SECTION 230200 - BASIC MATERIALS AND METHODS

1.0 Contract Specifications Requirements

A. Define the contractor's responsibility for applying, obtaining and paying for all charges associated with the connection to non-University owned utilities.

B. Prior to the connection to University owned utilities, the contractor shall obtain permission and coordinate such with the University Engineering Department. Refer to Part 1 – General, Article XIII – Site Utilities.

C. Define the contractor's responsibility for performing all excavation and removal of all excavations from the site.

D. Define shoring, excavated material storage, removal of unsuitable materials, trench depth, support of trench materials (i.e. pipe) and security requirements.

E. Include a description of the contractor's responsibility regarding removal, relocation, and salvage rights.

F. Excavation and Backfill:

1. As a minimum, the contract documents shall impose the following conditions up- on the contractor:

a) Perform all excavation, backfilling and pumping necessary for completion of work.
b) Carefully remove and export from the site all excavations, shrubbery, and sod. When underground work is complete and trenches are back- filled reinstall new sod and shrubbery to meet prior conditions or those defined by the University's Landscape Architect. Replace any damaged items to the satisfaction of the University Representative.
c) Coordinate with the University's Landscape Architect regarding tree removal/protection standards and all other landscape standards.
d) Trench depth shall allow adequate cover over piping, ducts and conduit. Walls shall be perpendicular to the top of piping and ducts and trench bottoms shall be graded in the direction of flow as required. Where necessary provide sand, pea gravel or other underlie required by the pipe or equipment manufacturer.
e) Each contractor shall provide sheathing, shoring and bracing necessary to complete his excavation and backfilling work.
f) It shall be the responsibility of the design professional and each contractor to check with the various utility companies and the PA 1-Call System. Each contractor is responsible for damage during excavation to existing piping or equipment. Such damage shall be repaired promptly without cost to the Owner.
g) Backfill after inspection and approval. Backfill shall be made with 100% clean imported earth, free from rocks, frozen particles, debris or other foreign materials. Deposit in uniform layers not over six inches (6") thick with each layer mechanically tamped before the next layer is applied. Partial backfill on piping with all joints exposed is mandatory for all underground systems. Final backfill may commence only after testing procedures have been completed and approved.
h) Each contractor shall perform all cutting and patching to sidewalks, curbs,

bituminous paving, walls, etc. required by performance of excavation and backfilling. Install and maintain temporary paving as required. Make repairs to sidewalks, curbs, paving, etc. in complete blocks, partial patching will not be acceptable.

i) All trenches shall be backfilled at the end of each working day. Where a trench must be left open, provide steel plates of adequate size and strength over entire open area.

j) The A/E is responsible for reviewing all City of Philadelphia Agency's, Veolia-Philadelphia (Steam Service), Philadelphia Gas Works, PECO Energy Company (Electric Utility), SEPTA, Telephone Companies and other communications carriers, Amtrak, Local Cable Companies, and Conrail requirements associated with installing, excavating and backfill- ing adjacent to non-University owned underground utilities. The contract documents shall not violate existing compliant conditions.

k) Contractors shall submit unit pricing for each type of work related to the excavation and installation of equipment, i.e. fittings, pipe, excavation, restoration etc.

2.0 Design Requirements

A. ASHRAE 90.1 Compliance: University of Pennsylvania buildings shall comply with the Commercial Energy Efficiency Requirements of ASHRAE Standard 90.1-2016. The ASHRAE 90.1-2016 compliance paths shall be followed instead of the International Energy Conservation Code (IECC) requirements as permitted by 2018 IECC Section 401.2 Application.

