Data Center Assessment Tool Suite "DC Pro"

Master List of Energy Efficiency Actions

CONTENTS

Purpose

This is a living document, meant to serve as the primary reference for all energy efficiency actions addressed by the DC Pro tool suite.

This document includes the number, title, and descriptions (both short and long) of each action, listed in numeric order and by major category.

It is expected that the author of a data center assessment report that is produced under the DOE Save Energy Now program will copy and paste relevant material from this master list in to the report as they see fit. It is not expected that this entire document would be attached to the report as an appendix, simply because it would add a large amount of (assumedly) irrelevant material.

Some of the actions listed in this document appear in the DC Pro on-line profiling tool (http://www1.eere.energy.gov/industry/saveenergynow/partnering_data_centers.html); others do not. Each action in this document is identified Yes or No in this regard.

The short descriptions are used to describe the actions that appear in the profiling tool. They can be used for other purposes as desired.

As of this date (June 6, 2008) some of the short descriptions, and most of the long descriptions, have not been developed yet.

It is expected that users of this document will have suggested changes to the existing actions, and suggested new actions. These are welcome; please submit them to:

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Global

GL-001: Upgrade All Cooling Supply Fan, Pump, and Cooling Tower Fan Motors to Premium Efficiency

Currently Listed in Profiling Tool? YES

Short Description

Premium efficiency motors are generally a few percent more efficient than their baseline counterparts. The efficiency gains are modest, but the incremental first cost tends to be low as well, especially when replacing existing motors that have reached the end of their service life. Specifying a premium efficiency motor is almost always cost effective for applications with long or continuous runtimes.

Long Description

Not available.

Energy Management

EM-001: Perform an Energy Audit

Currently Listed in Profiling Tool? YES

Short Description

The first step towards more energy-efficient operation is to quantify how efficiently your facility is currently operating. An audit will reveal how the total energy use of the facility is distributed among the IT equipment and its support systems -- power distribution, cooling, humidity control, etc. Comparing your results against public benchmark data will indicate the where the best opportunities for cost-effective improvements are.

Long Description

Not available.

EM-002: Create an Energy Management Plan

Currently Listed in Profiling Tool? YES

Short Description

Maintaining long-term energy-efficient operation of your facility is best accomplished by creating and executing an Energy Management Plan. This plan will identify who the responsible parties are and what the energy management goals are. It will address how to collect measurements of system performance, how the data is managed and interpreted, and the process of identifying, funding, and implementing energy efficiency actions.

Long Description

Not available.

EM-003: Assign an Energy Manager

Currently Listed in Profiling Tool? YES

Short Description

If your facility does not already have an Energy Manager, consider assigning one. Efforts to improve energy efficiency often falter when there is no clearly identified "champion" to lead and coordinate.

Long Description

Not available.

EM-004: Engage Upper Management with a Compelling Life-Cycle Cost Case

Currently Listed in Profiling Tool? YES

Short Description

Some energy efficiency actions have little or no first cost to implement, but many others do. Even if a proposed action has a very rapid payback, management may choose not to fund it based on the cost of implementation. A clearly presented analysis of the return on investment of the proposed action will help management compare it to alternate investment opportunities.

Long Description

Not available.

EM-005: Implement an Energy Measurement and Calibration Program

Currently Listed in Profiling Tool? YES

Short Description

It is often said "you can't manage what you don't measure". Identify the key parameters of your systems that indicate how well they are performing. Determine which of these parameters are already being monitored and what your recording capabilities are. Add instrumentation to capture the parameters that are currently not monitored. Finally, implement a program to regularly calibrate your sensors to ensure that you always collect accurate readings.

Long Description

Not available.

EM-006: Conduct Regular Preventive Maintenance

Currently Listed in Profiling Tool? YES

Short Description

Data center support systems are more likely to operate efficiently when they are kept in tune. It is often the case that a support system is meeting its nominal requirements, there are no alarm conditions, but the system is using more energy that it was designed to. Preventive maintenance will bring these situations to light and correct them before a lot of energy waste occurs.

Long Description

Not available.

