Why Do I Need Precision Air Conditioning?
Executive Summary

Today's technology rooms require precise, stable environments in order for sensitive electronics to operate optimally. Standard comfort air conditioning is ill suited for technology rooms, leading to system shutdowns and component failures. Because precision air conditioning maintains temperature and humidity within a very narrow range, it provides the environmental stability required by sensitive electronic equipment, allowing your business to avoid expensive downtime.
Defining Today’s Technology Rooms -
Not Just Computer Rooms Anymore

Precision environmental control requirements now reach far beyond the confines of the traditional data center or computer room to encompass a larger suite of applications, referred to as “Technology Rooms”.

Typical technology room applications include:

1. Medical equipment suites (MRI, CAT scan)
2. Clean rooms
3. Laboratories
4. Printer/copier/CAD centers
5. Server Rooms
6. Hospital facilities (operating, isolation rooms)
7. Telecommunications (switch gear rooms, cell sites)

One of the highest growth application areas is telecommunications, including a wide range of facilities from simple remote switch stations to complex central exchange centers.

Why Do I Need Precision Air Conditioning?

Because information processing is the lifeblood of all critical operations, reliability in your technology room is vital to your company’s health. IT hardware produces an unusual, concentrated heat load, and at the same time, is very sensitive to changes in temperature or humidity.

A temperature and/or humidity swing can produce problems ranging from processed “gibberish” to a complete system shutdown. This can create huge costs for the company, depending on the length of the interruption and the value of time and data lost.

Standard comfort air conditioning is not designed to handle the heat load concentration and heat load profile of technology rooms, nor is it designed to provide the precise temperature and humidity set point required for these applications.

Precision air systems are designed for close temperature and humidity control. They provide high reliability for year-round operation, with the ease of service, system flexibility and redundancy necessary to keep the technology room up and running 24 hours a day.
Temperature and Humidity Design Conditions

The maintenance of the temperature and humidity design conditions is critical to the smooth operation of a technology room. Design conditions should be 72-75°F and 45-50% relative humidity (R.H.). As damaging as the wrong ambient conditions can be, rapid temperature swings can also have a negative effect on hardware operation. This is one of the reasons hardware is left powered up, even when not processing data. Precision air conditioning is designed to maintain temperature at ±1°F and humidity at ±3-5% R.H. 24 hours a day, 8760 hours a year.

In contrast, comfort systems are designed to maintain 80°F and 50% R.H. only during summer conditions of 95°F and 48% R.H. outside conditions. There is usually no dedicated humidity control and the simple controllers cannot maintain the set point tolerance required for temperature, allowing potentially harmful temperature and humidity swings to occur.

Problems Caused by the Wrong Environment

A poorly maintained technology room environment will have a negative impact on data processing operations. The results can range from data corruption (gibberish) to complete system shutdowns and failures.

1- High & Low Temperature
   A high or low ambient temperature or rapid temperature swings can corrupt data processing and shut down an entire system. Temperature variations can alter the electrical and physical characteristics of electronic chips and other board components, causing faulty operation or failure. These problems may be transient or may last for days. Even transient problems can be very difficult to diagnose and repair.

2- High Humidity
   High humidity can result in tape and surface deterioration, head crashes, condensation, corrosion, paper handling problems, and gold and silver migration leading to component and board failure.

3- Low Humidity
   Low humidity greatly increases the possibility of static electric discharges. Such static discharges can corrupt data and damage hardware.
Differences Between Precision Air and Comfort Air Conditioning

1- Sensible Heat Ratio

A heat load has two separate components: sensible heat and latent heat. Sensible heat is the increase or decrease in air-dry bulb temperature. Latent heat is the increase or decrease in the moisture content of the air. The total cooling capacity of an air conditioner is the sum of the sensible heat removed and the latent heat removed.

\[ \text{Total Cooling Capacity} = \text{Sensible Cooling} + \text{Latent Cooling} \]

The Sensible Heat Ratio is the percentage of the total cooling that is sensible.

\[ \text{Sensible Heat Ratio (SHR)} = \frac{\text{Sensible Cooling}}{\text{Total Cooling}} \]

In a technology room, the cooling load is made up almost entirely of sensible heat coming from IT hardware, lights, support equipment, and motors. There is very little latent load since there are few people, limited outside air, and usually a vapor barrier. The required SHR of an air conditioner to match this heat load profile is very high, 0.95-0.99. Precision air conditioning is designed to meet these very high sensible heat ratios.

