SECTION 23 00 10 – HVAC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY:

A. This section details the general design requirements for Heating, Ventilation and Air Conditioning (HVAC) systems, for both new and retrofit applications.

B. Related Sections:
1. Section 01 13 01 - Design Guidelines for Energy and Environment
2. Section 01 13 51 – NGRID Electric Rebate Program
3. Section 01 13 52 – NGRID Gas Rebate Program
4. Section 01 17 01 - Building Systems Identification and Labeling
5. Section 01 17 71 – Contract Record Documents and Turnover Requirements
6. Section 23 09 00 - Building Automation Systems
7. Section 26 09 02 - Campus Central Metering System Design Criteria

1.2 BACKGROUND:

A. The Central Heat Plant (CHP) provides heat from October to May for approximately 100 buildings on the main campus, totaling 4.5 million square feet of space. It delivers high-temperature hot water (HTHW) through a network of underground piping, which presently operates at 300 degrees and a future scheduled maximum temperature of 250-275 degrees F and 185 degrees F. The HTHW piping is also referred to as the "Distribution Loop". Heat from this Distribution Loop is typically converted at the individual building, or building hub, to medium-temperature hot water (MTHW) operating at a maximum temperature of 180 F. As the conversion process is underway there are still a few instances of HTHW that presently convert to low pressure steam (LPS) for buildings requiring steam for heating, process or humidification uses but these will all be removed by October 2020. The HTHW distribution system shall no longer be considered a source to generate steam in any buildings.

B. The Central Heat Plant is shut down during summer months. If hot water is required for reheat, domestic or process needs, a separate local stand-by heating source shall be provided.

C. Brown University has four district chilled water systems which serve primarily the Science, Biomedical Research, and Academic buildings on campus. Three of these systems operate year-round, with limited "free-cooling" chilled water capacity in the winter. Wintertime chilled water use should be limited to equipment and systems that cannot utilize local winter air-side "free cooling". Whenever possible, it is expected that new buildings will be connected to the district chilled water systems, rather than have stand-alone chiller plants, where deemed to be cost-effective.

1.3 DESIGN SUBMITTAL REQUIREMENTS:

A. HVAC system designs shall include the following:

1. Conceptual/Schematic Design: Design narrative including a basis of design with description of each system, proposed utility connections, flow diagrams of the proposed system and HVAC zoning maps. The Basis of Design shall also include the following:
    a. Space design conditions – indoor temperature / humidity design conditions, outdoor design basis
    b. Hours of operation for occupied spaces
    c. Seasonal system availability for central utility systems (heating and cooling)
    d. Energy design criteria
    e. Acoustic design criteria
    f. Design specification sections headers only
    g. Framework for BAS/controls sequence of operations of major equipment
    h. Any proposed deviations from Brown Standards (all deviations shall be approved by Brown project manager prior to being included in Basis of Design)
    i. High performance design charrette outcomes including proposed initiatives, path for design integration, and any energy modeling/analysis required. (Design team needs to meet with Brown University's energy team for high performance design charrette prior to first basis of design submission.)
    j. Description of each system including: sizing, redundancy, and interconnections with central utilities, etc., with flow diagram
2. Construction documents: Updated/revised Basis of Design including the following:
    a. Updates/Deviations from <u>all</u> previous submittal items
    b. Approved deviations from Brown Standards (Approval process should be documented for each)
    c. Accessibility drawing detailing accessibility for equipment rigging/ installation as well as access to equipment for routine operation, service and maintenance.
    d. All basis of design components shall be integrated into the design documentation in drawing schedules, drawing notes, or design specifications

1.4 GENERAL DESIGN REQUIREMENTS:

A. Energy Conservation: For all new and renovation projects and for equipment selection refer to Brown Standards, Section 01301C - Design Guidelines for Energy and the Environment. A high performance design charrette will take place with the Brown University's energy team to evaluate sustainable design approach prior to the conceptual/schematic design basis of design submission.
B. For general temperature guidelines, Brown University recommends the following temperature guidelines for conditioned, interior building spaces:

	COOLING	HEATING
Occupied Mode	74°F	70°F
Unoccupied Mode	82°F	62°F
Standby	77°F	67°F