EM-007: Sub-Meter End-Use Loads and Track Over Time

Currently Listed in Profiling Tool? YES

Short Description

Many data centers have only a few main energy meters (electric, gas, etc). These typically report the total energy use of the facility accurately, but they can not indicate how the energy use is distributed among the IT equipment and support systems. Installing sub-meters at key locations provides a powerful tool for measuring the energy performance of individual systems. Providing these sub-meters with recording capability allows you to monitor system performance over time, providing evidence of degradations and improvements.

Long Description

Not available.

EM-008: Review Full System Operation and Efficiency on a Regular Basis

Currently Listed in Profiling Tool? YES

Short Description

You may already be monitoring some of your data center support systems and are satisfied that they are operating efficiently, but it is important to monitor the energy efficiency of the data center as a whole. Two common "big picture" metrics are PUE (Power Utilization Effectiveness) and DCIE (Data Center Infrastructure Efficiency). Both of these measurements indicate how much energy the support systems use in comparison to the IT equipment itself. The less energy the support systems use for a given IT load, the more efficiently the facility operates. Continuously monitoring this ratio is a good way to keep track of the performance of the whole data center.

Long Description

Not available.

EM-009: Install Monitoring Equipment to Measure System Efficiency and Performance

Currently Listed in Profiling Tool? YES

Short Description

If you do not have permanent instruments installed to measure key performance parameters, you can install temporary instruments to obtain the same information for selected periods of time. Electric power meters, chilled water flow meters, and temperature sensors can be quickly deployed and will quantify system performance.

Long Description

Not available.

EM-010: Raise Awareness and Develop Understanding Among Data Center Staff about the Financial and Environment Impact of Energy Savings

Currently Listed in Profiling Tool? YES

Short Description

Data center staff typically have a list of priorities. Maintaining continuous up-time is usually first, followed by providing capacity for future growth. Energy efficiency is usually third or fourth, at best. Implementing and preserving energy efficient operation is helped by coaching staff on how energy efficiency can increase data center capacity, save money, and support the company's overall environmental goals.

Long Description

Not available.

EM-011: Train / Raise Awareness of Data Center Designers in the Latest Energy Management Best Practices and Tools

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

EM-012: Use Life Cycle Cost to Make Decisions

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

EM-013: Install Peak Shaving Devices on Lighting Systems

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

EM-014: Implement a Continuous Commissioning Plan

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT Equipment

IT-001: Monitor Utilization of Servers, Storage, and Networks

Currently Listed in Profiling Tool? YES

Short Description

IT systems are often under-utilized. Servers may run at a fraction of their processing capability, data storage may be oversized and infrequently accessed, and network traffic may well below maximum transfer rates. This results in poor energy performance. Monitoring utilization rates will allow data center staff to optimize performance as the data center mission evolves.

Long Description

Not available.

IT-002: Perform an Audit to Ensure all Operational Servers are Still in Active Use

Currently Listed in Profiling Tool? YES

Short Description

In a large data center that has been in operation for a while, it is common to have servers that are drawing power but no longer have any assigned tasks. Performing an audit will identify which servers are candidates for shutting down.

Long Description

Not available.

IT-003: Evaluate the Potential Savings from Upgrading to Newer IT Equipment

Currently Listed in Profiling Tool? YES

Short Description

IT technology evolves rapidly, and improvements in energy performance are often provided in newer equipment. A cost-benefit analysis will reveal when it makes economic sense to replace existing equipment.

Long Description

Not available.

IT-004: Implement Server Virtualization

Currently Listed in Profiling Tool? YES

Short Description

Virtualization techniques can consolidate operations on fewer computers, permitting shutting down or eliminating some servers.

Long Description

Not available.

IT-005: Consolidate to Network-Attached Storage and Diskless Servers

Currently Listed in Profiling Tool? YES

Short Description

Servers typically have on-board mechanical disk drives. These drives are responsible for a significant percentage of the server's total energy use, but they often have a low utilization rate. Converting to solid-state memory at the servers, or consolidating to a network-attached (NAS or SAN) data storage device may be a path to an effective energy performance improvement.

Long Description

Not available.

