

Compliance: All building system design and construction shall be in compliance with the *ASHRAE Standard 90.1*. Decisions regarding building configuration and orientation, envelope construction, amount and orientation of fenestration, electrical systems, lighting, HVAC systems, etc. shall be governed by this standard. The AE shall use a computer simulation model to assess energy performance and identify cost effective energy efficiency measures. The AE shall quantify energy performance as compared to a “baseline” building that satisfies the minimum requirements of *ASHRAE Standard 90.1*. Each new building shall achieve a minimum 30% reduction in energy usage as compared to its baseline while major renovations shall achieve a minimum 26% reduction. *ASHRAE Standard 189, Standard for the Design of High-Performance Green Buildings*, and other advanced energy efficiency guides shall be referred to for additional guidance..

Priority: A high priority shall be given to energy conservation in all aspects of the design of U of I facilities.

Life Cycle Cost: Each design decision that significantly impacts long term energy usage shall be based upon life cycle cost analysis that incorporates long term operating and maintenance costs as well as installed cost. See the *Requirements for Project Design Calculations* section within these Standards.

Energy Efficient Equipment: The usage of *EPA ENERGY STAR* labeled equipment is encouraged where applicable. For categories of equipment not included in the *ENERGY STAR* program, selection of energy efficient equipment is still encouraged.

Central Utilities: Central utility systems typically operate with greater energy efficiency than do building level systems. Thus, HVAC systems in U of I buildings shall utilize central distributed chilled water, steam and electricity when these utilities are available. When central distributed steam is utilized, lower pressure “Campus Steam”, if available, shall be utilized to serve HVAC systems as opposed to higher pressure “Utility Steam”. The former has the

advantage of greater overall thermal efficiency.

Natural Gas Heating: Natural gas, rather than electricity, shall be used as the source of heat for all heating systems within campus buildings that are not served with central distributed steam.

Central HVAC Systems: Each building shall be served by a minimal number of larger central HVAC systems rather than numerous smaller systems (i.e. less than 5,000 CFM) or individual units such as fan coil units, window air conditioning units or “split systems”. The installation of a smaller number of larger central systems provides more opportunity for the application of energy conserving features and control strategies.

System Configuration: HVAC systems shall be configured such that spaces with similar usage are served by a common system. As much as possible, spaces with dissimilar usage types or schedules shall not be served by the same system. Each large lecture hall / public assembly area shall be served by a dedicated HVAC system. Each area that has special temperature and/or humidity requirements shall be served by a dedicated system. This approach allows the design of each system to be tailored to the specific needs of the area it serves and facilitates the implementation of specific control strategies for a limited number of similar use spaces

Energy Management System: All central station equipment shall be fitted with direct digital controls (DDC) to facilitate the monitoring of energy consuming equipment and the implementation of control strategies that maximize energy conservation. This includes air handling units and associated return and/or exhaust fans, chillers, cooling towers, chilled water and/or condenser water pumps, chilled water BTU metering stations, boilers, heat exchangers, hot water pumps, steam condensate return units, sump pumps, domestic water booster stations, lighting, etc. All DDC systems that serve a given facility shall be incorporated into the building automation system (aka energy management system) which in turn shall communicate with the appropriate central

host computer located at the central control station within the Physical Plant Service Building (PPSB). Utility meters serving U of I domestic water, natural gas, steam condensate, and chilled water systems (as well as steam, compressed air and raw water where applicable) shall be connected to the BAS to allow remote metering of these utilities. Electric metering (kWh), however, shall not utilize a BAS. It shall be designed and installed separately.

Outdoor Air: The conditioning of outdoor air is the most significant energy consumer on campus. Therefore, exhaust airflow and associated outdoor air makeup airflow shall be minimized to conserve energy. Fume hoods and other equipment that require large quantities of exhaust/makeup air to support their proper operation shall be installed with discretion and restraint. Outdoor air quantities for ventilation shall meet but not exceed the requirements of the *ASHRAE Standard 62*. Consideration shall be given to system designs and control strategies that accomplish the reduction of outdoor air quantities for ventilation during periods of reduced occupancy without violating the requirements of *ASHRAE Standard 62*. Thus, demand control ventilation, occupied/unoccupied scheduling, temperature/humidity resetting and similar strategies shall be employed to conserve energy while satisfying space requirements. Dedicated outdoor air units in conjunction with dual path AHUs shall be used as appropriate to condition return air separately from outdoor air.

Exhaust Air Systems: All exhaust air systems shall satisfy or exceed *ASHRAE Standard 90.1* requirements for energy recovery. Unless unachievable within practical limitations, a total energy recovery system (i.e. sensible plus latent) shall be employed. Strategies that allow exhaust air systems to be operated at reduced capacity or turned off altogether during periods of non-use or reduced demand shall be employed. Consideration shall be given to the installation of variable volume lab fume exhaust systems as well as "smart" variable flow kitchen exhaust systems. However, the F & S Engineering Services Department shall be consulted prior to implementation of such systems.

Fans / Ductwork: Fan energy consumption shall be minimized. This requires that careful attention be given to the selection of the most efficient fan type(s) and size(s) for each application. This will go a long way toward minimizing fan-generated noise. Ductwork shall be sized generously and configured so as to minimize the total pressure requirement at the fan(s). This requires that adequate space be provided in the architectural design of a building. The industry's movement toward increased energy recovery and improved filtration has resulted in a dramatic increase in the air pressure drop through air handling equipment. This heightens the need for optimized fan selection. Poor selection cannot be overcome by the use of a VFD.