B. Basic Piping Materials:

1. Refer to Division 22 - Plumbing, Section 220553 Identification for Plumbing Piping and Equipment for basic piping design requirements and a service listing with pipe material cross reference matrix

3.0 Hangers and Piping Supports:

A. Hangers and supports shall be sized to fit outside diameter of uninsulated pipe and tubing or, for all insulated lines, outside diameter of insulated pipe (or pre-insulated pipe supports). Provide pre-insulated pipe supports on insulated piping and tubing 3 inches and larger. Provide pipe insulation protection shields on all insulated piping and tubing up to and including 2-1/2-inches in size. All shields shall be galvanized steel. Length and gauge thickness of shields shall be based on MSS SP-58. Use 180 degree high- density (140 psi compressive strength) calcium silicate insulation meeting ASTM C 533 at each pipe insulation protection shield. Calcium silicate insulation shall be at least the length of protection shield.

B. All hangers and supports directly in contact with the piping must be of same or compatible materials. The following support types should be specified:

PIPE	HANGER
Uninsulated Carbon Steel, Cast Iron and Ductile Iron Pipe	Carbon Steel Clevis Type or Carbon Steel Roller Type
Insulated Carbon Steel Pipe, and Copper Tubing and Stainless Steel Tubing.	Carbon Steel Extended Clevis Type, (Use these pipe hangers with Pre-Insulated Pipe Supports or with Pipe Insulation Protection Shields).

PIPE	HANGER
Uninsulated Galvanized Pipe	Galvanized Clevis Type
Uninsulated Copper and Other Non-Ferrous Metal Tubing, 4 inches and Smaller.	Copper-Plated or Copper-Colored Epoxy Painted Carbon Steel Clevis Type.
Uninsulated Plastic Pipe or Tubing	Continuous Carbon Steel Tray, Angles or Sheet Metal Reinforcing Troughs, With V- Bottom Clevis Type Hanger. Trays or troughs shall be rigid enough so that the dead load de- flection (sag) does not exceed 0.1 inch.
Uninsulated Sanitary Stainless Tubing and Glass and Brass Pipe.	Plastic-Coated Steel Clevis Type.

C. Riser clamps shall conform to the following types:

1. Specify Carbon Steel Riser Clamp for Carbon Steel, Cast Iron and Plastic Pipe.
2. Specify Copper-Plated, Copper-Colored Epoxy or Painted Carbon Steel Riser Clamp for Copper Tubing.
3. Specify Plastic-Coated, Copper-Plated or Copper-Colored Epoxy Painted Steel Riser Clamp for Stainless Steel Tubing, and Glass and Brass Pipe.

D. Piping that connects to vibration-isolated (rotating) equipment shall be vibration isolated by means of spring hangers. If pipes exit mechanical spaces within 50 feet (developed pipe length) from point of connection to vibration-isolated equipment, the full 50 feet of pipe must be isolated. Isolators for first three (3) support points adjacent to connected equipment shall achieve at least one-half specified static deflection of isolators supporting connected equipment.

E. All piping which must be provided with expansion loops shall be fitted with pipe guides in the quantity and spacing recommended by the manufacturer. Guides shall be firmly attached to the building structure.

F. Securely anchor all piping utilizing expansion loops to the building structure with steel angles, properly braced and welded to the pipe. A Structural Engineer shall review all loads imposed upon the structure by the piping system. The contractor shall be required to submit shop drawings detailing the proposed anchors for review.

4.0 Hanger Spacing:

A. Horizontal steel piping shall be supported as follows:

PIPE SIZE (Inches)	ROD DIAMETER (Inches)	MAXIMUM SPACING (Feet)
Up to 1	3/8	8
1 1/2 to 2	3/8	10
2 1/2 to 3	1/2	12
4 to 5	5/8	15
6	3/4	17

PIPE SIZE (Inches)	ROD DIAMETER (Inches)	MAXIMUM SPACING (Feet)
8 to 12	7/8	20
14 to 16	1	25
18 to 20	1 1/4	28
20 to 30	1 1/2	30