IT-006: Assess Data Storage Usage

Currently Listed in Profiling Tool? YES

Short Description

It is not uncommon to have more storage allocated to processing tasks than is needed, and to have the storage accessed infrequently. This can result in poor energy performance, as storage devices draw energy whether they are in active use or not. Investigating data storage utilization patterns can reveal opportunities, such as moving less performance-sensitive data to higher capacity, more efficient media.

Long Description

Not available.

IT-007: Reduce the Capacity Requirements of Data Storage Systems

Currently Listed in Profiling Tool? YES

Short Description

Your data storage utilization patterns may allow for storage virtualization. In other words, selected processes can be assigned storage limits that, when summed, exceed the actual total provided storage capacity. If the needs of the individual processes for active storage are sufficiently non-coincident, the actual storage limit will rarely or never be exceeded.

Long Description

Not available.

IT-008: Evaluate Alternative Financing Methods to Enable Faster Technology Refresh

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT-009: Enable Power Management Features on Servers

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT-010: Consolidate User Data

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT-011: Automate Data Retention and Deletion Policies

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT-012: Obtain Realistic Estimates of IT Equipment Actual Power Use

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT-013: Use Vendor Programs to Dispose of Old Servers

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

IT-014: Specify More Efficient Power Supplies in IT Equipment

Currently Listed in Profiling Tool? NO

Short Description

This action addresses the final step in the chain of power conversions that occurs between the main power feed to the data center and the end-point of the IT equipment. It can be an effective strategy for reducing load in existing servers that have hot-swappable power supply capability, but most servers are not so equipped. This action is usually most effective for new equipment. A customer has more clout to specify efficient power supplies when placing a large order with a supplier.

Long Description

Not available.

IT-015: Specify Computing Performance Metrics for New IT Equipment

Currently Listed in Profiling Tool? NO

Short Description

Future procurements of IT equipment can benefit from use of appropriate performance metrics coupling computational performance with energy performance. This metric will allow comparison of overall computing efficiency and will take into account such issues as processor efficiency, hardware/software compatibility, memory efficiency, etc.

Long Description

Not available.

Environmental Conditions

EC-001: Measure the Return Temperature Index (RTI) and Rack Cooling Index (RCI)

Currently Listed in Profiling Tool? YES

Short Description

A low air temperature rise across the data center and/or IT equipment intake temperatures outside the recommended range suggest air management problems. A low return temperature is due to by-pass air and an elevated return temperature is due to recirculation air. Estimating the Return Temperature Index (RTI) and the Rack Cooling Index (RCI) will indicate if corrective, energy-saving actions are called for.

Long Description

Not available.

EC-002: Increase the Supply Air Temperature

Currently Listed in Profiling Tool? YES

Short Description

A low supply temperature makes the chiller system less efficient and limits the utilization of economizers. Enclosed architectures allow the highest supply temperatures (near the upper end of the recommended intake temperature range) since mixing of hot and cold air is minimized. In contrast, the supply temperature in open architectures is often dictated by the hottest intake temperature.

Long Description

Not available.

EC-003: Provide Warmer Temperatures at the IT Equipment Intakes

Currently Listed in Profiling Tool? YES

Short Description

Specifying a low IT equipment intake temperature causes the cooling system to run less efficiently and limits the utilization of economizers. Target the maximum recommended intake temperature from guidelines issued by ASHRAE (77F) and NEBS (80F) depending on the type of electronic equipment in the data or telecom center. If the air distribution system can be modified to deliver air more effectively to the equipment, it may be possible to raise the average intake temperature. This in turn will allow the cooling supply air temperature to be raised, which typically results in more efficient cooling system operation.

Long Description

Not available.

EC-004: Place Temperature and Humidity Sensors to Mimic the IT Equipment Intake Conditions

Currently Listed in Profiling Tool? YES

Short Description

IT equipment manufacturers design their products to operate reliably within a given range of intake temperature and humidity. The temperature and humidity limits imposed on the cooling system that serves the data center are intended to match or exceed the IT equipment specifications. However, the temperature and humidity sensors are often integral to the cooling equipment and are not located at the IT equipment intakes. The condition of the air supplied by the cooling system is often significantly different by the time it reaches the IT equipment intakes. It is usually not practical to provide sensors at the intake of every piece of IT equipment, but a few representative locations can be selected. Adjusting the cooling system sensor location in order to provide the air condition that is needed at the IT equipment intake often results in more efficient operation.

