element change indicator at the inlet to each dryer.
  5. Final line filters rated for 0.1 micron with element change indicators (per NFPA 99 5.1.3.5.8(3)&(4)), duplexed final line regulators, and duplexed safety relief valves shall be factory mounted and piped at the outlet of each dryer.
  6. Sensors for dew point and CO sensors are provided with a DISS demand check per NFPA 5.1.8.2.4.
- U. System piping shall be welded except where unions are required for service or where piping connects to valves or system components. Main flow path joints shall be flanged and provided with seals, use 37° SAE flares suitable for flaretight seals or SAE straight thread with O-ring seal for leak tight connection and ease of replacement or service. NPT fitting use shall be minimized.
- V. Provide 240 gallon capacity, corrosion resistant, powder coated, ASME Coded, National Board Certified receiver rated for a minimum 150 PSIG design pressure. Include a liquid level glass with bead, safety relief valve, manual drain valve, and zero loss tank drain. Systems employing timed solenoid type drain valves are not acceptable.
- W. The complete medical air package shall be pre-wired, pre-piped and assembled on one common base with single point connections for electrical, intake air, discharge air, and condensate drains. All piping shall be factory complete including all valves per NFPA 99 Fig. A-5.1.3.5.11.6.
- X. The complete medical air system and all electrical components shall be factory pretested prior to shipment by the MGEM.
- Y. Provide separately for installation at site in air delivery piping, one (1) pressure switch together with pressure gauge and demand check. The switch shall be wired at site by others to Master Alarm Panels.
- Z. The manufacturer shall supply the services of a factory-authorized technical representative to check the installation, start-up the compressor system, and instruct Owner's personnel in the operation and maintenance of the unit. A written report confirming that equipment was started and left in satisfactory operating condition shall be provided.
- AA. The supplier shall have a fully staffed factory-authorized service organization available 24 hours a day, 7 days a week, year-round.
- BB. Refer to schedule on drawings for required capacities
- CC. The entire system shall be covered by factory warranty for thirty (30) months from shipment, except for dryer air transfer valves, which shall be covered by factory warranty for sixty-six (66) months from shipment.
- 2.4 INSTRUMENT AIR COMPRESSOR
- A. Provide a complete laboratory air source, supplying laboratory air continuously for the life of the equipment. Provide BeaconMedaes model LAS15Q-240V-Q-40 or preapproved equal. The unit shall be rated for 86.7 SCFM at 145 regulated delivery pressure with one unit on standby.

- B. Furnish a complete plant consisting of compressors, corrosion-resistant receiver, air treatment system and controls capable of providing scheduled capacity.
- C. Compressor system including receiver, air treatment equipment, and starter panel shall be entirely on a single base or a base which can be separated in the field for rigging. If separable, bases shall be prepared for separation from the factory. System or system sections shall fit through a standard 36 inch door frame.
- D. Compressor system shall be completely factory assembled. Field connections to be (1) outlet (to air treatment system), (1) electrical conduit and power and (1) line to floor drain. Systems requiring site assembly are not acceptable (except reattachment of sections separated on site at contractor's convenience).
- E. System base, frames, control cabinet and receiver shall be powder coated for durable and attractive finish.
- F. The compressor modules and motors shall be fully isolated from the main compressor base by means of a four point, heavy-duty isolation system for a minimum of 95% isolation efficiency. System is engineered for equal weight distribution between four isolation points. Systems not having this feature shall have an inertia base sized for that system installed at this contractor's expense.
- G. Flexible connections between compressor units and the structure shall be provided for all outlets. Vibration flexes are all metal and of sufficient length to achieve full isolation. Systems using rubber tubing flex connectors with hose clamps are not acceptable. Systems with short flex connections providing only nominal isolation are not acceptable. Outlet flexes shall be metal and double wall with thermal isolation.
- H. Any piping or connection, which may exceed 150 degrees F., shall be guarded to prevent contact burns. Belt and fans shall be guarded to prevent worker injury. Hazard labeling alone is not acceptable.
- I. The compressors shall be a continuous duty rated scroll type. The design shall be single stage, air-cooled, consisting of one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves and rated for 145 PSIG discharge pressure. Orbiting bearings shall be grease filled. Compressors shall be field serviceable for tip seal change and bearing lubrication. Non-field serviceable scroll compressors are not acceptable. Noise level shall not exceed 75 dB(A) for duplex system, 78 dB(A) for triplex system, and 80 dB(A) for quad system with pumps running at peak demand. Belt tensioning shall be achieved with a sliding motor mounting base adjustable with two tensioning screws. Each compressor unit shall be equipped with a distinct after cooler with separate cooling fan designed for a maximum approach temperature of 7°C (15°F) at 37.8°C (100°F) ambient and complete with electronic drain valve. Designs using compressor cooling air for the aftercooler are not acceptable. The discharge of piping of each compressor shall incorporate an electronic solenoid valve to prevent reverse rotation of the scroll at shutdown.
- J. Each compressor airend or element shall be protected by an intake filter of quality no less than 2 micron for particulate. Designs that utilize a common intake filter for multiple elements or airends shall not be accepted.
- K. Control system shall be contained in a cabinet factory pre-punched for conduit connections. Provide two punches: for power in sized per NFPA 70 Article 310 and based on total system amperes and for communications and for alarm wiring, each sized at 1/2". Provide Ethernet connection port on exterior of cabinet. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 (Medical Device) registration. Provide in the control system door:
  - 1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control.

