PRECISION COOLING

- **What is a BTU?**
  The term BTU (British Thermal Unit) is a measurement of a quantity of heat. Specifically it is the amount of heat required to raise the temperature of 1 lb. of water 1 °F.

- **What are some of the most common conversion factors used in cooling and heating engineering?**
  °F = (°C x 9/5) + 32
  °C = (°F – 32)(5/9)
  1 ft^3 = 1728 in^3
  1 U.S. gal = 231 in^3 = 0.1337 ft^3
  1 psi = 2.309 ft of water (pressure)
  1 BTU = 778.17 ft lb
  1 therm = 100,000 BTU
  1 kw = 738 ft lb/sec = 1.341 hp = 3412.14 BTUH = 0.284 ton (refrigeration)
  1 hp = 33,000 ft lb/min = 0.746 kw = 2545.1 BTUH
  1 ton (refrigeration) = 12,000 BTUH = 3.517 kw

- **What is the difference between creature comfort (people) cooling and cooling critical electronics?**

  People produce both heat and moisture (humidity). Electronics produce heat and no moisture. People have a broad temperature and humidity tolerance range. Electronics require tight temperature and humidity tolerances to control static electricity and moisture condensation.

  The duty cycle for cooling people is typically only a few hours of the day during the hottest months of the year. Electronics must usually be cooled 7 x 24 x 365 (even when outside air temperatures may be subzero). Filtration requirements for electronics is much more stringent than required for people. Greater airflow is used in an electronic facility to minimize hot spots; 1 or more air changes per minute is typical for electronics and 3 to 4 air changes per hour for comfort cooling.

  Heat densities are much higher in an electronic facility (1 ton of cooling for every 10 – 60 ft^2 of space) than for a space occupied by people (1 ton of cooling for every 200 – 400 ft^2 of space).

- **How are these considerations manifested in the design of precision (electronic) cooling systems?**
  Precision cooling systems tend to be highly integrated, self-contained, modularized units for cooling one room or a small portion of a larger facility. They are relatively easy to install. The maximum possible amount of work content is performed at the factory to assure the highest possible quality of installation. Given that electronic generated heat is dry (all sensible heat), these cooling systems were designed to have very high sensible heat ratios (sensible cooling capacity/total cooling capacity). The result is a highly efficient system for

this application. Since people emit moisture, comfort-cooling systems are designed to provide both sensible and latent cooling and are efficient for that requirement. Precision cooling systems typically include a humidifier whereas comfort-cooling systems do not. Because of the much more stringent duty cycle imposed on them and the criticality of their mission, precision cooling systems are designed to be far more robust and reliable. Many such units incorporate dual refrigeration systems and might make use of dual cooling sources. To provide tight tolerance control over temperature and humidity, precision systems commonly use advanced state of the art microprocessor based controls which have the ability to interface with Network Manage Systems and/or Building Management Systems to allow remote alarming, monitoring and control. Typically a simple thermostat controls comfort-cooling systems. Larger fans are used in the precision models to obtain the desired airflow. Further, filter efficiencies of 30 to 60% are common.

- **What problems would likely be encountered if a comfort-cooling unit was used for electronic cooling?**
  Since a comfort-cooling system has a low sensible heat ratio it would be necessary to sufficiently oversize the unit to provide the required sensible capacity. In addition to higher initial cost and the waste of energy, this would likely lead to over-dehumidification of the space. Temperature would be hard, if not impossible, to control within the desired range and there would be no control of humidity unless a separate, stand-alone humidifier was installed. Filtering would probably be inadequate and the ability to monitor and control the system remotely is doubtful. It is unlikely that system reliability and life would be acceptable. Smaller evaporator fans would produce fewer air changes and hot spots in the critical space could be expected.

- **What are some of the configurations of precision cooling systems?**
  A complete description for each of the systems is available in the Precision Cooling pages by drilling down into the Guide Specifications, Technical Manuals, Installation Manuals and Operation and Maintenance Manuals. However, as an overview systems are classified by size (cooling capacity), method of heat rejection (air cooled, water cooled, glycol cooled, "Glycool" cooled or chilled water) and mounting location (floor, wall or ceiling).
  In an air-cooled system the refrigerant is directed through a condenser (normally outdoors) where it transfers heat to the environment. In a water-cooled system the heat is removed from the refrigerant in a condenser (heat exchanger normally within the indoor unit) by water. Typically the water carries the heat to a cooling tower (outside) where it is rejected to the atmosphere. However, in a few applications water passes through the condenser once and is directed down a drain. A glycol-cooled system is similar to the water-cooled system except that a water/glycol solution carries the heat from the indoor condenser to a drycooler (closed system cooling coil) outside where the heat is rejected.

  Some systems have the ability to use two different sources for cooling (commonly air-cooled refrigeration system for primary cooling and chilled water for backup cooling). Many options are available for each model to meet the specific needs of the client.

- **How do I determine what type of system is best for my application?**
  Many factors enter into this decision. Some relate to the configuration of the facility. Others depend on such things as the characteristics of the heat load, local code requirements, operating costs, the type of environment the system will be operating in and, certainly, installation costs. Following are some examples of these considerations:

How much space is available for the cooling system? If floor space is limited but there is ceiling space, as much as 10 tons of cooling in a single system can be installed above a dropped ceiling. Small systems (up to 3 tons) that can be wall mounted are available. External wall mounted systems to 5 tons are available for structures in which there is little or no floor space, such as telecommunications shelters. Larger systems (up to 60 tons) will be floor mounted.