C. HVAC system design and equipment selection should be determined by minimum life cycle cost including Construction, Operating and Maintenance costs. The following HVAC system design issues should be reviewed and addressed in the course of project development:
   1. Evaluate Exhaust Air Energy Recovery Systems: Evaluate system benefits and incorporate as applicable for individual fan systems. When implemented, include bypass or control the heat recovery system to permit air-side economizer operation.
   2. Evaluate demand control ventilation (DCV) controls for all spaces not required by Energy Conservation Code that have regular variability in occupancy. .
   3. Evaluate capability to shut down air handlers and exhaust systems in unoccupied areas of the building. Investigate proposed space use and programming; where cost-effective, serve different space use areas and different occupancy schedule areas with separate air and hydronic systems.

D. For new building projects and renovations of existing building spaces, develop and provide a matrix of competing HVAC design alternatives for Brown to review and consider for implementation. Matrix to include pro/con of each proposed alternative for:
   1. System operating flexibility from season to season
   2. Occupant comfort
   3. Initial cost
   4. Operational cost
   5. Estimated maintenance costs
   6. Lifecycle cost

E. Generally, spaces should not be mechanically humidified. Exceptions include Animal Care facilities, select research facilities and select library spaces, which are to be humidified in accordance with project-specific design guidelines. No new fossil-fuel fired humidification systems are allowed.

F. All system designs shall include detailed building HVAC water and air system flow diagrams showing all major system components, meters, controls and isolation valves, and interfaces with other building and campus utility systems. Diagrams shall include design loads, temperatures and flow rates.

G. For renovation projects, HVAC flow diagrams shall be provided with updates to clearly indicate locations of all new system tie-ins being added, or components to be removed, and changes to flow rates and loads.

H. A detailed HVAC control sequence of operations and BAS points list shall be included in the plans or specifications.

I. Apply good engineering practices for the design of air handlers, ductwork, and piping systems so as to create a quiet system appropriate for the specific project. Sound and vibration criteria should be defined early in the project and documented in the Conceptual/Schematic Design Basis of Design document.

J. Rebates: Actively seek out products which can qualify for rebates under National Grid’s programs and complete rebate applications as required under Brown Standards, Sections 01 13 51 and 01 13 52.

1.5 DETAILED HVAC DESIGN REQUIREMENTS:

A. ACCESSIBILITY:

1. HVAC equipment shall be designed and installed to allow for ready access and servicing of components. Include provisions for rigging of heavy components from lifting eyes and building steel where access is limited for floor-mounted lifting devices.
2. Separate "Equipment Accessibility and Rigging Plans" shall be developed and provided for all HVAC equipment.
3. Equipment Accessibility Plans shall indicate, as crosshatched areas, required service clearances around the equipment for routine equipment service access, and space required to operate and replace related valves and accessory components, per the manufacturer’s requirements. Accessibility plans shall include clearances required for rigging and removal of the equipment, and the dedicated clearances required for rigging and removal of major equipment components for periodic inspection and service, such as pull space for removal of tube bundles for heat exchangers and chillers, shaft pull space, space for removal of boiler inspection hatches, and other required equipment clearances.
4. Equipment Rigging Plans shall indicate sizes of major pieces of equipment and clearly marked paths of removal of this equipment from the point of installed equipment to the loading area exterior to the building. Entire egress path shall be coordinated for removal of equipment. Egress paths of equipment through removable louvers or rooftop ventilation louvers are acceptable provided they are crane accessible.
5. Components requiring regular maintenance shall not require the use of portable ladders, lifts, or other devices for service access, except for VAV boxes and dampers located above ceilings.
6. Preference for mounting of air handler temperature control valves and piping system isolation and control valves is for serviceability from the floor without the use of ladders; maximum height 6'0" AFF. Where service valves are mounted 8 feet or higher above the floor, provide service platform, catwalk, or valve chain wheels and safety-trimmed chains. Do not block equipment access when locating valves.
7. For valves being provided with position indication, mount them such that the position indicators are readily visible from floor level, and per valve manufacturer’s requirements.