2. Separate 16 bit, full color half VGA resolution touch screen for display of compressor unit functions and compressor unit control. These controls provide selector control of Automatic, Manual (continuous run) or Off for each compressor unit.
  3. A separate disconnect handle with door interlock for each compressor unit (note: for multiplex units greater than triplex, only two disconnect handles shall be required)
  4. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
  5. Power on lamp illuminated whenever any disconnect is On.
- L. Provide in the control cabinet interior:
1. Full voltage motor starters with overload protection, one per compressor unit.
  2. Circuit breaker disconnects, one for each compressor unit (note: for multiplex units greater than triplex, only two circuit breakers are required) operated by the through the door disconnect handle.
  3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
  4. Power distribution terminal block convenient for main power entry.
  5. All internal circuit boards and components needed for operation of the control system as described below.
  6. Volt free contacts for connection to master alarms.
  7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.
- M. The control system shall provide for the following functionality:
1. Display of pressure and dew point level on a single display for at a glance checking.
  2. Automatic lead/lag sequencing and alternation. Display clearly shows status of each compressor unit including running unit, next-unit-in-sequence, and units unavailable to run.
  3. Runtime hour-meters for each compressor unit.
  4. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.
  5. When H-O-A selectors are in Manual mode, system will operate on pressure switch and compressor units will not run if lead switch is satisfied.
  6. Visual and audible alarm indication and isolated contacts for remote alarm for at least Dew Point High and High Temperature (for each compressor unit alone or system altogether).
  7. Automatic indication of major maintenance intervals and details of required maintenance kits.
  8. Distinct separate indication on the control screens of alarms which shutdown the compressor vs. alarms which do not shut down the compressor vs. maintenance notifications.

9. Dryers shall be controlled from control panel with controls integral to touchscreen system. System shall include maintenance alerts and diagnostic for dryers.
  10. Controls shall provide isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, a condition which does not shut down the system and a maintenance alert.
  11. Control system shall permit individual test of Dew point, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls and connected alarms.
  12. Controls shall facilitate one-person “bumping” of the compressors to test rotation.
  13. Control system shall log and allow review of all alarm and shutdown and maintenance events.
  14. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to make air. Control systems which can lose any single component and fail to make air are not acceptable.
  15. An integral webserver using standard Ethernet shall allowing observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special software are not acceptable. Communication via BACNET protocol shall be enabled and manufacturer shall be a registered BACNET user.
- N. Compressor motors shall be NEMA Premium Efficiency rated, open drip proof unit with 1.15 service factor suitable for 208 or 230/460 volt, three phase, 60hz.
- O. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.
- P. A temperature sensor at the outlet of each compressor cylinder or air-end shall provide high temperature alarm and shutdown compressor. Systems employing a single switch for multiple cylinders or air-ends are not acceptable.
- Q. Provide redundant clean air treatment systems including desiccant dryers, filters, and regulators sized all compressors running simultaneously, including spare compressor. Include dew point monitoring. Air treatment shall include:
1. Desiccant dryers producing a -40°F (-40°C) pressure dew point. Refrigerant dryers are not acceptable. Desiccant dryers that cannot achieve -40 F dewpoint at full system flowrate are not acceptable.
  2. Dryer purge flow control through an integral dew point based purge control system or desiccant temperature.
  3. The inlet to each dryer shall include a 1 micron coalescing filter and a 0.01 micron high efficiency coalescing filter with automatic drain and element change indicator.
  4. Fully duplexed rough and fine particle final line filters in series, each with a manual drain and element change indicator. Final line filters rated for 0.01 micron.
  5. Duplexed final line regulators and safety relief valves.
- R. System piping shall be welded except where unions are required for service or where piping connects to valves or system components. Main flow path joints shall be flanged and provided with seals, use 37°

