

SECTION 15002C – HVAC Design Criteria

1. Background
 - a. Further information on central utilities at Brown University is available upon request.
 - b. The central heating plant, constructed in 1967, provides heat during winter months for 89 buildings on campus with approximately four million square feet of space. These buildings include dormitory, academic, laboratory, research, and computer information facilities housing all of the Universities mainframe computers and servers. These facilities are critical to the daily operation of the University.
 - c. The Central Heat Plant is shut down during summer months.
 - d. Cooling has, in the past, been provided within individual buildings. Recently, clustered buildings have been cross-connected using district or satellite systems to reduce overall operating costs, to provide redundancy at lower first cost, to reduce space requirements in satellite buildings, and to reduce neighborhood noise impacts from smaller air-cooled equipment near the boundaries of the institutional zone. This model is to be followed on all projects where possible.
 - e. Separate requirements (for example, other Division 15 work, Division 16 work, energy performance, and general conditions) relate to and may limit choices in HVAC design.
2. General
 - a. All HVAC designs shall include the following:
 - i. By first submittal or schematic design (or proposal for design/build projects), whichever is earlier:
 1. Design intent including owner's HVAC performance criteria
 - ii. By second submittal or schematic design, whichever is earlier:
 1. Basis of design including design conditions; complete thermal, acoustic, and energy design criteria,
 2. Description of the systems (capacities, etc.)
 3. Sequence of operation / systems interaction
 - iii. By third submittal, bid set, or construction documents, whichever is earlier:
 1. Testing requirements and criteria for acceptance
 2. Requirement for submittal of operation manuals and maintenance manuals
 3. Requirement for submittal of record drawings and control documents
 4. Testing, training, and other handover requirements
 - b. Connections to central utility systems are required for new buildings located on campus, unless economic analysis proves connections infeasible.
 - c. Heating source shall be the district heating system except where HTHW or HTHW-derived steam or MTHW cannot serve the site. Where capacity

- and safety margins permit, connections to existing heat exchangers are preferred.
- d. Medium temperature hot water is strongly preferred to steam or other heating systems for reliability, controllability, and to facilitate future conversion of yard steam systems to medium temperature hot water.
 - e. Independent boilers are required to provide hot water or any required and permissible reheat when Central Heat Plant is shut down.
 - f. For critical buildings, HVAC redundancy shall be provided as directed by Brown University.
 - g. Mechanically provided outdoor air intake is required in all spaces served by any new or retrofit HVAC systems, whether or not operable windows exist.
 - h. Rebate requirements shall be incorporated into all work and project requirements.
 - i. Chilled water is strongly preferred to direct expansion systems to facilitate future interconnection of district chilled water systems. Water-cooled plants are required for systems for 100 tons or over. For smaller plants, air-cooled chillers are allowed only where life cycle costs are lower than for water-cooled chillers.
 - j. Four pipe systems serving air handlers or, in small buildings, fan coil units are required unless two pipe system or air-only systems are approved in writing by the Brown University Project Manager.
 - i. Four-pipe systems can accommodate different spaces in the same building that require both heating and cooling at the same time, or buildings with spaces that require cooling in Fall or Spring when heating may still be required. A four-pipe system is more complex than a two-pipe system, but it provides heating and cooling with the same system and avoids frequent changeovers required with a two-pipe system.
 - ii. Use two-pipe systems only when all the loads are either heating or cooling at any given time. Two-pipe systems cannot be used when some spaces served by the system need cooling while others need heating. Switching from one mode of operation to the other increases overall energy usage and is either a fairly time consuming manual process or a complex automated process with high controls sensitivity and special chiller and boiler requirements.
 - iii. Where existing buildings are served by two-pipe systems, expansions or renovations, the limitations of the system must be acceptable or special provisions to allow cooling when the system is in heating mode are required.
 - k. 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.
 - l. HVAC equipment shall be configured to allow separate controls requirements to be met. [15900 Sections]

- m. Mechanical outdoor air intake shall be provided in air-conditioned spaces, except in rental properties and other residential spaces where operable sash adequately meets code requirements for ventilation. Where operating efficiency is improved, outdoor air intake shall be controlled to vary with occupancy or other ventilation load.
- n. Acoustical sub-consulting services by a Brown-approved firm on all projects with critical user requirements such as testing, research, teaching, or performance, and on projects including open plan office space with more than 10 workstations. These services shall include developing space requirements, testing actual performance indoors, and reviewing property line impacts of any outdoor equipment. NC levels only are not adequate; RC levels shall also be used.
- o. HVAC systems for spaces or buildings over 10,000 square feet require hour-by-hour energy modeling during design to evaluate design alternatives and optimize systems. EnergyPlus, DOE2.X, TranSys, Trane Trace, or Carrier HAP are preferred modeling software packages. Input and output files, and interpreted parametric results, shall be submitted to Brown University for review and approval or modification as required. Weather files from T.F.Green Airport or Quonset Point may be used. Extreme weather sequences that better represent College Hill's maritime microclimate may be required for system selection decision-making.
- p. Three-way valves that mix different temperature flows are not permitted, except on small projects where no alternatives are affordable and the use of three-way valves are approved in writing by the Brown University Project Manager.
- q. Air filters less than MERV 7 are not permitted except as prefilters where approved, unless on existing equipment where airflow restrictions cannot be avoided with an upgraded filter and would adversely impact equipment operation. Photohelic pressure drop indicators are required at filter racks of 4,000 cubic feet per minute and over, or for air handlers in research or other critical spaces. Filter maintenance schedules shall be established by filter loading as indicated by pressure drop so that rated filter efficiency is obtained. Future capability for filter alarms is incorporated in Photohelic devices, but is not currently preferred, and is allowed only as maintenance alarming on central BAS.
- r. Trane, Carrier, and York are preferred manufacturers for HVAC components including packaged unitary, chiller, heat rejection, and air handling devices.
- s. Refrigerants:
 - i. CFC refrigerants are not allowed.
 - ii. Refrigerant HCFC-123 is not allowed.
 - iii. Refrigerant HFC-134a is preferred where applicable.
 - iv. Use of refrigerant HCFC-22 is allowed.
 - 1. Since equipment purchased now has life expectancy beyond 2010 when production phase-out begins in the

USA, Owner may approve azeotropic refrigerant mixtures for use instead of HCFC-22.