B. Outdoor equipment locations, including rooftops, are not preferred except for cooling towers and exhaust fans. The following criteria shall be followed in the decision-making process to locate equipment outdoors;
   1. Serviceability and access
   2. Aesthetics
   3. Noise
   4. Equipment durability
   5. Vandalism

C. Fossil-fuel fired boilers shall not be installed without an approved waiver. Boilers/Heat pumps shall be selected so that individual units are rated at less than 30 BHP input. If larger boilers are necessary, those 30 BHP (1MMBTUH input) and above, as well as all chillers, shall be fully integrated into the campus Building Automation System (BAS) for remote supervisory monitoring and alarming.

D. Air handlers, energy-recovery units, fan-coil units and other terminal units shall not be provided with manufacturer-furnished controls; controls shall be furnished by the Building Automation System (BAS) manufacturer. Controls for specialty equipment such as chillers, shall be BACNET compatible with the building BAS system; Controls interfaces and all required monitoring points between systems shall be coordinated with the BAS Control Sequences during the Design phase.

E. All fans and pumps greater than or equal to 5 HP shall have soft-start or VFDs for motor control. Refer to Division 26 for VFD requirements.

F. Standby Power: Connect building BAS controllers and heating system pumps to the Standby Power system, where it is installed within a facility.

G. Unit heaters or other equipment not on BAS shall have locked or concealed adjustment controls.

H. Leak Detection: Evaluate if water leak detection sensors are required in mechanical rooms and critical rooms and spaces where hydronic piping and equipment is installed. Leak sensors to be connected to BAS, where installed.

I. Metering:
   1. Install Thermal (BTU) metering for monitoring of building energy consumption, where buildings are served from the campus Central Heat plant (for heating) or district chilled water plant. Metering requirements are found within Division 26 of the Brown Design Standards.
   2. Provide abatement water meters on large cooling towers (over 100 tons) on both makeup water and blowdown lines.

1.6 MECHANICAL ROOM DESIGN REQUIREMENTS:

A. Mechanical rooms shall be adequate in size for the proper servicing of equipment, including access for replacement of all mechanical equipment, and provide for required spare parts storage. Mechanical Rooms shall be accessible by a standard stair or elevator. Ship’s ladders and steep stairs are NOT acceptable. Double doors are preferred but at a minimum, a single door shall be a minimum of 36 inches wide.

Adjoining pieces of equipment shall be separated by a minimum of three feet. Provide space within mechanical room to store two changes of air filters, lubricants, etc.

B. Design shall provide for clear service and maintenance access to all equipment. Service areas shall comply with codes, manufacturer's recommendations and shall be reasonably planned for human access.

C. Mechanical rooms located above occupied floor levels shall be curbed, room floors waterproof sealed, and all floor penetrations sleeved to 2" above the floor to prevent liquid spills and leaks from traveling out of the space.

D. Mechanical Rooms shall be well lit, maintaining a minimum of 25 foot-candles. Lighting shall be switched at each exit. Power at 100% of mechanical room lighting from standby generator power source where it is available. Provide 120VAC convenience outlets in mechanical rooms to provide for ready servicing of equipment.

E. Provide adequate number of floor drains in mechanical rooms; drains are to be connected to the sanitary sewer system, not to storm sewer. Locate drains to avoid running of condensate drains and other similar equipment across mechanical room floors. Provide trap primers as required per Code.

F. Locate all floor-mounted major mechanical equipment on concrete housekeeping pads.

G. Provide thermostatically controlled ventilation as required.

1.7 TEST AND BALANCING:

A. For renovation projects, the Design team shall be responsible for generating and confirming the existing initial test and balance readings on the air and hydronic systems to be modified to confirm the existing operating conditions.

B. Provide test and balancing of all air-side and hydronic systems at the completion of the project to ensure systems are operating per the Design intent.

C. Provide local labels for the design flow values at the Test and Balance locations for major equipment.

1.8 NAMING CONVENTIONS AND EQUIPMENT LISTS:

A. HVAC Equipment designations, naming conventions, development of Equipment lists and Operating and Maintenance procedures shall be as indicated in Section 01 17 71 – Contract Record Documents and Turnover Requirements.