In contrast, a comfort air conditioner typically has a SHR of 0.65-0.70, and provides too little sensible cooling and too much latent cooling. The excess latent cooling means that too much moisture is continually being removed from the air and an energy-expensive humidifier is required to replace moisture.

![Sensible Heat Ratio (SHR)](image)
2- Precise Temperature and Humidity

Precision air conditioners have the sophisticated, fast-acting, microprocessor-based controls necessary to react quickly to changing conditions and maintain the tight tolerances required for a stable environment. Precision air systems usually include multiple stages of cooling and heating, a humidifier, and a dedicated dehumidification cycle, allowing them to satisfy any and all temperature and humidity control requirements.

Comfort air conditioners generally have basic, limited controls unable to react quickly enough to maintain the required tolerance. Comfort systems do not usually include heat or the humidification/dehumidification cycles necessary for a stable technological environment. The components, if available, are frequently “add ons” and not part of an integrated system.

3- Air Quality

Precision air conditioners operate at a high CFM, 600-1000 CFM/ton. This high CFM moves more air through the space improving air distribution and reducing the chance of localized hot spots. It also allows more air to move through filters, ensuring a cleaner environment. Precision air conditioners typically use a moderate- to high-efficiency filter bank, deep-pleated, to minimize airborne particles.

Comfort air conditioners operate at a much lower CFM, 300-400 CFM/ton. Low CRMs can lead to poor air distribution and more airborne contaminants. Filters for comfort air conditioners are usually flat, low-efficiency media that do not remove a sufficient percentage of airborne particles.

4- Hours of Operation

Precision air conditioners are designed and built to run non-stop 8760 hours a year. The systems are designed - with components selected and redundancy incorporated - to ensure zero downtime. System controls maintain room conditions for the full range of outside ambient conditions, summer or winter.

Comfort air conditioners are designed to run during summer days, up to an expected maximum of 1200 hours per year. The system is not designed or expected to operate non-stop, year round. Neither the controls nor the refrigeration system is designed for zero downtime or winter operation.

Design Criteria

1- Load Density

Due to the high equipment concentration, the load density within a technology room can be five times higher than that in a typical office. Systems must be designed to handle this extremely high-density load. Sensible capacity and air distribution are very important.

<table>
<thead>
<tr>
<th>Load Density</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Area</td>
<td>250-300 sq. ft./ton</td>
</tr>
<tr>
<td>Technology Room</td>
<td>25-30 sq. ft./ton</td>
</tr>
</tbody>
</table>

Figure 2: Load Density
2- Temperature and Humidity
Design goal conditions should be 72-75 degrees F, 45-50% R.H.

3- Air Quantity
Precision air systems are designed for a high CFM, 600-1000 per ton. This contributes to the high sensible heat ratio, improves air distribution, and increases filtration rates. The high CFM does not cause discomfort to personnel as it is distributed under the raised floor and drawn up through equipment and into the space around the room.

4- Air Cleanliness
Without filters, airborne dust can damage equipment. Filters should be deep pleated for moderate to high efficiency. Filter sizing is also important; the filter must operate with face velocities low enough to be effective. Regular filter changes are necessary.

5- Air Distribution Methods
With comfort air conditioning systems, the room air is usually distributed through the overhead ducts. To provide the best airflow in technology rooms, air should be supplied through perforated tiles in a raised floor.

a- Under-floor System (Recommended)
Most computer hardware is designed to take air in at the front of the unit and let it out through the back of the unit. The precision air conditioner takes warm room air in at the top and delivers cool air through the floor permitting higher air quantities without disturbing the occupants.

Modern technology rooms use a raised floor with a minimum clearance height of 9” (preferably 12 to 18”) to serve as a cable raceway and act as an ideal air distribution plenum.

Figure 3: Under-floor System
Figure 4: Overhead System
Frequently, motors and blowers will also need to be up-sized to handle the additional static losses presented by the ductwork.
b- Overhead System (Recommended for small room applications only)
Overhead systems discharge air into either a plenum or ductwork. These units are suited for areas where raised floors are less than 12" high. The precision air conditioner takes warm room air in through the front of the unit and delivers cool air through a plenum connected to the top of the unit and back down over the equipment. Considerable turbulence exists at upper air levels due to conflicting air streams from the IT equipment. The overhead system is not recommended in large room applications because the uneven distribution of cool air heightens as space increases, resulting in hot spots and cold spots.

A further problem with overhead ducts is their inflexibility to meet changes in hardware location, resulting in hot spots and cold spots that are often impossible or extremely expensive to remedy.