SAE flares suitable for flaretight seals or SAE straight thread with O-ring seal for leak tight connection and ease of replacement or service. NPT fitting use shall be minimized.

- S. Provide 240 gallon capacity, corrosion resistant, powder coated, ASME Coded, National Board Certified receiver rated for a minimum 150 PSIG design pressure. Include a liquid level glass with bead, safety relief valve, manual drain valve, and zero loss tank drain. Systems employing timed solenoid type drain valves are not acceptable.
- T. The complete laboratory air package shall be pre-wired, pre-piped and assembled on one common base with single point connections for electrical, discharge air, and condensate drains. All piping shall be factory complete.
- U. Refer to schedule on drawings for required capacities.
- V. The complete laboratory air system and all electrical components shall be factory pretested prior to shipment by the equipment manufacturer.
- W. Provide separately for installation at site in air delivery piping, one (1) pressure switch together with pressure gauge and demand check. The switch shall be wired at site by others to remote Alarm Panels.
- X. The manufacturer shall supply the services of a factory-authorized technical representative to check the installation, start-up the compressor system, and instruct Owner's personnel in the operation and maintenance of the unit. A written report confirming that equipment was started and left in satisfactory operating condition shall be provided.
- Y. The supplier shall have a fully staffed factory-authorized service organization available 24 hours a day, 7 days a week, year-round.
- Z. The entire system shall be covered by factory warranty for 18 months from shipment. The air ends shall be covered by factory warranty for 30 months from shipment.

## 2.5 MEDICAL GAS SHUT-OFF VALVES AND BOXES

- A. Multiple Zone Valve Box Assembly shall be constructed of 18 gauge steel with anodized aluminum cover frame and cover window with pull ring. Anchor brackets shall be designed to permit any number of boxes to be ganged together in a vertical stack.
- B. Shut-off valves shall be full port, double seal, ball type with Buna-N seals and O-ring packaging, chrome plated brass ball and designed for working pressures up to 300 psig. Only one-quarter turn of the handle shall be required to operate the valve from "open" to "closed" position; the valve handle shall protrude from the box and prevent the door from closing when the valve is in the "closed" position. Valve shall be securely mounted to back of zone box and provided with type L copper tube extensions to permit brazing outside of the valve box. All valves shall be serviceable in the line and supplied clean and prepared for oxygen service with pipe ends capped.
- C. Zone valve box assembly shall include 1-1/2" pressure gauges reading 0-100 psig for oxygen and air and 0-30 Hg for surgical vacuum. Vacuum shall be read upstream of the valve, oxygen and air shall be read downstream. Valves shall be piped left to right. Gauges shall be selected to read midway on the scale for "normal" operations. Zone valve shall also be equipped with ports and pressure sensors for line pressure monitoring/ connection to area alarm panel.
- D. The zone valve box assembly shall be supplied with color coded gas identification labels. The window shall conceal exposed piping and valves within the box and shall have a caution label.



- E. Multiple zone valve box assembly shall be manufactured by Amico, model number ZIU-M. Refer to floor plans and zone valve box details for valve arrangements and sizes.