- v. Zeotropic refrigerant mixtures are not allowed; azeotropic refrigerant mixtures require written approval from Brown University Project Manager.
- t. All equipment shall show service clearances, tube pulls, shaft pulls, and other clearances per manufacturer's requirements and drawings as crosshatched areas on drawings.
- u. Ship's ladders are not allowed in equipment or machine rooms.
- v. Components requiring regular maintenance per manufacturer's recommendations or Brown University standards shall not require portable ladders, lifts, or other devices for service access, except for VAV boxes and damper sets above ceilings.
- w. Chilled water, 180°F hot water, and other piping requiring insulation to avoid condensation or energy losses shall be insulated with fiberglass insulation with appropriate jacket for location and application. Insulation through building penetrations shall be continuous and of same type as adjacent pipe. Chilled water or other piping subject to condensation that exhibits moisture damage within the warranty period shall be replaced, unless demonstrated to be the result of a non-warranty issue. No insulation that has been wetted or that is stained or shows other evidence of having been wetted shall be installed, and if found to be installed, shall be promptly replaced. Lace-up blankets shall be used on components requiring service. Any 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. Foam insulation is not permitted except where approved in writing by Brown Project Manager, and then requires aluminum jacket on exposed and outdoor runs. [Section 01702P – Material Storage Requirements]
- x. All HVAC water subsystems, closed or open, shall be drained, flushed, and equipped with treatment systems.
- y. Treatment systems shall include complete, fully functional chemical injection and control systems.
- z. 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*.
- aa. Closed systems and portions of open systems running through buildings shall be pressure tested before lagging. Pressure tests shall be witnessed by Brown University personnel and documented by the contractor.
- bb. Operating and Maintenance procedures shall be provided in Owner-approved format compatible with FAMIS software and shall prescribe detailed:
 - i. PM schedule
 - ii. PM procedures

- iii. Baseline performance measurements for use in troubleshooting, re-commissioning, engineering, and cost analyses
 - iv. All building water systems Operations & Maintenance procedures shall meet the recommendations in ASHRAE Guideline 12, latest edition, *Minimizing the Risk of Legionellosis with Building Water Systems*.
3. Smaller Buildings (under 10,000 square feet)
- a. Many existing older buildings have been retrofitted with two-pipe, manual changeover fan-coil systems in the past. For future retrofits in other buildings, four-pipe automatic changeover systems are preferred.
 - b. For buildings where water distribution systems are appropriate, four pipe fan coil systems are preferred. Two pipe fan coil systems are allowed only with written permission of the Brown University Project Manager. [15000 sections]
 - c. Where two-pipe systems exist or four-pipe systems cannot be installed, automatic changeover systems with appropriate controls, as well as boilers and chiller barrels tolerant of thermal shock, may be required as directed by the Brown University Project Manager. [15000 sections]
 - d. Where outdoor air intake requirements exceed the latent capacity of the system, pretreatment or dedicated outdoor air units shall be indicated in all design documents including the earliest narrative, schematic, or design work packages. [15700, 15800 sections]
 - e. Where heating-only fan-coil systems are installed, condensate drain piping shall be installed, along with chilled water piping rough-ins where possible or, as a minimum, insulation adequate for dual-temperature application.
 - f. Fan-coil or packaged terminal air-conditioning units' wall-cap shall not be relied upon to meet outdoor air intake requirements. Either operable sash or additional mechanical ventilation is required.
4. Larger Buildings (10,000 square feet and over)
- a. Four-pipe systems are required in water-to-air systems. Heating shall use MTHW with indoor/outdoor reset schedules where perimeter baseboard or radiant heat is required.
 - b. Chilled water plants shall be optimized for seasonal operation, and shall be compatible with interconnection if not designed as part of a chilled water district system.
 - i. For large chilled water plants, variable primary only may increase operating flexibility of interconnected systems. Variable primary only may also allow longer shoulder season operation on one plant than primary/variable secondary. Load-specific hourly analysis shall be performed to determine optimal system configuration.
 - ii. Tertiary pumping is not allowed except where local coil recirculation is required as freeze protection.
 - c. For any building with over 20 tons of chillers installed, trend logging of chiller and chilled water system performance and efficiency factors shall be provided. System sub-metering shall be provided as required.

- d. Air-conditioning systems in buildings occupied in summer shall be capable of handling the latent load including the ventilation airflow when fully occupied. Economizers shall not allow saturated or near-saturated air to be delivered during periods of moderate dry bulb temperature coincident with high wet bulb temperature. Such conditions are frequent in College Hill's maritime microclimate.
5. Laboratories & Research Facilities
- a. 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.
 - b. Vivaria shall conform to the AAALAC Guide, latest edition.
 - c. No HVAC devices requiring scheduled preventive maintenance shall be located in or above drop ceilings in laboratory space, except fume hoods, snorkels, biosafety cabinets, tissue culture hoods, or other laboratory ventilation equipment that cannot be located adjacent to space without diminishing research functionality.
 - d. Outdoor equipment locations are not allowed except for cooling towers, since weather impacts serviceability.
 - e. Redundancy and connections to emergency power shall be as directed by Brown University, and shall be specified at all design document stages.