SECTION 23 00 10 – HVAC DESIGN CRITERIA

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 – Utility Rebate Programs
3. Section 01 17 71 – Project Turnover Requirements
4. Section 01 17 73 – Operations & Maintenance Manuals
5. Section 01 35 25 – Facilities Fall Protection
6. Section 01 70 10 – MEPS Identification & Labeling
7. Section 01 78 25 – Facilities Visual Aids Documentation
8. Section 01 81 10 - Building Service Equipment Accessibility Requirements
9. Section 01 81 11 – Confined Spaces
10. Section 01 93 10 – Equipment-Specific Energy Control Measures
11. Section 23 09 00 - Building Automation Systems
12. Section 26 09 02 - Campus Central Metering System Design Criteria

2. **BACKGROUND:**

A. The Central Heat Plant (CHP) provides heat from October to May for approximately 90 buildings on the main campus, totaling 4.7 million square feet of space. It delivers high-temperature hot water (HTHW) through a network of underground piping, which presently operates at a scheduled maximum temperature of 200-250 degrees F (Supply) and 170-185 degrees F (Return). 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.

B. The Central Heat Plant is shut down during summer months. If hot water is required for building reheat, domestic hot water or process needs, a separate local summer heating source shall be provided, designed to meet the required loads with 20% spare capacity.

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, new buildings will be connected to a district chilled water system, when deemed to be cost-effective.

3. **DESIGN SUBMITTAL REQUIREMENTS:**

A. HVAC system designs shall include the following:

1. **Conceptual/Schematic Design:** A design narrative including the basis of design with description of each system, proposed utility connections, flow diagrams of the proposed system and HVAC zoning maps shall be provided. 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. Energy design criteria;

d. Acoustic design criteria;

e. Design specification sections - headers only;

f. Description of each proposed system including: connected and demand loads, sizing, redundancy, and interconnections with central utilities, etc., with flow diagrams;

g. Provide details of spare capacity for any new system or details of the reduction in existing system spare capacity when connecting into existing systems;

h. Anticipated new load data for each proposed system, including connected and coincident demand loads, flows, temperatures and operating pressures;

i. Description of each existing building or central utility system that is being connected to, including existing loads, flows, temperatures and operating pressures, as well as confirmation that the existing systems have the capacity to serve the new loads; review any seasonal system availability for central utility systems (heating and cooling);

j. Framework for BAS/controls sequence of operations of major equipment, in both normal operating modes and in all various failure modes (ie: power failure, smoke control, purge mode, etc.);

k. Any proposed deviations from Brown Standards shall be approved using the standards waiver process prior to being included in basis of design;

l. High performance design charrette outcomes, including proposed initiatives, path for design integration, and any energy modeling/analysis shall be required. (Design team needs to meet with the Office of Sustainability for high performance design charrette prior to the first basis of design submission.)

2. **Construction Documents:** Updated/revised basis of design including the following:

a. Updates/deviations from all previous submittal items;

b. Approved deviations from Brown Standards (approval process should be documented for each);

c. All basis of design components shall be integrated into the design documentation in drawing schedules, drawing notes, or design specifications, system flow and 1-line diagrams, equipment schedules and equipment sequence of operation descriptions.

4. **GENERAL DESIGN REQUIREMENTS:**

A. 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	76°F	66°F

Standby	74°F	68°F

B. Unoccupied areas, such as mechanical and electrical rooms, should be ventilated as required, and heated to 50°F minimum in the heating season.

C. Unless otherwise specified in the design criteria, use the tabulated weather data tables as per the latest edition of the State of RI Energy Conservation Code, as indicated below. More extreme design conditions shall be considered to ensure the proper space conditioning of vivaria, and research labs that require the use of 100% outside air ventilation systems.

Table 301.1 Exterior Design Conditions	Value
Climate zone	Providence County
Winter, design dry-bulb (degree F)	0
Summer, design dry-bulb	87
Summer design wet-bulb	71
Degree days heating	6831
Degree days cooling	371

D. HVAC system design and equipment selection should be determined by minimum life cycle cost including construction, operating and maintenance costs.

E. 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 pros/cons 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. Full lifecycle cost that includes items 3,4 and 5 and any major upgrades needed to make all evaluated options have the same life expectancy.

F. Generally, spaces should not be mechanically humidified. Exceptions include vivaria, select research facilities and library spaces, which are to be humidified in accordance with project-specific design guidelines per the basis of design.

G. No new fossil-fuel fired humidification systems are allowed.

H. A detailed HVAC control sequence of operations in both normal operating modes and in all various failure modes (ie: power failure, smoke control, purge mode, etc.), as well as a BAS points list, shall be included on the drawings.

