REQUIREMENTS FOR BUILDING THERMAL CONDITIONS

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The simplest, most cost-effective, and easiest way to save energy in a building is to turn off all the lights, all the heating and cooling systems, and unplug all the appliance and equipment. This building would use no energy whatsoever, but it would be uncomfortably cold and hot, inadequately ventilated, dimly lit by whatever light comes in the windows, and a very unpleasant place to work. Freezing in the dark is not the object of energy conservation.

The object of energy conservation is to use the minimal amount of energy necessary to perform the required work in a building in a safe and efficient manner. The amount of energy a building uses depends upon its size (small Vs. large), the location (hot climate like Miami, FL; moderate climate like Washington, DC; or cold climate like Anchorage AK), and the type of building (barrack, office, warehouse, laboratory) as well as any number of design parameter selections such as building orientation, window orientation, HVAC system selection, and envelope performance. For any given building, factors like ventilation rates, thermostat set points, and lighting levels have a significant impact on the energy consumption. All other things being equal, a building with higher ventilation rates will usually use more energy than a building with lower ventilation rates. A building with lower light levels will use less energy than a building with higher light levels. And a building with higher heating set points and lower cooling set points will use more energy than a building with lower heating set points and higher cooling set points.

It is important that engineers and O&M personnel design for and use appropriate rates and set points to maintain occupant comfort, health, and productivity AND minimize energy usage. Setting these rates and set points can be as much an art as a science, but there are a number of standard references that are used to help in the operation of the building. The following references provide guidance on the suggested values.

Thermal requirements include criteria for thermal comfort and health, process needs, and criteria preventing mold mildew and other damage to he building materials or furnishings.

Thermal comfort and health criteria primarily involve the temperature and humidity conditions in the building. Too high a temperature means that occupants are uncomfortably hot. Too low a temperature means that occupants are uncomfortably cold. The wrong humidity (rooms typically don't have humidistats) means that occupants feel damp or sweaty or too dry. Thermal comfort is defined by ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy. The latest version of Standard 55 was published in 2004 and is available from ASHRAE.

The following Dry Bulb room air temperatures and Relative Humidity values are within the ASHRAE Standard 55 range and shall not be exceeded:

Cooling Period: The DBT in occupied spaces shall not be set below 70 °F (21 °C) with the RH maintained below 50%. When the space is unoccupied during the short period of time, room thermostat shall be reset to 85 °F (29 °C) with the relative humidity maintained below 50%. In space unoccupied for an extended period of time, temperature shall not be controlled but the building air RH shall be maintained below 50%.

Heating period: Relative humidity of ALL building air shall be maintained below 50% and above 30% at all times (unless required differently for health reasons at the hospitals, day care facilities or by processes). The DBT in occupied spaces shall not exceed the following:

1. Barracks and other living quarters: 70 °F (21 °C) Monday through Friday from 0500-2200 and 65ºF (18 °C) from 2200-0500. Temperature settings for barracks Saturday and Sunday 70º (21 °C) from 0600-2200 and 65ºF (18 °C) from 2200-0600.
2. Offices, warehouses, etc. where personnel work seated or in standing position involving little or no exercise: 70 °F (21 °C) during working hours and not more than 55 °F (12.80C) during non-working hours.
3. Child Care facilities: 72 °F (22.2 °C) during working hours.
4. Issue and similar rooms: 60 °F/15.5 °C.
5. Special process rooms, such as paint shops and drying rooms: 80 °F (26.6 °C) allowed, or the one required by the process.
6. Shops, hangars and other buildings where employees work in a standing position or exercise moderately, such as sorting, or light packing or crating: 60 °F/15.5 °C during the day; 40 °F (4.4 °C) during night time.
7. Shops, warehouses and the like, where employees do work involving considerable exercise, such as foundries, heavy packing, crating, and stacking, or where heat is required to protect material or installed equipment from freezing: 40 °F (4.4 °C). EXCEPTION: Localized heat, not to exceed 55 °F (13 °C) may be furnished in areas where the work requires medium or light personnel activity.
8. Heat will not be permitted in warehouse areas that do not contain material or equipment requiring protection from freezing or condensation, and warehousing of stored goods is the only operation. Heat for the prevention of condensation on stored machinery and material will be supplied after a thorough survey of all conditions and the approval of the major Army or operating agency (DeCA, AAFES, etc.) manager.
9. Buildings other than those specified above will not be heated to temperatures higher than 65ºF (18 °C) without approval (in writing) from the subordinate garrison or garrison DPW.