## 2.6 AREA LINE PRESSURE ALARMS

- A. Area alarm panels shall be designed to meet the requirements of NFPA and CSA standards. Area alarms shall be U.L. listed as an assembly and shall include all necessary gauges, factory wiring, transformers and circuitry requiring only 115 or 230 volt primary power. Internal voltage shall be stepped down to 5 volt and 20-volt control circuit power.
- B. Area alarm panels shall be modular in design and have one LED to indicate each normal/abnormal condition. Each gas monitor shall have an LCD to continuously indicate actual conditions.
- C. The Control Module will have a test switch and an alarm silence switch. The test switch tests all modules one at a time. There will also be a LED on the Control Module to indicate status of the micro-controller (green is normal, red is for a malfunction).
- D. Each Line Pressure Module shall have a normal/abnormal LED, LCD window, and a window for the gas label.
- E. The back box shall contain factory installed copper tube extensions, 6" long 1/4" ID flared to 3/8" ID to accept installer furnished lines from the medical gas system. Each inlet tube shall have an internal check valve and female quick connect coupling to accept pressure/vacuum transmitters. For digital modules provide remote gas specific transducers.
- F. The master circuit board shall have two circuit breakers on the secondary side of the circuitry. It shall also contain dual transformers and selector switch to field select either 230 or 115 AC volt primary service. A detachable fuse holder on the primary side shall be included to insure that power is disrupted when the transformer cover is removed.
- G. The alarm audio tone shall be continuous. The sound intensity shall be 90 dBA. The audio signal shall be canceled only by the "alarm silence" button or fault correction.
- H. The audio alarm condition shall reactivate every half hour until the fault has been corrected. Regardless of the audio alarm the LED shall indicate "abnormal" as long as a fault condition exists. The alarm shall automatically reset with the correction of the fault condition.
- I. The panel will be equipped with dry contacts for each pressure/vacuum module. This will enable the alarm to interface with another alarm or central computer system.
- J. The area alarm panels shall the capacity to monitor and display 8 separate points.
- K. Digital area alarm panels shall be Amico Alert 3 as indicated on the plans.

## 2.7 MEDICAL GAS WALL OUTLETS

- A. Outlets shall have stainless steel fascia with pin indexing into matching, keyed slots to preclude mixture of services.
- B. Outlets shall be equipped with adjustable valve mechanism to compensate for variations (1/2 to 7/8 in.) in plaster thickness.
- C. Outlets shall be self-sealing, have service identification by color-coded indicia, and shall conform to NFPA #99C requirements utilizing the diameter index safety system (DISS) to prevent accidental interchangeability of secondary equipment between services.

- D. Outlets shall have color-coded thread protectors and shall bear the label of listing under re-examination service of the Underwriters' Laboratory.
- E. DISS outlets shall be gas specific and accept only corresponding DISS nuts and nipples.
- F. Wall outlets shall be manufactured by Amico Alert 1 (O-DISWAL-U). Refer to floor plans for locations.

## 2.8 EMERGENCY OXYGEN CONNECTION ASSEMBLY

- A. The Emergency Oxygen Connection Assembly shall be as manufactured by Tri-tech medical, Inc..
- B. Inlet shall be designed to meet NFPA 99, [Current Edition] and shall be bubble-tight.
- C. The assembly shall be factory-assembled as a complete unit. It shall be provided with two check valves for installation in the main line in the field by the contractor.
- D. It shall be provided with a relief valve in accordance with NFPA 99.
- E. It shall be provided within a weather-tight box with a padlock staple suitable for recess mounting.