1.9 VENTILATION:

A. Natural Ventilation is allowable, where practical and meets code/standards design requirements, for Residence halls and residences, student study areas, small offices and administrative locations with low occupant density, where operable windows with sufficient free area are provided. Selection and use of natural ventilation vs. mechanical ventilation to be reviewed in the project Planning and Design phase. When operable windows are employed, status controls are to be designed and installed to determine if windows are the open or closed position and this information needs to be interlocked with parallel mechanical HVAC system serving the space so a scenario is never produced where the two methods of conditioning fight each other.

B. Fan-coil or unit ventilators utilizing outside air via thru-wall vents are not acceptable for fresh air supply.

C. Any air intakes located near grade shall be located to be remote from vehicle exhausts, emergency generator exhausts and sited to avoid building exhaust reentry as well as comply with other mechanical code requirements.

1.10 UTILITIES - HEATING:

A. Connection of building heating system to Central Heating Plant High Temperature Hot Water (HTHW) heating system (Distribution Loop) is required for new buildings located on the main campus, unless approval from Brown University project manager has been given based on economic analysis proving the connection is not economically feasible or financially beneficial.

B. Below is the planned progression of supply and return temperatures for the campus HTHW heating system("distribution loop"), where HTHW is the distribution loop High Temperature Hot Water Supply and HTHWR is the distribution loop High Temperature Hot Water Return. All new loads connecting to the campus heating distribution loop must be designed and sized to work in both the Present state and the future state scenarios called "Post Decarbonization". The heat exchanger(s) must be designed to work with the lowest supply temperature shown below, and water returning to the loop from the new heat exchanger shall be 130 degrees or lower without modifications to the heat exchangers or apparatuses.

Loop Condition	Temp. Range		Distribution Required Temperature Differential
	Loop Supply [HTHWS]	Loop Return [HTHWR]	
Current State (2019)	325-345°F	225-245°F	50°F
Post Thermal Efficiency Project (Est. Oct 2020)	250-275°F	175-200°F	75°F
Post Decarbonization (TBD)	165-185°F	125-130°F	50°F

C. Available HTHW differential pressure at the building entrance depends on the distance from the Central Heat Plant. This can range from 50 psi near the plant to 10 psi at remote locations. Building medium Temperature Hot Water (MTHW) shall be designed with a maximum 140 F supply and target a minimum 20 degree delta.

D. If an independent boiler(s) are required to provide hot water, or any required and permissible reheat, when the Central Heat Plant is shut down or for any buildings not served by the CHP, the fuel source for these boilers is to be discussed and approved with the Brown University project manager.

E. Provide for the ability to reset hot water heating system temperatures, based on outside air temperatures.

1.11 UTILITIES - COOLING:

A. Use of direct-expansion chiller systems, versus chilled-water systems, is to be reviewed in the project Design phase. Chilled water is preferred to direct-expansion systems where buildings are located in areas that will facilitate future interconnection of district chilled water systems, and/or when cooling is required on a year round basis.

B. Where buildings are to be connected to existing campus district chilled water systems, the University's design standard is for a "variable flow"-only configuration. Any connection to, or expansion of, this system shall conform to this design scheme.
   1. District chiller plant summer design supply temperature is 42 F and return is 54 F.
   2. During winter, in waterside economizer mode, design supply temperature is 50 F.

C. Use of alternative chilled-water cooling system designs within the building, such as "chilled beams" is acceptable. If chilled beams are used in buildings with operable windows, special provisions shall be made to shut the cooling system off when space conditions exceed a specific dew-point temperature.

D. Process cooling loads shall not be directly connected to the house chilled water or condenser water systems, but shall be isolated on a separate loop by means of a plate-and-frame heat exchanger. Provide heat exchangers with supply and return isolation valves and strainers to facilitate cleaning/flushing.

E. Within Research labs, all User loads shall be connected to the building process or chilled water system via a local plate and frame heat exchanger; exceptions are allowed for the direct connection of hard-piped process chillers and refrigeration equipment where it has been verified they can withstand the building system operational pressure.

