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Hospital Engineering

24/7 Cooling in Healthcare

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Creating and maintaining comfort conditioning in hospitals has long been the design goal and an operational requirement of HVAC systems, not only for patients and healthcare providers but also for equipment such as telephone rooms and computer rooms.

New medical technology has a direct impact on cooling needs

Lately, it has become even more of a challenge. Most comfort central air systems operate 24 hours a day, seven days a week to provide comfort conditioning and minimum air change rates as required by code. The increasing use and need for digital communications, computerized patient records, digital radiology imaging and storage systems are creating an increasing need for year-round cooling in hospitals and related healthcare facilities. To identify your 24/7 cooling needs and the best ways to serve them, it is important to know the *what*, *why*, *where* and *how* of 24/7 cooling in healthcare applications.

Digital radiographic equipment, such as CT scan equipment and heat exchanger, Cardiac Cath lab and EP lab computer equipment, magnetic resonance imaging equipment, computer rooms, and uninterruptible power supplies (UPS) systems, create a large cooling load. Adding Information Technology (IT) closets and server rooms for security, nurse call, and telephone systems can create a 75 to 150 ton continuous equipment cooling load in the average 500,000-square-foot hospital. Server densities are also increasing, creating a greater need for heat rejection (cooling load).

Computer imaging and storage equipment must remain “on” and ready in order to be functional when needed. The loss of cooling to a space with this equipment can cause equipment overheating and malfunction, rendering its use as a diagnostic tool useless. The loss of use of patient medical records or imaging records could slow down the treatment, admission or transfer of a patient. It could also result in lost productive time for staff and caregivers, and especially revenue. Loss of power or internal high temperature shut down of imaging equipment may require recalibration when the equipment is re-energized.

A central building distribution frame (BDF) room is usually located at grade or point of entry for the outside communication system such as telephone service. IT closets can be scattered throughout a large facility or neatly stacked from floor to floor. IT closets at a nominal 10 by 10 foot space can house racks of servers, routing and termination points for CATV, MATV, telephone, data, security, telemetry, and nurse call cabinets as well as code blue communications to the appropriate response team. Each of these components is vital to the operation of the hospital and the care of its primary occupants and creates a heat load in this room. Most IT rooms have a cooling load of 9,000 12,000 BTUH. Diagnostic and treatment equipment such as Computed Tomography (CT) scanners or Cardiac Cath labs have computerized control rooms, signal generators and imaging equipment. They can also have water cooled heat exchangers provided by the equipment vendor to provide heat rejection for the imaging equipment. The heat from these heat exchangers is also rejected to the room depending upon the medical equipment manufacturer. New technology such as Magnetic Navigation Cath Labs have further requirements of enclosed equipment rooms and separate magnet cooling units.

Sometimes a majority of these loads can be served by all air systems from central station air handlers, provided that the air delivery temperature is low enough and the system operates continuously.

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During a normal cooling season, a facility's central cooling plant can provide the necessary chilled water at 42 to 44 degrees Fahrenheit to the central air system. What happens when the building cooling load is not at peak condition during the fall and spring or completely goes away in the winter in some climates? The air system can go into an economizer mode using all outdoor air. Computer room A/C units, however, do not have this capability. Central station unit discharge air temperatures can also rise and still meet the load and space conditions as the cooling and dehumidification requirements are lessened. However, the equipment cooling loads go on unchanged. The temperature sensitive nature of the computer processors and the water cooled heat generators do not take into account a building's other operational elements or its human occupants. So, how can this equipment and its cooling loads be kept happy and operational? There are several ways to address this situation.

Methods of Cooling

The simplest way is to have the air handling system and computer equipment connected to the central building chilled water system, and operate the chillers, pumps, and cooling towers year-round regardless of the remainder of the building load. This arrangement could lead to inefficient central equipment operation and would use more energy than desired. A second method is to use a separate smaller chiller either air cooled or water cooled with a winterized cooling tower, of sufficient capacity to handle the telecom and equipment loads. A second or redundant chiller and pumps should be provided in the event of a primary cooling equipment failure. The building cooling system may also be used as the redundant or backup cooling source. This source, however, may be more difficult to start and operate in the winter due to the cold entering condenser water temperatures.

Data center computer rooms have long used separate cooling systems for equipment cooling and heat rejection. Direct Expansion (DX) cooling and chilled water systems with glycol to inhibit water freezing have both been used successfully. This type of system can also serve the computer and communications rooms. There are some specialty process chiller manufacturers that match chiller load exactly to the medical equipment heat rejection. For single pieces of equipment, this may be appropriate. Redundant cooling system sources would need to be provided so the operational integrity of either system is not compromised.

In appropriate climates, air side economizers are used for free cooling using outdoor air. This allows building chiller plants to shut down. In this case, a third cooling source is a plate frame heat exchanger for tower free cooling. This source, which uses cold condenser water to reject heat and cool the building chilled water loop, allows for cooling of areas of constant heat load (for example, the process cooling and sensible cooling requirements of the equipment room and communication room loads). Problems can exist though, as the outdoor air increases to the point where the chilled water temperature approaches the upper limits of what the equipment can stand – usually a maximum of 55 to 60 degrees Fahrenheit. This is where the supplemental mechanical cooling is required. A small chiller can then provide reliable cooling or the building chilled water source is required to be activated. An economic evaluation should be performed to determine a cost effective means to provide equipment cooling. Emergency or standby power for cooling systems needs to be considered as well, and it needs to match the equipment operational scenario under loss of normal power.

New facilities should consider separate cooling sources for communication closets and sensitive electronic equipment rooms in the design of their HVAC systems. These sources can be through separate fan coil units or separate air handling units serving only those rooms, which can then use cooling sources separate from the building sources. Some hospitals or facilities include certain areas or occupancies such as offices or clinics, which can go into an unoccupied mode, thereby reducing the cooling requirement and resulting capability or in some cases shutting the air unit off altogether. This energy saving scenario, while benefiting the building, can be very detrimental to those areas requiring 24/7 cooling.

Many older healthcare facilities have been retrofitting their existing buildings by adding IT rooms and closets to provide space for the electronic data racks and communication equipment. This process requires re-evaluation of the building cooling requirements and cooling capabilities as the building cooling loads increase when this much technology is added. A means for providing the cooling requirements for the year-round load can be a challenge. Studies should be performed and planning should take place to make this happen. Ways to provide reliable, efficient, cost effective year-round cooling are available and need to be incorporated into both new and renovation projects involving HVAC and technology design.

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