## 2.9 MEDICAL GAS MANIFOLD (NITROGEN, NITROUS OXIDE CARBON DIOXIDE)

- A. Provide one medical gas manifold for each of the nitrogen, nitrous oxide, and carbon dioxide systems, as manufactured by Hill-Rom, Series P6804.
- B. Medical gas manifold assembly shall be constructed and installed in accordance with NFPA 99, National Electric Code, CSA/CAN, ANSI B57.1 and shall be factory furnished and U.L. listed as a complete assembly.
- C. Manifold assembly shall be provided with the following features:
  - 1. Full duplex line pressure regulators in four valve configuration with intermediate pressure service bypass.
  - 2. Fully automatic changeover from primary to secondary supply, including the rotation of primary bank to ensure emptying of cylinders.
  - 3. Central control unit factory assembled and pre wired.
  - 4. Separate 120 volt to 24 volt stepdown transformer.
  - 5. Pre piped relief valves for connection to vent line, and a union for connecting to facility main.
  - 6. External header and pigtail connections, keyed to CGA V 1 connection.
- D. Manifold shall be floor mounted as indicated on the drawings.
- E. Environmental conditions
  - 1. Manifolds are to be installed in accordance with requirements stated by NFPA 99, CGA and all applicable local codes. Manifold components are designed to work best over a temperature range of 0 degrees F through 130 degrees F. Wider temperature variation may cause manifold malfunctions to occur. Manifold shall be environmentally tested to MIL STD 810F. The manifold power supply and control board shall be fully contained inside a NEMA 4 enclosure, allowing for outdoor installations. Liquid-tight conduit fittings are required for outdoor installations.
- F. Flow characteristics
  - 1. Manifold shall be capable of handling the following flowrates:

- a. Gas Type Flow per Container
- |    |                |                     |
|----|----------------|---------------------|
| 1) | Nitrous Oxide  | 1.8 SCFM (110 SCFH) |
| 2) | Carbon Dioxide | 2.5 SCFM (150 SCFH) |
| 3) | Nitrogen       | 5.8 SCFM (350 SCFH) |

## 2.10 NITROGEN CONTROL PANEL

- A. Provide Nitrogen Control Panel where indicated on the drawings. Panel shall be designed to deliver variable pressures to power pneumatic surgical tools. Unit shall be a complete factory pre piped package and shall be factory tested and cleaned for nitrogen use.
- B. Unit shall be factory furnished with an inlet supply gauge with an operating range of 0 to 300 psig to indicate the supply line pressure, and a supply line shutoff valve immediately upstream of this gauge rated at not less than 250 psig pressure. Only one quarter turn of the handle shall be required to operate the valve from the fully "open" to fully "closed" positions.
- C. Unit shall be factory furnished with an outlet supply gauge with an operating range of 0 to 300 psig to indicate outlet pressure.
- D. Entire panel shall be factory pre piped internally, requiring only external supply line connections. Furnish a remote outlet pigtail located within the control panel for connection of additional outlets. Control panel outlet shall be D.I.S.S. nitrogen.
- E. An adjustable relieving type pressure regulator with an operating range of 0 to 250 psig shall provide the required pressure to the nitrogen service outlet, and shall be designed to 200 psi maximum working pressure. Maximum design flowrate shall be 27 cfm at 150 psi outlet pressure with 200 psi input.
- F. Unit housing shall be an 18 gauge steel box with two 1 1/4" x 1 1/2" x 5" aluminum mounting angles. Angles shall be field adjustable to allow for ease in installation and to secure the unit to a structural support.
- G. Unit shall be factory furnished with a satin metal panel, to which all controls shall be mounted. Metal panel shall allow for varying plaster or surface thickness of up to 3/4 inch.
- H. Nitrogen Control Panel shall be as manufactured by Chemetron, Series 75 20. Refer to floor plans for locations.

## 2.11 CYLINDER STORAGE RACKS

- A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
- B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

## 2.12 NITROGEN

- A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
  - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.
  - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
    - a. Scrub to ensure complete cleaning.
    - b. Rinse with clean, hot water to remove cleaning solution.

### 3.2 PIPING INSTALLATION

- A. Comply with NFPA 99 for installation of medical gas piping.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and specialties to allow service and maintenance.
- F. Install compressed-air piping with 1 percent slope downward in direction of flow.
- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications.
- H. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- I. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- J. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and for branch connections.
- N. Piping Restraint Installation: Install seismic restraints on compressed-air piping.
- O. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

3.3 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on compressed-air piping where reduced pressure is required.
- F. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

END OF SECTION 226100



## SECTION 22 6700 - PROCESSED WATER SYSTEMS FOR HUMIDIFIERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes: system equipment.
  - 1. Reverse-Osmosis Water System. (R.O.)