Long Description

Not available.

EC-005: Recalibrate the Temperature and Humidity Sensors

Currently Listed in Profiling Tool? YES

Short Description

Temperature sensors generally have good accuracy when they are properly calibrated (+/- a fraction of a degree), but they tend to drift out of adjustment over time. In contrast, even the best humidity sensors are instrinsically not very precise (+/- 5% RH is typically the best accuracy that can be achieved at reasonable cost). Humidity sensors also drift out of calibration. To ensure good cooling system performance, all temperature and humidity sensors used by the control system should be treated as maintenance items and calibrated at least once a year. Twice a year is better to begin with. After a regular calibration program has been in effect for a while, you can gauge how rapidly your sensors drift and how frequent the calibrations should be. Calibrations can be performed in-house with the proper equipment, or by a third-party service.

Long Description

Not available.

EC-006: Network the CRAC/CRAH Controls

Currently Listed in Profiling Tool? YES

Short Description

CRAC/CRAH units are typically self-contained, complete with an on-board control system and air temperature and humidity sensors. The sensors may not be calibrated to begin with, or they may drift out of adjustment over time. In a data center with many CRACs/CRAHs it is not unusual to find some units humidifying while others are simultaneously dehumidifying. There may also be significant differences in supply air temperatures. Both of these situations waste energy. Controlling all the CRACs/CRAHs from a common set of sensors avoids this.

Long Description

Not available.

EC-007: Add Personnel and Cable Grounding to Allow Lower IT Equipment Intake Humidity

Currently Listed in Profiling Tool? YES

Short Description

The lower humidity limit in data centers is often set relatively high (40% RH at the IT equipment intake is common) to guard against damage to the equipment due to electrostatic discharge (ESD). Maintaining this level of humidity is energy intensive if the humidifiers use electricity to make steam (this is the most common type). Energy can be saved if the allowed lower humidity limit can be lowered, particularly if the cooling system has an airside economizer. ESD can be kept in check by conductive flooring materials, good cable grounding methods, and providing grounded wrist straps for technicians to use while working on equipment.

Long Description

Not available.

EC-008: Disable or Eliminate Humidification Controls or Decrease the Humidification Setpoint

Currently Listed in Profiling Tool? YES

Short Description

Tightly controlled humidity can be very costly in data centers since humidification and dehumidification are involved. A wider humidity range allows significant utilization of free cooling in most climate zones by utilizing effective air-side economizers. In addition, open-water systems are high-maintenance items.

Long Description

Not available.

EC-009: Disable or Eliminate Dehumidification Controls or Increase the Dehumidification Setpoint

Currently Listed in Profiling Tool? YES

Short Description

Most modern IT equipment is designed to operate reliably when the intake air humidity is between 20% and 80% RH. However, 55% RH is a typical upper humidity level in many existing data centers. Maintaining this relatively low upper limit comes at an energy cost. Raising the limit can save energy, particularly if the cooling system has an airside economizer. In some climates it is possible to maintain an acceptable upper limit without ever needed to actively dehumidify. In this case, consider disabling or removing the dehumidification controls entirely.

Long Description

Not available.

EC-010: Change the Type of Humidifier

Currently Listed in Profiling Tool? YES

Short Description

Most humidifiers are heat based; ie, they supply steam to the air stream by boiling water. Electricity or natural gas are common fuel sources. The heat of the steam becomes an added load on the cooling system. An evaporative humidifier uses much less energy. Instead of boiling water, it introduces a very fine mist of water droplets to the air stream. When set up properly the droplets quickly evaporate, leaving no moisture on nearby surfaces. This has an added cooling benefit, as the droplets absorb heat from the air as they evaporate.

Long Description

Not available.