F. Design process cooling loops with as high a supply temperature and temperature rise as possible.

1.12 HYDRONIC SYSTEMS - BUILDINGS:

A. Four-pipe systems are required in all buildings requiring simultaneous heating and cooling, based on building size, orientation, and building space program needs.

B. Where modifications are made to existing buildings already served by two-pipe systems, two-pipe changeover designs will be considered, where it is determined this design will not impact the planned program needs of the space.

C. If connecting a new variable-flow system to an existing changeover or constant-volume systems, provide 2-way injection valves on the primary side supply line and modulate these valves to maintain the desired secondary side HW or CHW temperature set point.

D. Preheat coils on large air handlers shall be provided with freeze pumps to protect against freezing and temperature stratification.

E. For systems requiring freeze protection, when other design methods are ineffective, utilize 40% concentration Propylene Glycol. Proposed glycol system use shall be reviewed in the design phase.

F. Provide vents at the high point of all piping systems, in accessible locations, to allow for system venting. All vents shall have isolation valves.

G. Closed-Loop Hydronic Systems:
1. Expansion tanks shall be diaphragm type; the pre-charge pressure shall be specified to suit the system.
2. Air and dirt separators shall be installed in each heating system distribution loop at the point of lowest air solubility and vented to atmosphere.
3. A chemical pot feeder shall be installed across the hot water pump.
4. Gauges:
    a. Provide differential pressure gages at all pumps, strainers and heat exchangers; gauges shall be glycerin filled.
    b. All gauges on a common hydronic system shall have consistent scale ranges.
    c. Provide isolation "pete" plug valves on all gage connections.
5. Provide temperature indicators on the supply and return side of all heat exchangers, chillers and boilers. All gauges shall have consistent temperature ranges.
6. Provide pressure gauges on the supply and discharge sides of all pumps and heat exchangers.
7. Piping systems shall be pressure-tested before installation of insulation. Pressure tests shall be witnessed by Brown University personnel and documented by the contractor.

1.13 MOTOR ALIGNMENT:

A. All base-mounted pumps and motors shall be laser-aligned.

B. Belt-connected motors shall be laser-aligned and belts tensioned; belts shall be re-tensioned after 100 hours of use, or per manufacturer's recommendations.

1.14 INSULATION:

A. Piping:
1. Closed-cell foams such as "Armaflex" or "Rubatex" are not allowed, except for use on small-diameter piping within confined spaces, or on refrigerant lines, pumps and chiller barrels.
2. Removable blankets with Velcro fasteners shall be used for HTHW and steam control valves, and for where regular maintenance or metering access is required.
3. Do not wrap valves unless they are equipped with valve extensions to permit continuous insulation thickness and vapor barrier.
4. Exposed piping in finished spaces and mechanical rooms shall have a PVC outer jacket over the pipe and fitting insulation.
5. Exposed exterior piping shall have an aluminum jacket over the pipe and fitting insulation.

B. Ductwork:
1. Minimize the use of acoustic linings; Silencers are the preferred method of sound attenuation. Use of acoustic duct liners shall be determined during Design phase; where used, acoustic duct liner to be Mylar-faced.
2. Lining in medium and high velocity ducts shall have a perforated metal cover (i.e. double-wall construction) with Mylar interior facing.

3. For exterior locations, provide flexible roofing membrane over duct insulation.

C. Nameplates on heat exchangers or other equipment requiring insulation shall be removed and riveted or screwed to the nearest adjacent permanent, suitable, and accessible frame.

1.15 WATER TREATMENT:

A. All HVAC water subsystems, closed or open, shall be drained, flushed, and equipped with treatment systems.

B. Treatment systems shall include complete, fully functional chemical injection and control systems.

C. Water treatment procedures and equipment shall be coordinated and specified based on Brown University's current contracted Chemical Treatment vendor. Chemicals and chemical feed equipment shall also be provided by this same vendor.

D. All building water systems including cooling tower installations and treatment systems shall meet the recommendations in ASHRAE Guideline 12, latest edition: Minimizing the Risk of Legionellosis with Building Water Systems.