#### 1.3 SUBMITTALS

- A. Submittal shop drawings for all materials specified in this section in accordance with section 220050.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the products.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Wiring Diagrams: For power, signal, and control wiring.
  - 5. Operation and maintenance manuals.
- B. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

#### 1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures of mineral and brine tanks.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
    - d. Attrition loss of resin exceeding 3 percent per year.
    - e. Mineral washed out of system during service run or backwashing period.
    - f. Effluent turbidity greater and color darker than incoming water.
    - g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS AND COMPONENTS

- A. Section Includes skid-mounted package including the following components:
  - 1. Water Softener

2. Activated Carbon Filter
  3. Five (5) Micron Pre-filter
  4. Reverse Osmosis Unit
  5. Storage Tank
  6. Distribution Pump
  7. Ultraviolet Sterilizer for Bacteria Control.
  8. Instrumentation.
  9. Interconnected piping, plumbing and connection fittings.
- B. Provide a self-contained, skid-mounted, pre-piped and pre-wired component package to produce Reverse Osmosis (RO) water for humidification purposes. Components and configuration shall be as indicated on the drawings attached to this specification. Provide auxiliary (dry) contacts (normally open or normally closed) for signaling the building automation system.
- C. Except as otherwise indicated, provide water treatment systems and ancillary equipment with manufacturer's standard materials and components as indicated by published product information, designed and constructed by manufacturer for complete installation. Site to provide power line, water to the unit and drain (not by humidifier manufacturer) and feedlines to secondary systems.
- D. Acceptable Manufacturers: Subject to compliance with requirements, provide the product indicated on drawings/specifications or a comparable product by one of the following:
1. Condair or approved equal.
- E. The pretreatment equipment shall be designed to remove particulates that can affect the operation of the reverse osmosis unit. The pretreatment equipment shall include the following components:
1. Water Softener and brine tank.
  2. Activated Carbon Filter ML Systems
  3. Five (5) Micron Pre-filter

#### 2.2.1 REVERSE OSMOSIS WATER TREATMENT PACKAGE

- A. General: Provide reverse osmosis water treatment system of size and capacity as indicated on the schedule and delivering this from its holding tank at a pressure of 3 bars. The system uses a membrane separation process in which water molecules can pass through the membrane, while the majority of salts and minerals are retained and thereafter flushed out the drain. System shall be furnished as a package from the humidifier vendor to include combined distribution skid (RO water treatment system), storage tank, additional system hardware, controls, and all associated devices required for a complete and functioning water treatment system.
- B. All equipment listed in this specification shall be factory provided by the manufacturer of the RO package (one of the listed manufacturers). The RO system specified herein shall be factory provided as a skid package. The equipment supplier must be able to provide a fully functional system including all water treatment equipment specified, instrumentation and controls, installation, start-up, owner training and the necessary turnover package including Operation and Maintenance manuals and drawings.
- C. Units shall be complete, factory assembled, and tested; and of sizes, arrangements, capacities, and performance as scheduled and as specified in the schedules shown. Units stand-alone use for treating water.



- D. Units shall be capable and designed for year-round, 24-hours-a-day operation; and requiring only connections of piping, utilities, and remote sensors, and controllers
- E. All components exposed to water shall be made of corrosion resistant material
- F. RO water storage tank shall include sterile breathing filter and low-water level cutout switch. RO Tank shall come with a 0.2 micron filter to restrict bacteria movement. The RO water storage tank shall be completely black and opaque, allowing no light to pass through and thus restricting bacterial growth due to light. No transparent or semi-transparent (White translucent) or other tanks will be accepted.
- G. Distribution skid and storage tank:
  - 1. Provide reverse osmosis skid assembly, fully factory built and tested. RO skid shall consist of the following principal components: one or more RO membranes, one or two RO pumps that pump raw water through the RO membrane at a pressure of 116-174 psi (8-12 bar) and into the RO water tank and one RO water transfer pump, which delivers pressurized RO water to the consumer at 3 bars. RO membranes, pumps and storage tanks are installed on a powder coated steel frame with vibration isolators.
  - 2. All components exposed to water are made of corrosion-resistant material. All hoses are steel-reinforced and drinking water-approved.
  - 3. Low-pressure cut-off switch: A pressure switch just after the inlet filter protects the RO pump from dry running.
  - 4. Both the transfer and RO pump are directly mounted on their electric motors. Power is supplied to the 3-phase asynchronous motors via a magnet-operated protective motor switch.
  - 5. The RO water storage tank shall be completely black and opaque, allowing no light to pass through and thus restricting bacterial growth. No transparent or semi-transparent (white-milky/semi-clear) or other tanks will be accepted
- H. Water Softener: The purpose of the water softener is to remove mineral hardness from water. Softening shall be accomplished by an ion exchange process utilizing a high capacity cation exchange resin in the sodium exchange mode. Automatic regeneration shall be accomplished using a salt (brine) solution.
  - 1. A non-electric water softener (mechanical only) shall be provided as a pre-treatment to extend the life of the RO Membrane.
  - 2. A dual tank system shall be used to regenerate on-demand, while the other tank acts on standby and immediately switches over during period of regeneration.
  - 3. The system shall include two tanks. This duplex configuration shall be flexible to operate in alternating or parallel mode depending on installed program disc. In alternating mode, one tank will be on-line during service. In parallel mode, both tanks will be on-line during service. With either mode, during regeneration cycles, one tank shall provide water to service and to the regenerating tank. A water meter shall initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Service flow shall be down-flow and regeneration flow shall be up-flow.
  - 4. A combination salt storage tank, with cover, and brine well shall be supplied as part of the system. The brine tank shall be large enough to hold salt for at least ten regenerations between refills. The brine tank shall be made of polyethylene or FRP.
  - 5. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through