What is the characteristic of the load? Are there hot spots (areas of high heat density) that need to be cooled? Many of the systems allow ducting of the supply air directly to the exact point of need. Downflow systems deliver the supply air under a raised floor where it is distributed to the heat source through perforated tile. Otherwise, supply air is commonly discharged through plenum grilles.

What type of heat rejection option should be used? Generally, an air-cooled system has the least up-front cost. However, installation cost will be more than that for a water-cooled or glycol-cooled system since the refrigeration lines that are run between the indoor unit and outside condenser must include proper slopes and traps. These constraints do not apply to water or glycol lines. Standard outside condensers used in air-cooled systems can operate at ambient temperatures of -20°F. The optional Lee-Temp configuration increases this range to -30°F. Be careful to check with local codes. To minimize energy consumption some jurisdictions require the use of cooling systems that incorporate air or water economizers. Introducing large amounts of outside air prohibits the control of humidity in the critical space, which is unacceptable. A good solution is to use a system that includes a "free" cooling coil ("Glycool").

If the building has an existing cooling tower with enough capacity to allow the addition of the precision cooling system on the loop, then a water-cooled unit may be a good alternative. Similarly, if the building has an existing chiller with the capacity to support the precision cooling load, a chilled water unit would be an option. Core must be taken to assure redundancy in the chilled water system. Losing a chiller pump can cause the computer cooling system to go down.

A glycol-cooled system provides ease of installation (no special routing considerations for the glycol piping other than not placing it over electronic equipment) and good performance in cold climates. If a glycol cooled system is chosen, upgrading to a "Glycool" configuration should be considered. It is not uncommon for the added capital cost to be recovered, by energy savings alone, in 6 to 18 months, depending on climatic conditions.

- **What are some of the considerations that should be made when designing an electronic facility requiring precision cooling?**
  Location of the space within the building is an important consideration. Locating it within the core of the building provides isolation from seasonal environmental load influences. The space should not be adjacent to any mechanical room or unconditioned area to prevent thermal impact on the space.

  When calculating the cooling load it is important to consider all of the load factors, not just the electronic equipment heat rejection. These factors include heat from the adjacent areas, including from above and below; heat load from windows if on an outside wall (considering direction of exposure); heat from people regularly in the room and, importantly, heat from lighting (usually in the range of 3 watts/ft^2).

  To maintain the desired humidity in the controlled space and avoid costly humidifier run times and dehumidification cycles it is imperative to minimize (if not eliminate) the incursion of outside air. One of the key factors in doing this is to seal the room with a vapor barrier.

For example, plastic sheets placed between sheetrock in the walls in new construction provides an excellent barrier. A rubber- or plastic-based paint can be used on concrete walls and floors. Doors should not be undercut or have grilles. A proper vapor barrier can reduce moisture migration by as much as 80%.

- **Electronics are commonly installed in rooms with raised floors. What issues need to be addressed when installing precision air conditioning in this type of facility?**
  Raised floors provide a great and flexible alternative for routing cables and piping as well as distributing cooling air. For this type of application a downflow cooling system delivers the cold air to the space under the floor where it is directed to the desired location either through vents or, more commonly, perforated tiles. The space under the floor is, in essence, a supply air plenum. Raised floor heights are commonly in the 12 to 18 inch range. However, they may be as low as 6 inches or as high as 24 inches.

  Cooling systems are heavy. Therefore, floorstands fabricated to the height of the raised floor are normally, but not always, used to provide structural support. Obviously, the strength of floor must be evaluated when making this decision. Using a floorstand also allows the cooling unit to be installed, piped, wired and inspected prior to the installation of the raised floor to allow easier access. A floorstand also provides vibration isolation while eliminating the need for cutting special floor panel openings under the unit. Floorstands can be manufactured to meet local seismic requirements. It is important when installing the system that the floorstand be bolted to the subfloor and the cooling unit bolted to the floor stand. Otherwise there would be no restraint in a seismic event. If the height of the raised floor is less than 12 inches a turning vane should be ordered with the floorstand and installed to assure proper air distribution.

  For underfloor air distribution, the units (if more than one) should not be placed too close together or in a long, narrow space or the effectiveness of the air distribution will be reduced. Air supply grilles or perforated panels should be selected to minimize circuit pressure loss. Air volume dampers on grilles are usually detrimental to airflow.

  Care should be taken when laying out the piping, wiring, etc. under the floor to avoid blocking the free flow of cooling air. Wherever possible all piping should be run parallel to the airflow.

- **What is the status of R-22 phase-out?**
  R-22 has been the refrigerant of choice used by most cooling system manufacturers for decades. Because it is mildly toxic to the atmosphere it was included in the provisions of the Clean Air Act Amendments of 1990. This Act stipulated phase-out dates for various refrigerants, including HCFC-22 (a Class II substance). Essentially it says that no new products will be built containing R-22 after January 1, 2010 and no R-22 will be produced after January 1, 2020. Systems operating with R-22 will be able to continue using that refrigerant after the 2020 date. However, with the cessation of R-22 production replacement refrigerant will become more difficult to obtain. Equipment manufacturers will undoubtedly develop products using new, acceptable refrigerants prior to the cutoff date in 2010. In fact, Liebert is beginning to sell products using R-407C refrigerant (although those same products can be ordered with R-22 until the phase-out date). R-407C was designed to have operating characteristics similar to R-22.