1.16 REFRIGERANTS AND RELATED SYSTEMS:

A. CFC refrigerants and refrigerant types HCFC-123 and HCFC-22 are not allowed.

B. Refrigerant HFC-134a is currently being phased out and new equipment shall not be installed using HFC-134a.

C. Conform to ASHRAE Standards 15 and 34 when designing both central plant and smaller DX-type refrigerant systems.

D. Brown does not require Self-Contained Breathing Apparatus (SCBA) to be located on site.

E. Provide refrigerant leak detection in all occupied spaces and mechanical rooms per ASHRAE requirements.

F. Avoid routing of refrigerant piping through any occupied areas where there is no mechanical ventilation, such as residence hall sleeping or study rooms.

1. Variable-refrigerant volume (VRF) systems: Maximum allowable refrigerant concentration from a system leak in an occupy-able space, other than mechanical rooms, shall not exceed 50 % of the maximum allowable levels under the ASHRAE guidelines.

1.17 SOUND, VIBRATION AND SEISMIC CONTROL:

A. Acoustical sub-consulting services by a Brown-approved firm shall be utilized on all projects with critical User requirements such as testing, research, teaching, or performances. Acoustic services shall also be provided for outdoor-located mechanical equipment and air intake and exhaust louvers serving loud interior-located equipment, which may have an impact on the surrounding community, in order to verify that local noise criteria ordinance is met.

B. Acoustical consulting services shall include developing space requirements, testing actual performance indoors, and reviewing property line impacts of any outdoor equipment.

C. Provide recommended sound attenuation features in the design.

D. NC levels only are not adequate; RC levels shall also be used. Do not exceed ASHRAE published guidelines.

E. Sound and vibration criteria shall be defined early in the project and documented in the Basis of Design. Equipment and systems requiring isolation or attenuation to satisfy ASHRAE, or the User's own, noise and vibration requirements shall be identified and appropriate design measures shall be implemented during the project design.

F. Rotating equipment within buildings, except slab-on grade or basement locations, shall be designed with isolation springs to prevent excessive transmission of noise and vibration to the building structure.

1.18 AIR DISPERSION:

A. All projects that may involve air re-entrainment or excessive concentrations of fume exhaust at nearby air intakes or buildings shall utilize a Brown-approved firm to perform an air dispersion analysis.

1.19 HEAT RECOVERY:

A. Even where reheat is allowed by code, enthalpy exchange energy recovery, and other dehumidification methods, are required to minimize fuel-fired or electric reheat costs.

B. For Wet Labs and Vivaria, sensible-only heat recovery shall be implemented in order to prevent airstream cross-contamination.

1.20 LABORATORIES & RESEARCH FACILITIES:

A. If a project requires Fume Hoods, Brown EH&S and FOE staff shall be consulted during the project design phase to review proposed occupied and unoccupied design air change rates and the associated fume hood selections.

B. Conform with NIH guidelines except for specific provisions where Brown University has verified in writing that provisions do not apply, e.g., multiple species provisions where single species space is being built.

C. Vivaria shall conform to the AAALAC Guide, latest edition.

D. Facility utilities and terminal equipment that support animal care and critical Research areas shall be located outside of the spaces, within service corridors or dedicated mechanical spaces. Isolation valves and dampers for lab and research space HVAC equipment shall be located outside the labs.

E. Hydronic heating and cooling equipment, such as fan-coil units, and other HVAC equipment that may require preventive maintenance, where installed in labs, shall not be located above active research equipment and spaces within the lab; this equipment is also not allowed in animal housing areas.

F. HVAC equipment redundancy may be required at certain facilities. Redundancy and connections to emergency power shall be as directed by Brown University, and shall be included at all design submittal stages.