VAV Systems: Each standard air distribution system with design recirculated airflow of 5,000 CFM or more shall be a variable air volume (VAV) type system that utilizes a variable frequency drive (VFD) to control fan motor speed. VAV systems reduce fan energy consumption while reducing simultaneous cooling and reheating of distributed air. Integration of occupancy sensors to allow VAV boxes to be closed and lighting to be turned off during unoccupied periods is encouraged.

Other Systems: The installation of displacement ventilation systems shall be considered. Appropriate applications include large lecture halls, sizable classrooms and atria. The installation of chilled beams shall also be considered. Installation of chilled beams is only allowed in new facilities with special construction to minimize moisture migration.

Air Side Economizers: Air side economizers shall be provided as required by *ASHRAE Standard 90.1*.

Pumps / Hydronic Systems: Pump energy consumption shall be minimized. This requires that careful attention be given to the selection of the most efficient pump type(s) and size(s) for each application. Piping and hydronic system components shall be sized and configured to minimize the total pressure requirement at pump(s). Piping shall be insulated as required by *ASHRAE*

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Standard 90.1. As with fans, pump selection must follow calculated pressure drops rather than inflated estimates. Otherwise poor pump selection and inefficient operation will result. As with fans, the use of VFD(s) cannot solve this problem.

Variable Flow Hydronic Systems: All closed loop hydronic secondary/distribution systems, hot water heating as well as chilled water-cooling systems that incorporate pump motors that are 3 HP or larger shall be variable flow systems with two-way control valves. Systems that incorporate smaller pump motors may be either constant flow or variable flow type systems. Each pump motor that is 3 HP or larger shall be served by a variable frequency drive (VFD). Separate reheat and perimeter heat distributions systems shall be provided. Perimeter heating systems shall be turned off during cooling mode.

Cooling Equipment: Cooling equipment, including chillers, shall be selected with efficiencies that meet or exceed minimum values listed in ASHRAE Standard 90.1.

Heating Equipment: Similarly, heating equipment shall be selected with efficiencies that meet or exceed minimum values listed in ASHRAE Standard 90.1.

Electric Heating: Electric-resistance heating shall not be used, with one exception. Electric heat may be provided as an integral component within a specialized packaged HVAC unit (e.g. Liebert CRAC unit) when needed to provide tight humidity control.

Specialty Heating Systems: Heated floor, heated ceiling or radiant panel type systems shall not be installed. Neither shall built-in sidewalk and/or entryway snow melting systems be installed. Similarly, roof, gutter and/or downspout ice melting systems are not allowed.

Domestic Hot Water Systems: Opportunities to reduce energy usage for domestic hot water systems are encouraged. The use of solar thermal heating shall be considered. The use of steam condensate or

other waste heat sources to preheat domestic hot water shall also be considered.

Interior & Exterior Lighting: Interior and exterior lighting energy consumption shall be minimized while still providing adequate light level and control. General strategies shall include the use of efficient fixtures and layouts to reduce the total lighting power density beyond the maximum requirements specified by ASHRAE Standard 90.1. Rooms with multiple occupants shall be fitted with occupancy sensors. Multi-level switching and daylighting techniques shall also be utilized as appropriate. See the *Lighting* section within these *General Guidelines* for additional information.

Transformers: Transformers shall be rated NEMA TP-1 for energy efficiency.

Motors: All electric motors shall be of the manufacturer's high efficiency design with a minimum efficiency of 92%. Each motor shall be sized so as to be loaded to at least 75% of its rated horsepower when the equipment it powers is operating at full load conditions.

Variable Frequency Drives: Consideration shall be given to the application of a variable frequency drive (VFD) in each instance where energy conservation can be accomplished by varying the operating speed of an electric motor. In each case, the final decision regarding the installation of a VFD shall be based on life cycle cost considerations.

Public Entrances: Each high-usage public entrance shall incorporate a vestibule with two sets of doors to provide an air lock to minimize outdoor air infiltration. This results in occupant comfort as well as energy conservation.

Exterior Glazing: Large expanses of exterior glazing, particularly on building faces exposed to the most solar gain (e.g. west exposures) shall be avoided in order to minimize summer heat gain and winter heat loss. The use of "Low-E" exterior glazing is encouraged for energy conservation as well as occupant comfort. Glazing U-value shall be minimized within boundaries supported by life cycle cost analysis with requirements of *ASHRAE Standard 90.1* establishing the

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maximum allowable value. Treatments and architectural features that reduce solar heat gain, including awnings, blinds, and shades shall be considered.

Envelope Insulation and Infiltration:

Envelope insulation levels shall meet or exceed those required by ASHRAE Standard 90.1 and those identified elsewhere within these Facilities Standards, whichever is more stringent. Design and implementation methods that tighten the building and reduce infiltration are highly encouraged. The judicious use of insulation can also reduce the size of mechanical equipment. Roofs shall be vegetative or high-reflectance type.

Natural Lighting: Full advantage shall be taken of opportunities to provide natural lighting. However, full compliance with the *ASHRAE Standard 90.1* shall not be sacrificed in the process. Daylighting strategies shall incorporate opportunities to reduce artificial lighting during periods of adequate natural lighting.

Water Conservation: Reduced flow fixtures shall be utilized to achieve low usage while still meeting performance needs. Projects should achieve a minimum 30% reduction from the baseline prescribed by LEED 2009 for New Construction and Major Renovations. Fixtures shall meet or exceed EPA WaterSense program requirements.