I. Sound and vibration criteria, including nearby outdoor environments, should be defined early in the project and documented in the conceptual/schematic basis of design document. Systems shall be designed to meet ASHRAE guidelines for indoor and outdoor sound power levels. In the absence of project specific or ASHRAE sound levels, noise criteria (NC) levels for offices and classrooms shall be NC 35, auditoriums shall be NC 25 and storage spaces and computer rooms shall be NC 40.

J. Design systems to accommodate future changes and renovations. This may include future additional capacity or space to add additional components, targeting 20% future capacity additions in all functions.

K. Redundancy and reliability requirements shall be established and addressed by the design team early on the project design effort. BAS and critical system control panels shall be connected to building standby power where it is available.

5. **Flow and Riser Diagrams:**

A. All system designs shall include detailed building HVAC water and air system flow diagrams. Include the following for each system diagram as applicable:

1) Diagrams shall be generally geographic in nature. For example, a building with chillers in the basement, and air handlers throughout the building: the chillers shall be at the bottom of the riser diagram; each of the major chilled water and condenser water lines shall be shown diagrammatically correct to the general piping configuration throughout the building and inclusive of the room numbers where it is located.

2) The diagrams shall indicate all the major terminal loads and equipment served, as well as critical flow rates and design ratings of key components in each system and interfaces with other building and campus utility systems.

3) Equipment shall be referenced by its specific common name identification, and include its nominal equipment ratings (or capacities), relevant line sizes and interrelationships with other building systems and utilities.

4) Flow and riser diagrams shall include room numbers for the location of the equipment as well as room number of the spaces being served by the specific system.

5) Indicate relevant incoming utility capacities (i.e.: HTHW design temperature / flowrates).

6) Show all major system isolation and control valves and isolation dampers. Include valve tag information where it is available.

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

6. **DETAILED HVAC DESIGN REQUIREMENTS:**

A. 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 (1 MMBTU 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.

B. 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 Brown selected 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.

C. All fans and pumps greater than or equal to 5 HP shall have soft-start or VFDs for motor control. Review the need for VFD's versus soft-start motor controls. Brown prefers to use soft-starters for constant-speed loads that are only intermittently used, such as smoke control fans and fire pumps. Refer to division 26 for VFD requirements.

D. Standby Power: At a minimum, connect building BAS controllers and heating systems to the standby power system, where it is installed within a facility. Review project program requirements to determine additional HVAC equipment and systems that may be required to be on standby power.

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

F. Leak detection sensors are required in mechanical rooms, critical rooms and spaces where hydronic piping and equipment is installed. Leak sensors shall be connected to the BAS.

G. 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 sewer abatement water meters on large cooling towers (over 100 tons) on both makeup water and blowdown lines. Meters shall be provided with remote reading connected to the BAS for flow totalization.

H. Remote located HVAC dampers and valves: supply air and critical exhaust air dampers and valves shall be provided with position status indication to the BAS where they are not readily visible from floor level or are located behind access panels.

7. **TEST AND BALANCING:**

A. For renovation projects, the project design team or general contractor shall be responsible for generating and confirming the existing test and balance readings on all HVAC air and hydronic systems that will be modified during the project prior to commencing modifications.

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 specifications.

8. **VENTILATION:**

A. Natural ventilation is allowed, where practical and shall meet 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 shall be reviewed in the project planning and/or design phase. When operable windows are employed in facilities that have humidification control, window status indicators shall be designed and installed to indicate in the BAS when windows are open;

this information shall be interlocked with the HVAC systems serving the space.

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

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

9. **UTILITIES - HEATING:**

A. Connection of building heating system to the central heat plant high temperature hot water (HTHW) heating system (distribution loop) is required for new buildings located on the main campus, unless approval from a 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 progression of supply and return temperatures for the campus HTHW heating system ("distribution loop"), where HTHWS 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 shall be designed and sized to work in both the present state and the future state scenarios called "post decarbonization". The heat exchanger(s) shall 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]	
Post Thermal Efficiency Project (Oct 2020)	250-275°F	175-200°F	75°F
Temperature Reduction (Oct 2022)	200-250°F	150-200°F	50°F
Post Decarbonization (Date TBD)	160-170°F	120-130°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 the furthest location from the plant. 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 Office of Sustainability.

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

10. **UTILITIES - COOLING:**

F. 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.

G. Where buildings are to be connected to existing campus district chilled water systems, Brown's design standard is for a "variable flow"-only configuration. Any connection to, or expansion of, this system shall conform to this design scheme.
   3. District chiller plant summer design supply temperature is 42 F and return is 54 F.
   4. During winter, in waterside economizer mode, design supply temperature is +/- 46 F.