1. Above 30" - as determined by pipe and hanger stress analysis calculations and code requirements.

B. Horizontal copper piping shall be supported as follows:

PIPE SIZE (Inches)	ROD DIAMETER (Inches)	MAXIMUM SPACING (Feet)
Up to 1	3/8	5
1 1/4 to 2	3/8	8
2 ½	1/2	9
3 to 4	1/2	10

C. All hub or joint pipe shall be supported within the above recommendations for steel and at each joint.

D. Plastic piping systems such as (polyvinyl chloride pipe (PVC) and polypropylene piping) shall be supported at intervals recommended by the manufacturer for a 120°F fluid temperature. Other specialty piping systems, such as PVDF tubing for specialty water systems, shall be continuously supported as recommended by the manufacturer.

E. All pipes shall be supported within one (1) foot of elbows, valves, flanges, or fittings.

F. All vertical piping shall be supported at 10 feet maximum intervals or designed as necessary to meet MSS guidelines.

5.0 Unions and Flanges: Install accessible unions or flanges and isolation devices in all supply and return connections to equipment and specialties as required to facilitate the removal and or servicing of equipment such as:

A. Heat exchangers

B. Pumps

C. Chillers

D. Steam traps

E. Unit heaters

F. Control valves

G. Expansion joints

H. Pressure reducing valves

I. Coils

J. On all equipment provided with flanged connections. All flanges shall be faced, drilled and spot faced to ASME Standards.

K. Unions and flanges in steel pipe:

1. Unions shall be ground joint, malleable iron, screw type, conforming to ASTM A-197 and ANSI B16.39.
2. Flanges shall be forged steel conforming to ANSI B16.5, B16.42, or B16.47 as applicable.
3. Unions and flanges shall be 150 lb. or 300 lb. rated to meet system design requirements.

L. Unions and flanges in copper piping shall be wrought copper, ground joint, solder ends, conforming to ANSI B16.22.

M. Flanges 4" and above shall be secured using B-7 bolts.

6.0 Piping Expansion Provisions: Use expansion loops in lieu of expansion joints. Approval for the use of expansion joints must be obtained from the University Engineering Department during the design process. The desired methods of expansion compensation in underground steam piping, in order of preference, are as follows:

A. Loops.

B. Ball joints.

C. Telescoping slip joints.

D. All loops shall be constructed with long radius elbows welded into the line. All loops must be subjected to cold spring during installation to approximately one-half of the total compensation between hot and cold conditions. The use of ball joints and/or telescoping slip joints must be approved by the Office of the University Engineer.

7.0 Balancing and Flow Measurement Provisions - General: All systems shall be designed using the following general balancing provisions:

A. Flow Measuring Devices (Line Sizes 2 Inches and Smaller):

1. Device shall be fabricated of heavy brass combining a valve for linear throttling, a memory stop, a dial and position pointer, and positive shut-off valved pressure taps with quick-couplers.
2. Valve shall be full-ported and have a non-rising stem.
3. Valve shall be rated at 200 psi and 250 degrees F.
4. Furnish one (1) portable differential pressure meter [per building] to the Owner with positive shut-off and vent valves with quick-couplers, and two (2) 12 foot lengths of hose with quick-couplers. Meter(s) shall become the property of the Owner upon completion of testing and balancing.
5. Approved Manufacturers:

a) Balancing Valve: Circuit Setter Plus by ITT Bell and Gossett, STA-D/STA-F by Tour & Andersson, Model CBV by Armstrong.
b) Meter: Readout Kit by ITT Bell and Gossett, DTM-C by Tour & Andersson, CompuFlo Meter by Armstrong.