EC-011: Change Cooling Unit Air Temperature Setpoints Based on IT Equipment Thermal Demand

Currently Listed in Profiling Tool? YES

Short Description

IT equipment is designed to operate most reliably within a certain range of intake air temperatures, and a certain temperature rise of the air is expected before it is exhausted. Programming the cooling system to match these temperatures avoids cooling system energy waste due to overcooling the supply air, and ensures reliable IT equipment operation.

Long Description

Not available.

EC-012: Use an Enthalpy Sensor to Control the Airside Economizer

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

Air Management

AM-001: Ensure Adequate Match between Heat Load and Raised-Floor Plenum Height

Currently Listed in Profiling Tool? NO

Short Description

The cooling capacity of a raised floor depends on its effective flow area, which can be increased by removing cables and other obstructions that are not in use. Still, the heat density may need to be reduced. Undersized and/or congested plenums often require an overall elevated static pressure to deliver the required airflow. Providing the increased static pressure requires additional fan energy.

Long Description

Not available.

AM-002: Provide Adequate Ceiling Supply/Return Plenum Height

Currently Listed in Profiling Tool? NO

Short Description

The plenum height can be increased if the clear ceiling allows. A return plenum often means a lower clear ceiling but allows placing the return grilles directly above the hot aisles. Such a plenum needs to be maintained similar to a raised floor. A shallow plenum may result in high pressure losses, poor pressure distributions, and high fan-energy costs.

Long Description

Not available.

AM-003: Provide Adequate Clear Ceiling

Currently Listed in Profiling Tool? NO

Short Description

Remove the dropped ceiling if not used for air and the clear ceiling is less than 12 feet. Tall open ceilings promote thermal stratification, and the placement of the return grilles is not critical. The stratification ensures that the hot air is not mixed with the cooler ambient air but is rather returned directly to the air handler. Such ceilings have an unmatched simplicity compared to return plenums.

Long Description

Not available.

AM-004: Use Existing Dropped Ceiling as Return Plenum

Currently Listed in Profiling Tool? NO

Short Description

The thermal effectiveness of the data center increases when the return air temperature is maximized, and a return plenum allows the return grilles to be placed directly above the hot aisles. If no dropped ceiling exists, however, installing one is generally not warranted.

Long Description

Not available.

AM-005: Remove Abandoned Cable and Other Obstructions

Currently Listed in Profiling Tool? YES

Short Description

Under-floor and over-head obstructions often interfere with the distribution of cooling air. Such interferences can significantly reduce the air handlers' airflow as well as negatively affect the air distribution. The cooling capacity of a raised floor depends on its effective height, which can be increased by removing obstructions that are not in use.

Long Description

Not available.

AM-006: Implement a Cable Mining Program

Currently Listed in Profiling Tool? YES

Short Description

Cable congestion in raised-floor plenums can sharply reduce the total airflow as well as degrade the airflow distribution through the perforated floor tiles. Both effects promote the development of hot spots.

Long Description

Not available.

AM-007: Implement Alternating Hot and Cold Aisles

Currently Listed in Profiling Tool? YES

Short Description

This is generally the first step towards separating hot and cold air, which is key to air management. Cold air is supplied into the cold front aisles, the electronic gear moves the air from the front to the rear and/or front to the top, and the hot exhaust air is returned to the air handler from the hot rear aisles. Some data centers are not suitable for hot/cold aisles, including those with non-optimal gear (not moving air from front to rear/top).

Long Description

Not available.

AM-008: Provide Physical Separation of Hot and Cold Air

Currently Listed in Profiling Tool? YES

Short Description

Physical barriers can successfully be used to avoid mixing the hot and cold air, allowing reduction in airflow and fan energy as well as increase in supply/return temperaturses and chiller efficiency. There are four principal ways of providing physical separation:
- Semi-enclosed aisles such as aisle doors; allows some containment of the cold air.
- Flexible strip curtains to enclose aisles; allows good separation of hot and cold air.
- Rigid enclosures to enclose aisles; allows excellent separation of hot and cold air.
- In-rack ducted exhaust; allows effective containment of the hot exhaust air.

Long Description

Not available.