1.21 TUBE-IN-SHELL HEAT EXCHANGERS:

A. Common Requirements:
1. Tube-in-shell heat exchangers shall be manufactured in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, with "U" stamp.
2. Provide heat exchanger with minimum 3" thick fiberglass insulation with outer steel jacket.
3. Heat exchanger design to incorporate standard 0.0005 fouling factor.
4. Provide capability for manual blowdown, including ASME rated flash tanks, vents and tempering devices to drain as needed.
5. Provide hard-wired safety shutoffs that require manual reset when activated. Safety shutoffs shall close the control valve when activated and annunciate an alarm on the BAS. Refer to section 23 09 00 for additional control requirements.
6. Provide heat exchangers with supply and return isolation valves and duplex strainers on each side to facilitate cleaning/flushing.
7. Dual heat exchanger sets shall have a dedicated control valve with isolation valves on each heat exchanger. For a single heat exchanger installation, provide a bypass globe valve around the control valve, in addition to the isolation valves.

1.22 PLATE AND FRAME HEAT EXCHANGER [NOT CONNECTED TO HTHW DISTRIBUTION LOOP]

A. Common Requirements:
1. Plate and frame heat exchangers shall be manufactured in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels", and rated per AHRI 400, "Liquid to Liquid Heat Exchangers".
2. Plates shall be 316 stainless steel with gaskets to suit temperature service.
3. Splashguard shall be aluminum or stainless steel.

B. Frames shall be sized for 20% future capacity expansion.

C. Plate and frame heat exchangers, where installed (typically for Process and Condenser water cooling systems) shall be configured and piped to allow for ready disassembly for inspection and cleaning.

D. Provide isolation and drain/fill valves and connections on each side of the heat exchanger to allow for system isolation and ready cleaning of the heat exchanger.

E. Provide differential pressure indicator gage across each heat exchanger water circuit.

1.23 BRAZED PLATE HEAT EXCHANGERS [HTHW (Distribution loop) to MTHW]

A. Common Requirements:
1. Heat exchangers shall be manufactured in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels", and rated per AHRI 400, "Liquid to Liquid Heat Exchangers".
2. Plates shall be 316 stainless steel and brazed.
3. Splashguard shall be aluminum or stainless steel.

B. Manufacturer shall be SWEP and model selected as follows:

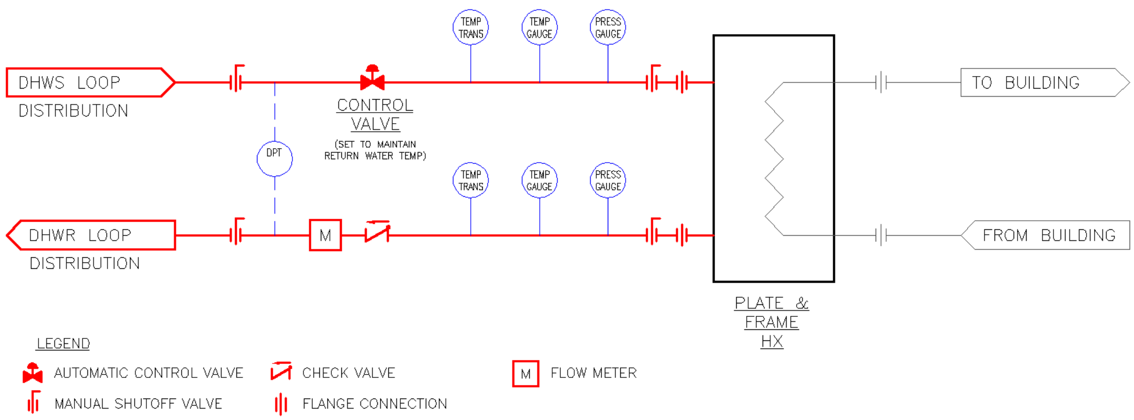
Connection size	Approved model
2½"	B35T
4"	B427
6"	B633

C. Frames shall be sized for 20% future capacity expansion.

D. Provide isolation and drain/fill valves and connections on each side of the heat exchanger to allow for system isolation and ready cleaning of the heat exchanger. Strainers shall be simplex type on the loop side (distribution) and duplex type on the building side.

E. Provide differential pressure indicator gage across each heat exchanger water circuit.

F. Typical connection is as follows:



1.24 CLEAN-STEAM GENERATORS AND HUMIDIFIERS:

A. For facilities requiring "clean" or chemical-free steam, the makeup water shall be pre-treated with a water softener, or a reverse-osmosis / deionized (RO/DI) water source shall be used.

End of Section