B. Flow Measuring Devices (In Line Sizes 3 Inches and Larger):

1. Device (pitot tube) shall be fabricated of stainless steel and be designed for 150 psig service utilizing one high-pressure impact tube and one low-pressure static pressure tube.
2. Device shall be provided with safety shut-off valves, quick-coupling connectors, and a rustproof tag showing pipe size, metered fluid, design flow rate and station number.
3. It shall be possible to rotate the sensing element so that the ports point down-stream.
4. The accuracy shall be within plus or minus 2.0 percent.
5. Furnish one (1) portable meter [per building] to the Owner with a flow scale for direct reading in [gpm] {l/s}, a carrying case and two (2) 12 foot hoses with quick- couplers. All wetted parts shall be stainless steel. Meter(s) shall become the property of the Owner upon completion of testing and balancing.
6. Approved Manufacturers:

a) Measuring Station: Annubar by Emerson Rosemount, as dictated by pipe size, or equivalent by Taco or Preso.
b) Meter: Emerson Rosemount, or equivalent by Taco or Preso.

7. Line size service and balancing valves shall be provided in accordance with details shown on Drawings.

C. Chilled water primary/secondary interface shall use ultrasonic transit time flow meters.

D. Chillers over 500 tons shall be provided with an insertion type pitot tube meter with direct leading manometer and instrumentation interconnected with the campus Operations Control Center (OCC).

8.0 The designer shall indicate on the drawings the locations and size of all flow meters and balancing provisions. Balancing provisions shall be provided as follows:

A. In each heating and/or cooling circuit.

B. On all cooling and heating coils.

C. On all supply main piping adjacent to pumps.

D. Entrance to chillers and heat exchangers.

E. In all branches of hydronic systems requiring balancing.

F. Domestic water hot water recirculating systems to deliver the minimum recirculation rates indicated on the drawings.

G. All measuring devices shall be installed per manufacturer's recommendations. The A/E shall provide allowance for the manufacturer's recommended number of diameters up-stream and downstream of the flow measuring devices in the system design.

9.0 Valves

A. General: The system shall be designed for the provision of isolating valves at all equipment, fixtures, hydronic circuits, control valves, individual pieces of equipment, and all branch mains. Isolation valves shall be installed in accessible locations and provided at sub-mains at take-offs to each floor on multi-story buildings and on branches where two or more devices are served or where future renovation is anticipated. Control valves shall be located on the return lines from the equipment being controlled. Generally, the following valves shall be designated:

B. Steam Systems:

1. 50.0 PSIG and Above:
2. Up to 2" - Forged steel body gate valves with rising stem, Class 300 rated for 410.0 PSIG at 800°F.
3. 2-1/2" and Above - Cast carbon steel body gate valves with outside screw and yoke, Class 300 rated for 410.0 PSI at 800°F.
4. Below 50.0 PSIG:
5. Up to 2" - Forged steel body gate valves with rising stem, Class 150, rated for 125.0 PSIG at 650°F.
6. 2-1/2" and Above - Cast carbon steel body gate valve with outside screw and yoke, Class 150 rated for 125.0 PSIG at 650°F.
7. Gate valves shall be manufactured by Velan or approved equal. Obtain approval from the University Engineering Department.

C. Hot Water Systems:

1. Up to 2 1/2" piping - Bronze body, two-piece full port ball valves with teflon seat.
2. Above 2 1/2" piping - Lugged type, resilient seated butterfly valve. ANSI 150 cast iron body. EPDM, terpolymer of ethylene propylene and adiene, seal and seat; seat fully retained mechanically with retaining rings with bronze disc. 416 S.S. Shaft; 1 piece solid thru shaft, pinned to disc; Provide lever handles up to and including 4". Provide handwheel operators for valves 6" and above. All valves located 6'-0" or more above the valve access level shall be fitted with chain operators. Valves shall be manufactured by DeZurik, Jamesbury, Watts, Milwaukee or Nibco.