6- Vapor Barrier
Because almost all construction materials are transparent to moisture, a well-designed technology room must include a vapor barrier. Without a vapor barrier, the technology room will lose humidity in the winter and will gain it in the summer. This makes humidity set point control very difficult and increases the run times of energy-expensive compressors and humidifiers.

To create an effective vapor barrier, ceilings should be sealed with a polyethylene film, concrete walls should be painted with a rubber or plastic base paint, doors should seal tightly, and all pipes and cable penetrations should be sealed.

7- Outside Air Requirements
Technology rooms tend to be sparsely populated and do not require much outside air for personnel. Outside air should be minimized to limit the latent load brought into the room. A quantity of 20 CFM per person is currently sufficient to satisfy Indoor Air Quality (IAQ) concerns in the U.S.

8- Redundancy
Redundancy is achieved by operating additional equipment to provide 100% of the required cooling capacity even after a unit shutdown or failure. The cost of redundancy should be weighed against the projected cost of technology room downtime.

The difference between redundancy and over capacity should be noted. A 20-ton load with 3 x 15 ton systems or 4 x 10 ton systems provides redundancy. A run-time-based rotation of equipment operation and a controls interface that provides automatic start up are required for standby equipment to be considered redundant.

9- Security
The security of the air conditioners is as important as that of the technology room hardware since the hardware cannot operate without them. The indoor units must be located within the technology room and should be subject to the same restricted access as the IT hardware. The outside heat rejection equipment should be placed on a roof or some other secure area within the facility.
System Selection Factors

1- Load Calculations

Heat in technology rooms is generated by hardware, lights, people, outside air, transmission loads, sun, and support equipment (PDU's, UPS, etc.).

As a rule of thumb, use 50 sq. ft./ton for load calculations. For a more detailed load calculation use the following form. After calculating the sensible load be sure to add in the following:

- Safety factor
- Growth factor
- Redundancy

It is important to remember to select systems based on sensible capacity. Check with the air conditioning manufacturer that cataloged net cooling capacities have been calculated to include motor heat. Motor heat must be considered as part of the room's heat load.

<table>
<thead>
<tr>
<th>Heat Source</th>
<th>Base Data</th>
<th>Factor</th>
<th>BTU/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>Hardware may be rated in BTU/hr directly:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>or if rated in kw, multiply kw by factor of 3400</td>
<td>1</td>
<td>3400</td>
</tr>
<tr>
<td></td>
<td>or if rated in kva, multiply kva by .9 then by 3400</td>
<td></td>
<td>3060</td>
</tr>
<tr>
<td>Lights</td>
<td>Area in sq. ft. ____ x 2 watts per sq. ft. = ____ x</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Transmission:</td>
<td>Walls: Surface area ____ x 0.15 x temp diff across wall ____° = ____ x</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ceiling: Surface area ____ x 0.20 x temp diff of ____° = ____ x</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Floor: Surface area ____ x 0.30 x temp diff of ____° = ____ x</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sun on glass surface</td>
<td>Surface area ____ x 100 = ____ x</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sun on roof</td>
<td>Surface area ____ x 0.80 x temp diff of 78° = ____ x</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>People</td>
<td>Number of people = ____ x</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Outside Air</td>
<td>Number of people ____ x 7.5 cfm/w x 1.08 x ____°td = ____ x</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Motors in A/C Units</td>
<td>Use 10% of “Hardware” BTU/hr (verify with A/C supplier if their ratings include the motor heat, or add heat to room load).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This load should be the basis of selecting modular air conditioners using their “sensible heat” capacities. The number of units needed = Total Sensible Load/Sensible capacity of the cataloged air conditioner. Add one or two more conditioners for redundancy. Does this load allow for growth?

Figure 6: Calculation Form

Total “Sensible” Load =
2- Unitary Systems

a- Air Cooled

System configuration
- Refrigeration system is “split” between indoor air conditioner and outdoor air-cooled heat rejection unit.
- Compressors can be located in the indoor or outdoor equipment. For security and maintenance, compressors are usually located in the indoor unit.
- Refrigerant pipelines (two per compressor) interconnect two halves of the system.
- Refrigerant piping design is critical. The design must address pressure losses, refrigerant velocities, oil return, and traps.
- Qualified expert contractors should install the service unit.
- Excellent for multiple units and expanding installations. Each system is a self-contained, stand-alone module.

