Steam Heating: Medium pressure “Campus Steam”, if available (as opposed to high pressure “Utility Steam”), shall typically be used to provide heating for campus buildings that are served by Abbott Power Plant through the central steam distribution system. If Campus Steam is not available (e.g. at remote locations such as the Veterinary Medicine Complex and the furthest north reaches of campus) Utility Steam is typically utilized to serve building heating systems. (See paragraph entitled Utility Program Statement below.)

Natural Gas Heating: Natural gas, as opposed to electricity, shall typically be used to provide heating for buildings that are not served with steam from Abbott Power Plant. (See paragraph entitled Utility Program Statement below.) When natural gas is used as a heating source for an office, classroom and/or laboratory building it shall not be used to heat air directly, but shall be used to fire steam or hot water boiler(s). The use of gas fired air heating units is allowed in less substantial building types (e.g. residential, light commercial, farm) but shall be vented type. Direct gas-fired heating units shall not be used for any application.

Electric Heating: Electric resistance heating is not allowed for any application except where integrated into a specialized packaged HVAC unit for the express purpose of providing humidity control. Such applications are rare. Heat pumps shall not be used, either with or without electric resistant heaters. Exception: Ground-source heat pumps may be used if specifically approved by F&S Engineering Services.

Hydronic Heating: Steam shall not be used as a direct source of heating for an HVAC system. It shall be used in conjunction with a heat exchanger (aka hot water converter) to heat fluid within a hydronic heat transfer system. Thus, the use of steam heating coils, unit heaters, cabinet unit heaters, convectors, finned-tube elements, etc. is not allowed. Exception: In areas within existing buildings where only steam heat is available and it is impractical to provide a hydronic system, steam heating equipment may be used if specifically approved by F&S Engineering Services. However, this exception is application to unitary and terminal equipment only. It is not applicable to central air handling equipment.

Boilers: As stated above, when campus steam is not available as a heat source for a hydronic heating system, natural gas shall be used to fire hot water generators (boilers). Boilers shall be of the sealed combustion high efficiency type. Boilers shall be configured and operated in a manner that takes full advantage of available efficiency. Achieving “real life” efficiencies that approach that advertised by boiler manufacturers is a rare accomplishment.

Achieving Boiler Efficiency: Achieving advertised boiler efficiency requires that boiler(s) remain in continuous operation with flue gas temperatures below condensing temperature. This requires boilers to have enough turn-down capability to allow them to remain in operation at very low loads. It also requires that hot water systems be configured and operated such that the return water temperature is kept as low as possible, preferably below 130 degrees F. It requires that hot water coils be selected for low supply water temperature. Thus, coils that may have been selected as single row in the past may now need to be double row. It is important that water temperature be settable based upon actual load conditions. It is important that the control system, and the control valves in particular, be capable of maintaining maximum supply/return temperature differential (aka delta T) in order to maintain low return water temperature. Thus, pressure independent control valves should be used given that they yield higher delta T than standard control valves. Regarding the number and capacity of boilers, these are typically selected so as to minimize boiler cycling in response to variations in load. In this vein, it is important to provide automatic isolation of non-operational boilers in order to maximize flow through operating boilers, thus reducing boiler cycling.

Perimeter Heating: Each occupied space with an exterior exposure shall incorporate hydronic perimeter heating unit(s). This can be in the form of baseboard finned tube (preferred) or ceiling radiant heating panels (allowed if baseboard is impractical).
Heating units shall be strategically located adjacent to areas of greatest heat loss (e.g. beneath windows). Exceptions to this requirement for perimeter heating in all occupied spaces will be considered by F&S Engineering Services for approval on a case by case basis.

**Forced Air Systems:** All occupied areas and public spaces shall be served by a central forced air system in addition to perimeter heating, as addressed above. Thus, each occupied space with an exterior exposure shall be served by both a forced air system and a separate perimeter heating system. When heated supply air is used to augment perimeter heating it too shall be strategically located near areas of greatest heat loss (e.g. directly above windows) and shall provide high velocity downward air projection.

**Public Entrances:** At each public entrance one or more cabinet unit heaters shall be provided. At larger, high traffic entrances one heater shall be provided at each side of the entrance. These units shall be floor supported or wall mounted. They may be either recessed or surface mounted. They shall not be installed overhead. Given that buildings typically operate with negative pressurization relative to outdoors, entrances function as makeup air intakes and the associated cabinet unit heaters end up serving as preheat coils for the building. Thus, it is important to generously size these units.

**Non-Public Entrances:** The installation of cabinet unit heaters is not specifically required at low-traffic entrances. However, hydronic heating of some form (e.g. finned tube, convectors) will typically be needed to mitigate the effect of cold drafts in adjacent areas (e.g. corridors).

**Loading Docks:** High capacity unit heaters and/or heated air curtains shall be provided at loading docks and other high infiltration service areas.

**Pressurization:** Building pressurization has a substantial effect on localized occupant comfort. Negative building pressure relative to outdoors results in cold air leakage through cracks and openings. Thus, building pressure control shall be treated as a key component of occupant comfort as it relates to building heating.

**Backup Equipment:** A 100% backup or duplex unit shall be provided for each critical piece of heating equipment (e.g. equipment required for freeze protection of facilities or critical service to animal rooms) that is vulnerable to failure. Critical equipment includes boilers, heat exchangers, hot water pumps and condensate pumps along with associated equipment/systems dedicated to each.

**Utility Program Statement:** Specific direction regarding which steam system(s) are to be used to serve a specific building/site and associated operating pressures and temperatures to be used for design purposes shall be obtained from the Owner via a Utility Program Statement. As applicable, specific direction regarding the use of natural gas and associated design information shall be obtained in the same manner.