D. Campus Chilled Water Systems:

1. Up to 2 1/2" piping - Bronze body, two-piece full port ball valves with teflon seat.
2. 2 -1/2 - 4" piping - Lugged type, resilient seated butterfly valve. ANSI 150 cast iron body. EPDM, terpolymer of ethylene propylene and adiene, seal and seat; seat fully retained mechanically with retaining rings with bronze disc. 416 S.S. Shaft; 1 piece solid thru shaft, pinned to disc; Provide lever handles up to and including 4". Provide handwheel operators for valves 6" and above. All valves located 6'-0" or more above the valve access level shall be fitted with chain operators. Valves shall be manufactured by DeZurik, Cameron DEMCO.
3. 6" and Above piping: Lugged type ANSI 150, high performance butterfly valve. Bi-directional bubble tight shutoff to 285 PSI. Carbon steel body. 316 S.S. disc.316 S.S. shaft; 1-piece solid thru shaft; pinned to disc; shaft to have maintained groove on top flat to indicate disc position. Bearings, 317 S.S. wire mesh encapsulated in PTFE liner. PTFE seat with integral hoop stressed Titanium back-up ring. Provide lever handles up to and including 4". Provide handwheel operators for valves 6" and above. Valves shall be manufactured by DeZurik BHP, Cameron WKM, Delta T 851, or Jamesbury 815L.

E. Campus chilled water choke valve: V-port ball valve. ANSI 150 flanged, 317 S.S. body. PTFE Chevron packing. 317 S.S. nickel hardened ball. 2205 duplex S.S. shaft. 317 S.S. PTFE bearings. Note: Choke valves must be sized for proper operation. Upstream/downstream pipe sizes and pressures must be provided for optimal sizing calculations. Valve shall be manufactured by DeZurik, VSI or Fisher.

F. Underground chilled water valves: Butterfly AWWA C504 valve. Mechanical joint. Cast Iron body. Acrylonitrile butadiene non-adjustable packing. Buna seat. AWWA Class 150B – service class. Cast iron or ductile iron disc with 316 S.S. edge, 304 S.S. shaft. Totally enclosed gear with 2” nut for buried service. Valves shall be manufactured by DeZurik or Crispin K-FLO 500 series.

G. Domestic Water Systems:

1. Up to 2 1/2" piping: Bronze body, two-piece full port ball valves with teflon seat, rated for 150 PSIG.
2. Bronze, non-rising stem gate valve, soldered ends, rated for 125 PSIG (Supply to emergency showers shall be Nibco Figure S-113-L with lockshield).
3. Above 2 1/2" piping - Cast iron, non-rising stem gate valve, flanged ends, rated for 125 PSIG (Supply to emergency showers shall be locked in the open position).

H. Laboratory, Medical, and Process Gases (oxygen, nitrogen, nitrous oxide, compressed air, argon, cylinder gases)

1. For Zone Valves and Riser Valves – all size piping –Union ball type, bronze body, chrome-plated brass ball which seals in both directions, full flow, Teflon seat, seat and O-ring packing, quarter turn, threaded ends, rated for 300 PSIG. All valves shall be washed, degreased, and tested for medical gas piping system use in accordance with NFPA 99 Standards. Ship valves sealed, ready for installation.
2. Outlet Isolation Valves - 1/2" to 2" piping - Bronze, serviceable in line ball valve, quarter turn, lever- operated, 3-piece, full port, threaded connections, rated for 150 PSIG.
3. Outlet Isolation Valves -2 1/2" and larger piping - Bronze body ball valve, chrome-plated bronze ball, full flow with Teflon seats and double Teflon stem seal, rated for 400 PSIG.

10.0 Insulation

A. General: All thermal and acoustic insulating materials shall have a non-combustible fire and smoke hazard system rating and label as tested by ASTM-84 and NFPA 255, not to exceed a flame spread of 25, fuel contributed 50, smoke developed 50.

B. ASHRAE 90.1-2016 Compliance Requirements: Minimum insulation thickness shall comply with the requirements of Section 6.4.4. of ASHRAE 90.1-2016.