When the space is unoccupied during the short period of time, room thermostat shall be set back to 55 °F (13 °C) with the relative humidity maintained below 50%. In space unoccupied for an extended period of time, temperature shall be controlled at 40 °F (5o) to prevent freezing with the building air RH maintained under 50%.

Process related criteria include temperature and humidity needed to perform the process housed in the building (e.g., painting, printing) or to operate process equipment such as electronics. While new design guidance for computer systems indicates a much higher tolerance for high temperatures than previously thought, there are specialized electronic and laboratory equipment that have fairly tight temperature and humidity requirements. An archival storage of important documents also involves relatively tight tolerances for temperature and humidity.

Building materials and furnishings requirements. The environmental conditions (temperature and humidity) maintained in indoor spaces determines not only the comfort of the occupants of those spaces but also the long-term “health” of the building itself. Historically, only the dry-bulb temperature of indoor spaces was controlled to achieve comfortable indoor conditions for the occupants. Little attention was given to control of moisture/humidity in the spaces. As a result, many existing army buildings have significant mold/mildew problems.

Eliminating mold/mildew from Army buildings requires year-round control of both the dry-bulb temperature and the dew point temperature (or air relative humidity) in the indoor spaces. Control of indoor humidity will also significantly improve the comfort of Army building occupants.

Building materials and furnishing damage occurs when humid air meets a cold surface. Mold/mildew grows on a surface in a building when that surface’s relative humidity is above 85% for extended periods. This condition easily occurs in buildings even with low average air relative humidity when cold spots exist on poorly insulated supply air ducts and chilled water pipes, supply air diffusers and poorly

insulated and not air tight building envelope elements and the areas with thermal bridges, etc. Careful design and operation of the building envelope and the HVAC, ventilation, and exhaust systems is required to eliminate the potential for mold growth in Army buildings. By controlling ALL the air inside the building above the dew point will reduce potential moisture related problems. According to the ASHRAE Humidity Control Design Guide, the suggested dew point limits which meet both health and mold problems requirements are < 57 °F in summer and > 35 °F in winter.

It is important, that designers and O&M personnel design and maintain the building and HVAC systems, to satisfy all three categories of requirements. In most of cases, thermal comfort requirements satisfy the process. Preventing moisture related problems require special attention to the design and building operation. Energy conservation shall not be achieved at expense of health, occupant's wellbeing and building sustainability. Certain strategies and technologies can minimize or eliminate premium energy use.

Thermal requirements to unoccupied spaces. Requirements for temperatures and relative humidity discussed above are developed for occupied spaces (Table 1). Many DOD and other government buildings are not occupied at night or on weekends. Some DOD facilities including barracks, administrative and dining facilities may be unoccupied for an extended period of time due to training and deployment. So, one of energy conservation strategies may be to set back temperatures for heating or set up for cooling. One source of guidance on set back or set up temperatures is ANSI/ASHRAE/IESNA Standard 90.1-2004 *Energy Standard for Buildings Except Low-Rise Residential Buildings*. Standard 90.1-2007 does not regulate thermostat set backs or set ups, but it does regulate the capabilities of thermostats installed in buildings. Section 6.4.3.3.2 of Standard 90.1-2004 Setback Controls – requires that heating systems in all parts of the US outside of Miami FL and the tropical islands (that is, climate zones 2-8 as shown in the map below) must have a capability to be set back to 55°F. Heating systems in zone 1 are assumed to have minimal usage and therefore no need of setbacks. Cooling systems in hot dry areas (zones 1b, 2b, and 3b) must have the capability to be set up to 90°F. However, cooling systems in hot and humid climates (zones 1a, 2a, and 3a) are not required to have cooling setbacks due to potential for moisture problems. It is wasteful to cool DOD facilities left unoccupied for an extended period of time, which are located in hot and humid climates. Significant energy savings can be achieved without damage to building materials and furnishing if a combination of measures related to the building envelope and HVAC maintain the requirements for ALL the air inside the building.

Table 1. Requirements to dry bulb temperature and relative humidity for occupied and unoccupied facilities to reduce the risk of moisture related problems.

Occupancy/Use	Humidity not to exceed	Maximum Dry Bulb Temp	Minimum Dry Bulb Temp
Occupied	50%	75 °F	70 °F
Unoccupied (Short term)	50%	85 °F	55 °F
Unoccupied (Long term)	50%	No Max	40 °F
Critical Equipment	50% or equip requirement if less	Equip max allowed	Equip min allowed