b- Water Cooled

System configuration
- Indoor air conditioner is a complete, self-contained refrigeration system.
- Heat is rejected to a coolant water supply via a heat exchanger in the indoor unit. The coolant water is then usually pumped to a cooling tower and re-circulated. Other water sources such as wells also can be used.
- Cooling tower should be winterized in cold and temperate climates.
- Tower should be designed with redundancy, or an emergency back-up water supply should be available.
- Water treatment is required when a cooling tower is used.
- Water pipe design is a lot less critical and easier to install than refrigerant piping.
- The refrigeration system arrives factory charged and tested.
C- Glycol Cooled

System configuration
- Indoor unit is similar to water-cooled system.
- A glycol solution is circulated in place of water and the heat rejection occurs in an outdoor liquid to air heat exchanger or “dry cooler.”
- Dry coolers are lower maintenance than cooling towers.
- Presents excellent opportunities for heat recovery application.
- System E.E.R. is lowest of three unit types.
- Multiple units can be linked to single large dry coolers and pump packages. Be aware of redundancy requirements if this is done.

D- Free-cooling Glycol

System configuration
- Product is identical to glycol-cooled but also includes an additional free-cool coil for energy savings.
- When the outside temperature drops, cool glycol solution is run through the supplementary free-cool coil and cooling is obtained without running the compressors.
- Presents excellent operating cost reductions in appropriate climates.
- Extra coil means more blower motor HP.
- Look for systems with larger free-cool coils for more cost savings. Free-cool coils should be installed before the DX coil for assisted capacity during mild, ambient temperatures.

E- Supplementary Chilled-water Coil

System configuration
- A supplementary chilled-water coil can be included in a DX system to provide complete redundancy in a single unit.
- Unit may operate as a chilled water system with 100% modular DX back up in the event of an emergency.
- Unit may act as a DX system with emergency central plant chilled-water back up if required.
- Unit may use chilled water when available. For instance, if chiller runs primarily to support a manufacturing process in a factory or to support summertime comfort systems, and switch to DX when chilled water is routinely no longer available.
f. Chilled Water

**System configuration**

- Chilled water is supplied from a central chiller to packaged units in the technology room. The refrigeration system is contained in the packaged chiller.
- Indoor air conditioners contain controls, chilled-water coil, chilled-water control valve, blowers, filters, humidifiers and reheat.
- Chilled-water temperature should be as high as possible to keep a high sensible heat ratio (47°F or higher).
- Redundancy should be extended to central chilled plant and pump packages.
- Central plant should be winterized for year-round operation.
- May require operating personnel in some cities.
- Do not combine with comfort cooling chillers since chilled-water supply temperatures should differ (42°F comfort, 47°F+ for technology room).

**Cost of Ownership**

1- **Operating Costs**

Technology room air conditioning costs are typically ten times higher per square foot than office or comfort air conditioning. This is because of year-round instead of seasonal operation and the greatly increased heat load density. However, precision air conditioning operating costs are far less than comfort air conditioning if both systems are applied to a technology room.

Precision air conditioning costs are lower than comfort air conditioning for comparable use because of the following:

a. Under-floor System - A high sensible heat ratio eliminates over-dehumidification and subsequent humidifier operation.

b. High Energy Efficiency Ratio (E.E.R). With the oversized coils, high CFM, and heat pump duty compressors, computer grade systems have higher sensible cooling energy efficiency ratios than conventional comfort cooling.
C- Precision air equipment is designed with high-efficiency components for year-round operation.

Look for the following:

- Oversized, shallow cooling coil
- High efficiency blower motors
- Steam canister humidifiers
- Heat pump duty rated compressor
- High S.H.R.’s
- Dedicated dehumidification cycle
- Low FLA
- 100,000 HR L^20 rated bearings
- Extended warranties

2- Service Costs

The largest costs incurred during the service or repair are generally in technology room downtime. For this reason, redundancy should always be designed in first. However, to further reduce this exposure, equipment can be selected with features that will reduce required service and repair time dramatically. Look for the following:

a- Bolt in refrigeration components. Compressor and filter dryer should be removable without gas torches.
b- Primary and secondary engineering drain pans.
c- Quick-change canister humidifier.
d- Components should be out of the air stream in a separate mechanical section.
e- Removable fan deck assembly.
f- Color-coded and numbered electrical wiring.
g- Motor start protectors instead of fuses.
h- Easily removable and/or hinged access panels.
i- Run-time-based maintenance calls.

Conclusions

Technology rooms house sensitive electronics that need precise environmental conditions to run optimally. By providing the environmental stability that this type of electronic equipment requires, precision air conditioning helps your business avoid expensive system shutdowns and component failures.