11.0 Pressure Vessels

A. All pressure vessels must conform to ASME Code, and the Commonwealth of Pennsylvania requirements, and shall be constructed, inspected and stamped accordingly. Certificates shall be issued to Owner and shall be hung at the vessel as required by the Commonwealth of Pennsylvania. The design engineer shall notify the Owner regarding the size and pipe of all pressure vessels for the Owner’s use in obtaining city inspection.

12.0 Welding

A. Each welder engaged to work on any University project shall be certified as having passed qualification tests prescribed by the National Certified Pipe Welding Bureau or other reputable laboratory or agency. Specify the protection of adjacent surfaces, ventilation requirements and system fire alarm shutdown and fire watch as detailed in the standard University Scope Document. Provide dye-penetrate testing of welded joints in accordance with the Procedure and Acceptance requirements of the ANSI/ASME Code for Pressure Piping, B31.1, for high-pressure steam piping and chilled water piping 16 inches and larger. Imperfections revealed by examination shall be evaluated in accordance with the criteria in the specified (ANSI/ASME B31). Repair or replace weld joints in accordance with approved procedures and at no additional cost to the Owner.

13.0 Dielectric Fittings

A. Isolate connections between dissimilar metallic materials. Use dielectric fittings or nipples that provide a complete isolation of the two ends using materials suitable for the de- sign pressure, temperature and fluid contained.

14.0 Escutcheons

A. Provide escutcheons, at all locations where piping, installed exposed to view, penetrates walls, partitions, floors and ceilings.

15.0 Supplemental Steel

A. In portions of buildings which are steel-framed, attach hangers to building structural steel beams. Where hangers do not correspond with building structural steel beams, provide supplemental steel members continuously welded or bolted to building structural steel beams. Provide two (2) coats of primer on supplemental steel. In portions of buildings which are concrete structure, attach hangers to concrete structure by installing anchors into concrete. Submit details of hanger attachments to building structure to Design Professional for approval before drilling or burning holes in structure.

16.0 Piping Slope

A. Hot water and chilled water - Pitch piping inside the building to drain to a low point where the system can be drained. No portions of the system shall trap water which cannot be drained. Provide valved drains with 5/8 inch hose bibbs at all low points and valved air vents at all high points.

B. Condensate drainage - Slope piping 1/4 inch per foot consistently from pan to drain point. C. Steam and Condensate - Pitch steam supply mains, and pumped and closed condensate return piping at 1 inch per 50 feet of pipe. Pitch open condensate return piping at 1 inch per 10 feet of pipe. Steam piping shall be sloped toward the trap when a trap is present; otherwise, it shall be sloped toward the main. Condensate piping shall be sloped in the direction of flow.

D. Domestic water - Pitch water pipe inside the building to drain to a low point where the system can be emptied. No portions of the water piping system shall trap water that can- not be drained. Install drains at all low points. Drains shall be l/2 inch valve with hose end.

E. Sanitary, Storm and Laboratory Drainage - Install horizontal drainage lines 4 inches and larger with a minimum uniform pitch of 1/8 inch per foot unless indicated otherwise. In- stall drainage piping 3 inches and smaller with a minimum uniform pitch of 1/4 inch per foot unless indicated otherwise. Make changes in pipe sizes with reducers or increasers.

17.0 Combination Pressure/Temperature Test Stations

A. Design to provide locations on contract drawings. Stations (not for use on steam service or high-purity water systems) shall be 1/4 inch NPT fitting designed to receive a 1/8 inch O.D. temperature or pressure probe. Stations shall be solid brass with neoprene seals (for maximum 200 degrees F service), grooved test plug cap and chain.

18.0 Chain Operators

A. Install valve extension stems or chain operators where the center of valve handwheels is more than 6 feet-6 inches above the floor or valve access level. Provide chain hooks where required to prevent falling of chains on equipment and to clear walkways. Terminate chains approximately 3 feet-6 inches above the floor. Provide worm gear operators or impact handwheels for all valves 6 inches and larger. Chain operators are not required on valves 2 inches and smaller, and on valves with threaded ends.