the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi (1.7 bar). Pressure shall be used to drive all valve functions. No electric hook-up shall be required. Control valve shall incorporate four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. Service cycle shall operate in a down-flow direction. The brine cycle shall flow up-flow, opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice nozzle and self-adjusting backwash flow control. The control valve will prevent the by-pass of hard water to service during the regeneration cycle.

6. A combination salt storage and brine production tank shall be manufactured of corrosion resistant, plastic. The brine tank shall have a chamber to house the brine valve assembly. The brine float assembly shall allow for adjustable salt settings and shall provide for a shutoff to the brine refill. The brine tank shall include a safety overflow connection to be plumbed to a suitable drain.
7. Provide interconnecting plumbing and instrumentation.
- I. Activated Carbon Filter: The purpose of the activated carbon filter is to remove chlorine, chloramines, tastes, and odors from the water. The media shall be a high capacity black granular carbon with rugged grain structure, high density and large surface area for efficient removal of chlorine/chloramine as well as other taste, odor, and color-causing organics. It shall work effectively over a wide pH range.
  1. The system shall include one tank. This simplex system is designed to operate in an up-flow mode. This configuration allows the unit to run in service without the need for a backwash cycle.
  2. The tanks shall be designed for a maximum working pressure of 125 psi (8.6 bar) and hydrostatically tested at 300 psi (20 bar). Tanks shall be made of polyethylene and reinforced with a fiberglass wrapping. Each tank shall include a 2.5 inch (6.35 cm) threaded top opening. Each tank shall be NSF approved. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of water.
  3. Each system shall include an activated, acid washed carbon. The media shall be between 8 and 16 Mesh in particle size.
- J. Control Panel: Mounted on the main pump station frame, includes a manual on/off/auto switch, fault light indicator, service light indicator, and terminal connection for power and control wiring. Display to show required maintenance 48 hours before service is due. Connection glands for power and control wiring. The control unit which consists of a touch display and a PLC mounted in the IP rated electrical cabinet as well as a power board for the control of the high pressure pump and connection terminals for power supply. From the touch screen, the operator can view the status of the RO system, water levels in the tank, production, adjust alarm limits, view hour counters, view logged alarms. The pump station is electrically wired at the factory and the control panel must be tested at the factory prior to release.
- K. Controls and Wiring: Factory-installed microprocessor type to control and monitor unit, communicate to central-control processor. The controller shall be connected to the building DDC control system via Modbus interface.
  1. The unit shall have a factory wired and unit mounted central, electrical control panel with a single power supply connection. All internal wiring shall be in accordance with the National Electrical Code. Unit shall have a non-fused main power disconnect and control components required for automatic operation based on signals from the humidity controls. Control panel shall have terminals for remote control devices.
- L. Ultraviolet Water Disinfection System: Provide UV light to disinfect the water as it passes through the system. UV technology ensures a safe supply of water by using a non-intrusive, physical disinfection method. The flow rates of the UV light vary according to different standards. A flow rate of 11.0, 6.0, and 4.0 gallons per minute are recommended by US Public Health, VIQUA Standard, and NSF/EPA, respectively.