H. 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.

I. 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 in close proximity to the heat exchanger.

J. 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 and local circulation pump(s).

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

11. **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 the atmosphere.
   3. Show flow-limiting devices and isolating valves for each load point. Size the piping so

a minimum use of balancing valves will be required.

4. Make extensive use of insertion test plugs to assist in balancing.
5. Install flow meters or other flow measuring devices to indicate rate of flow in each system and zone serving critical research and lab spaces.
6. Gauges:
    a. Provide differential pressure gauges 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.
7. Provide temperature indicators on the supply and return side of all heat exchangers, chillers and boilers. All gauges shall have consistent temperature ranges.
8. Provide pressure gauges on the supply and discharge sides of all pumps and heat exchangers.
9. Piping systems shall be pressure-tested before installation of insulation. Pressure tests shall be witnessed by Brown's personnel and documented by the contractor.

12. **MOTOR ALIGNMENT:**

A. All base-mounted pumps and motors shall be laser-aligned and balanced to minimize vibration.

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.

13. **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 removable wire 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 and piping run in unconditioned spaces 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 shall 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.

14. **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'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.

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

F. Variable-refrigerant volume (VRF) systems: maximum allowable refrigerant concentration due to a system leak in other than mechanical rooms, shall not exceed 50 % of the maximum allowable levels under the ASHRAE guidelines for occupiable spaces.

16. **Refrigerant Leak Detection and Monitoring:**

A. Provide refrigerant leak detection in all occupied spaces and mechanical rooms per ASHRAE requirements. Locate monitors outside the monitored space where practical; where monitors are located in the room, provide a remote monitor outside the room at the main room entrance.

B. Leak detection status and alarms shall be interlocked with the BAS for remote alarm notification.

C. Provide signage outside all room entrances as noted below:

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.

18. **AIR DISPERSION:**

A. For projects that include new exhaust fans for vivaria, lab spaces and fume hoods, or projects that may involve exhaust air re-entrainment concerns or new fossil fuel exhaust or emergency/standby generator exhausts, utilize a Brown-approved firm to perform an air dispersion ('wind-wake") analysis. Analysis shall conform to ASHRAE Handbook of Fundamentals, "Airflow Around Buildings" to confirm the adequate dissipation of fumes to air intakes and windows of the project building as well as surrounding buildings.

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.

20. 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.

21. 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 guage across each heat exchanger water circuit.

22. 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.
4. Heat exchangers shall be provided with valved drain connections on each side to facilitate ready cleaning and backflushing of heat exchanger cores.

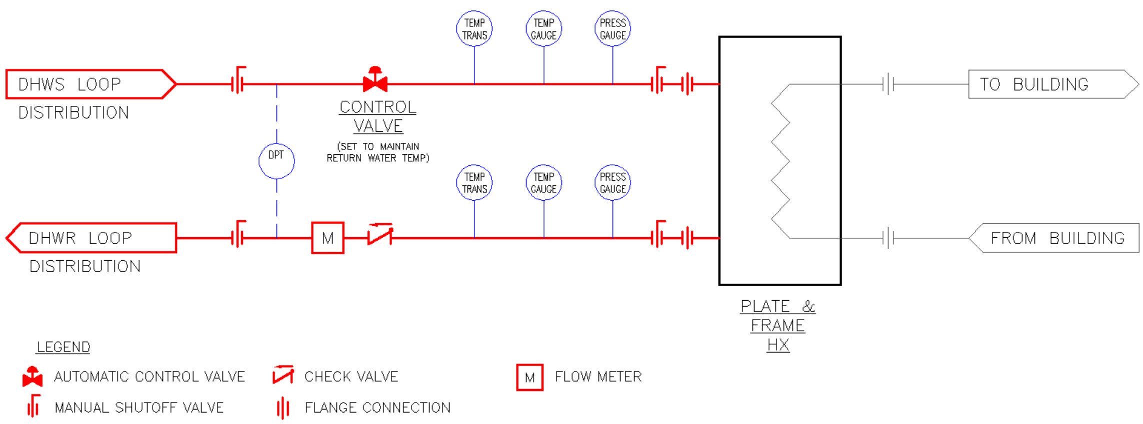
5. Provide hard-wired safety shutoffs that require manual reset when activated. Safety shutoffs shall close the control valve when activated and annunciate an alarm on the BAS. Refer to section 23 09 00 for additional control requirements.
6. Provide heat exchangers with supply and return isolation valves 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.
8. Provide differential pressure indicator gage across each heat exchanger water circuit.

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. Typical connection is as follows:



23. 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