19.0 Vacuum Breaker

A. Vacuum breakers shall be provided at terminal equipment controlled by temperature regulated modulating steam control valves to automatically relieve vacuum from pipe, coil, or vessel. Vacuum breakers shall be constructed of brass or stainless steel body, stainless internals, threaded connections, with a minimum working pressure of 125 PSIG. Spirax/Sarco Model VB or equal.

20.0 Sleeves

A. The specifications and drawings shall define and detail the installation of grouting and waterproofing of sleeves and sealing of the annular spaces between piping and sleeve consistent with the building construction.

B. Pipe sleeves are required where piping passes through floor slabs, grade beams, access floor panels, metal gratings, interior walls, partitions, fire walls, exterior walls and roofs.

C. Pipe Sleeve Type: (Exterior wall or interior concrete or masonry wall or floor penetration): Schedule 40 galvanized steel pipe.

D. Pipe Sleeve Type: (Gypsum Wallboard Interior Wall): No. 20 gauge galvanized sheet metal with flanged-out edges to secure sleeve to wall.

E. Furnish sleeves to the proper trades for installation (i.e. concrete, masonry, drywall).

F. In finished areas, set floor sleeves flush with the top of the finished floor surface. In kitchens, cafeterias, janitor’s closets and similar service areas, set floor sleeves 4 inches above the finished floor, unless such areas are slab-on-grade. In laboratories, pipe chases, pipe spaces and other unfinished areas, set floor sleeves 4 inches above the floor, unless otherwise indicated or specified. In mechanical rooms, a 4-inch high concrete pad shall be provided with a minimum of 6-inch horizontal surface around piping penetrations. Sleeves shall be flush with the underside of slabs.

G. Install escutcheons on all exposed piping penetrations.

H. Each through penetration fire-rated sealant shall be located on as-built drawings and identified by UL directory file number.

21.0 Counterflashing

A. Provide counterflashing for piping, vents, ductwork, breechings, chimneys and stacks passing through roofs and exterior walls. Provide counterflashing for curbed roof openings except where counterflashing is an integral part of roof-mounted mechanical equipment.

22.0 Vibration Isolation

A. Provide concrete inertia bases, structural steel bases, and vibration control devices and accessories of appropriate sizes and proper loadings for mechanical equipment, piping and ductwork systems as indicated on the following schedule.

B. Types of isolators indicated on the schedule are as follows:

1. Unit FSN (Floor Spring and Neoprene).
2. Unit FSNTL (Floor Spring and Neoprene Travel Limited).
3. Unit FN (Floor Neoprene).
4. Unit NP (Neoprene Pad).
5. Unit DNP (Double Neoprene Pad).
6. Unit HS (Hanger Spring).
7. Unit HSN (Hanger Spring and Neoprene or Glass Fiber).
8. Unit HN (Hanger Neoprene or Glass Fiber).
9. Unit PCF (Precompressed Glass Fiber) Vibration and Noise Isolation Pads.

C. Types of bases indicated on the schedule are as follows:

1. Unit BSR (Base - Steel Rail).
2. Unit BSF (Base - Steel Frame)
3. Unit BIB (Base - Inertia Base).
4. Unit BC (Base - Curb).

23.0 Redundancy Considerations

A. The A/E shall consider for each project the level of service and equipment redundancy in conjunction with the criticality of the process, building function, and project budget. Multiple levels of full redundancy shall be considered as required to support the function; such as N+1 (100% capacity during failure or maintenance procedure), or "Emergency Mode" operation where partial capacity is maintained during an equipment failure or maintenance procedure.