Voltages vary from 100 - 240 volts, and the frequency varies from 50 to 60 Hertz. Power consumption is 30 Watts. More than 75% UV transmittance is output.

M. Mixed Bed Ion Exchange Resins, CO<sub>2</sub> dosing and Electrical Conductivity (EC) monitoring:

1. Provide in the scope of work a modular add-on package which allows for the connection of one or two mixed bed ion exchange resin tanks (polishers), alarms for high conductivity, and CO<sub>2</sub> dosing to the RO tank for increasing the conductivity up to 5 µS/cm.
2. The modular add-on electrical conductivity (EC) panel shall be added on to the existing pump station and frame. The EC add-on panel will be seamlessly connected to the pump skid, via existing embedded software from the main control panel, no additional or external software will be accepted.
3. The EC add-on panel shall communicate to the primary control panel on the main pump skid via an Ethernet network cable (RJ45, CAT5 or CAT6), no other means of communication will be accepted.

N. The ion exchange resin tanks shall be furnished with the system to "polish" and demineralize the reverse osmosis water even further, producing deionized water. A conductivity of less than 0.1 µS/cm shall be achieved when passing the reverse osmosis water through the mixed bed filter. The mixed bed resin shall contain anion and cations that will aid in demineralizing the water even further. To raise the conductivity above 5 µS/cm - CO<sub>2</sub> shall be added to RO tank - no salts or minerals shall be introduced to the system to raise conductivity.

O. Self-cleaning module/kit of RO Tank (Clean-in-Place)

1. Provide alongside the direct room system and main pump assembly a complete means of disinfection and cleaning in place module that periodically adds or doses the RO tank with a disinfection fluid.
2. The modular self-cleaning add-on box shall comprise a self-priming diaphragm pump with direct digital dosing, a power / control box and a bottle of disinfection fluid.
3. The pumping system shall incorporate pressure monitoring, integrated flow measurement, dosing timer and auto de-aeration. The Clean-in-Place add-on panel will be seamlessly connected to the pump skid, via existing embedded software from the main control panel, no additional or external software will be accepted.
4. The add-on self-cleaning module panel shall communicate to the primary control panel on the main pump skid via an Ethernet network cable (RJ45, CAT5 or CAT6), no other means of communication will be accepted.

P. Transfer (Forwarding) Pump

1. A forwarding pump shall be included with the system whereby the pump can transfer RO water to other uses outside of the intended primary humidification equipment.
2. Forwarding pump shall be embedded onto the main pumping station and installed at the factory by the RO water treatment manufacturer

## PART 3 - EXECUTION

### 3.1 Installation

- A. Install RO water treatment system and ancillary equipment per manufacturers' instructions. Turn-key installation should be provided by Reverse Osmosis water treatment/humidifier manufacturer.

- B. Install with required clearance for service and maintenance.

3.2 Accessories

- A. Install accessories in accordance with manufacturer's recommendations.

3.3 Commissioning

- A. Start-up and commissioning of RO water treatment system and ancillary equipment should be completed by the manufacturer's field technician.

3.4 Field Test

- A. A BactiQuant (BQ) Water Test, using an enzyme targeted analysis, shall be performed by a BQ Certified manufacturer's technician. The field test shall consist of, an enzyme activity which shall be measured by use of a highly sensitive fluorescence technology, and shall quantify the amount of microbial enzymes. The fluorescence signal shall be directly proportional to the content of bacteria. The BQ test shall be completed in less than 60 minutes with passed results, indicating a clean hygienic system. If test results shows BQ values higher than 57, the system must be disinfected according to manufacturer's instructions.
- B. The field test must be a verified method by the United States Environmental Protection Agency (US-EPA). No Heterotrophic plate counts, nor ATP methods for bacterial test shall be accepted.

3.5 Maintenance

- A. The Reverse Osmosis water treatment system manufacturer must perform a minimum of three (3) maintenance visits, via field technician employed by the water treatment manufacturer - one after six months, a second six months after that, and a third one year after that.

END OF SECTION 226700