VIBRATION ISOLATION SCHEDULE				
UNIT	ISOLATOR TYPE (NOTE 1)	MINIMUM STATIC DEFLECTION INCHES	BASE TYPE (NOTE 1)	REMARKS
Centrifugal Chillers On Grade Slab	PCF	0.25	None	(NOTE 1)
Screw Chillers On Grade Slab	PCF	0.25	None	(NOTE 1)
Screw Chillers Above Grade	FSNTL	1.50	None	
Reciprocating Chillers On Grade Slab	FSNTL	0.75	None	
Reciprocating Chillers Above Grade	FSNTL	2.5	None	
Reciprocating Chillers Outdoor On Grade	-	-	-	
Condensing Units On Grade Slab	FSNTL	0.75	None	
Condensing Units Above Grade	FSNTL	2.5	None	
Condensing Units Outdoor On Grade	-	-	-	
Air-Cooled Condensers - Outdoor On Grade	-	-	-	
Air-Cooled Condensers - Roof-Mounted	FSNTL	.5	None	
Rotary Air Compressors On Grade Slab	FSN	0.75	BIB	(NOTE 1)
Rotary Air Compressors Above Grade	FSN	1.50	BIB	
Reciprocating Air Compressors On Grade	FSN	1.50	BIB	
Reciprocating Air Compressors Above Grade	FSN	2.50	BIB	
Tank-Mounted Air Compressors On Grade Slab	FSN	1.50	None	
Tank-Mounted Air Compressors Above Grade	FSN	2.50	None	
Rotary Vacuum Pumps On Grade Slab	FSN	0.75	BIB	
Rotary Vacuum Pumps Above Grade	FSN	1.50	BIB	
Fans In All Pre-Engineered AHUs	FSN	1.5	BSF	
Pre-Engineered AHU Cabinets On Grade Slab	-	-	-	
Pre-Engineered AHU Cabinets Above Grade	PCF	0.35	None	

VIBRATION ISOLATION SCHEDULE				
UNIT	ISOLATOR TYPE (NOTE 1)	MINIMUM STATIC DEFLECTION INCHES	BASE TYPE (NOTE 1)	REMARKS
H&V Units - Floor-Mounted	FSN	1.5	None	
H&V Units – Suspended	HSN	1.5	None	
Rooftop AHUs - Curb-Mounted	BC	1.0}	None	With Integral Base
Rooftop AHUs – Dunnage	FSNTL	1.5	None	
Centrifugal and In-Line Centrifugal Fans:				
Floor-Mounted; Below 10 Inches w.g. S.P.	FSN	1.5	BSF	
Floor-Mounted; Above [10 Inches w.g.] {2.5 kPa} S.P.	FSN	1.5	BIB	
Suspended	HSN	1.5	None	
Axial, Tube-Axial, And Vane-Axial Fans:				
Floor-Mounted	FSN	1.5	BIB	
Suspended	HSN	1.5	None	
Roof-Mounted Exhaust Fans (Roof Ventilators)	BC	1.0	None	With Integral Base
Fan Coil Units - Floor Mounted	-	-	-	
Fan Coil Units – Suspended	HSN	0.75	None	
Fan-Powered Terminal Boxes	HN	0.25	None	
Suspended In-Line Pumps	HN	0.35	None	
Base-Mounted Pumps Less than 1 HP On Grade Slab, or Above Grade	FSN	0.75	BIB	
Base-Mounted Pumps 1 HP and Larger On Grade Slab	FSN	0.75	BIB	(NOTE 1)
Base-Mounted Pumps Less Greater Than 1 HP and Less Than 150 hp Above Grade	FSN	1.5	BIB	
Base-Mounted Pumps 150 hp and Larger Above Grade	FSN	2.5	BIB	
Cooling Towers Outdoor On Grade	-	-	-	
Cooling Towers Above Grade (In-cluding Roof-Mounted Towers)	FSNTL	2.5	None	
Diesel Engine Generators	FSN	0.75	None	With Type SN Snubbers

NOTES: If the equipment is in a vibration-insensitive building, such as a remote Central Utility Plant, isolation requirements may be reduced.