AM-009: Convert to Variable Speed Fans

Currently Listed in Profiling Tool? YES

Short Description

This action allows variation of airflow to meet cooling demand. Traditionally, few CRAC units have the capability to vary the airflow in real time, and adjusting the supply temperature is the only option. With variable speed drives, the capacity control can be modified to improve the cooling effectiveness of the electronic equipment as well as save fan and cooling energy.

Fan power consumption can be reduced drastically (potential saving up to 40% of fan power consumption.) with the use of VFDs. This also helps preserve adequate pressurization of the supply plenum (if any) because all fans continue to run, in contrast to action AM-030: Shut off CRAC/CRAH Units.

Long Description

Not available.

AM-010: Configure Equipment in Straight Rows

Currently Listed in Profiling Tool? YES

Short Description

Since straight equipment lineups are generally a prerequisite to alternating hot and cold aisles, it should have a very high priority. Straight lineups also allow structured cable management.

Long Description

Not available.

AM-011: Place Supply Air Devices in Cold Aisles Only

Currently Listed in Profiling Tool? YES

Short Description

Perforated floor tiles or over-head supply diffusers should only be placed in the cold aisles to match the "consumption" of air by the electronic equipment. Too little or too much supply air results in poor overall thermal and/or energy conditions. Note that the hot aisles are supposed to be hot, and supplies should not be placed in those areas.

Long Description

Not available.

AM-012: Implement a Tile/Diffuser Location Program

Currently Listed in Profiling Tool? YES

Short Description

A program should be in place to maintain the alternating hot and cold aisle configuration of perforated tiles or over-head diffusers. There should be no reason to place tiles or diffusers in the hot equipment aisles.

Long Description

Not available.

AM-013: Use Appropriate Overhead Diffusers

Currently Listed in Profiling Tool? YES

Short Description

The generally high pressure drops across the end devices (diffusers) and low pressure losses in the distribution system (ductwork) promote high air stability. Stability means that the system can be balanced successfully and that external disturbances have limited impact on that balance. In addition, the diffusers should have characteristics promoting penetration of the supply air into the cold aisles.

Long Description

Not available.

AM-014: Place Air Returns at High Elevation

Currently Listed in Profiling Tool? NO

Short Description

The importance of this measure is a second-order effect in most environments. Nevertheless, CRAC units can benefit from ducted vertical extensions that help capture the return air higher up in the equipment room rather than at the top of the unit.

Long Description

Not available.

AM-015: Take Return Air from Hot Aisles

Currently Listed in Profiling Tool? NO

Short Description

The thermal efficiency of the data center increases when the return temperature is maximized. The closer the return is located to the heat source, the better. If a return plenum is used, the grilles should be placed directly above the hot aisles. If over-head diffusers are used with wall returns, the diffusers should be dropped to allow hot air to pass horizontally along the ceiling.

Long Description

Not available.

AM-016: Provide Adequate Floor Plenum Pressure

Currently Listed in Profiling Tool? NO

Short Description

A high static pressure often means high floor leakage and by-pass air. A moderate static pressure (0.05 in. of water) allows relatively high tile airflow rates but caps the floor leakage. If a standard 25% perforated tile cannot deliver enough airflow to cool the equipment at the target pressure, rather than increasing the pressure consider using a tile with a larger open area.

Long Description

Not available.

AM-017: Seal Floor Leaks

Currently Listed in Profiling Tool? YES

Short Description

A large fraction of the air from the air-handler may be lost through leaks in the raised floor. The leaks are often hidden under the equipment racks and not visible during a casual walk-through audit. Such leakage often causes by-pass air that does not contribute to cooling the electronic equipment. There are a number of commercial products that can be used to seal the raised floor.

Long Description

Not available.

AM-018: Implement a Floor Tightness Program

Currently Listed in Profiling Tool? YES

Short Description

Raised-floor leakage can be a significant part of the total airflow delivered by the air handler, especially in less dense and lightly populated environments. A well-maintained raised floor results in less air leakage, a higher plenum pressure, and higher flow rates through the perforated floor tiles.

Long Description

Not available.

AM-019: Use Supplemental Cooling

Currently Listed in Profiling Tool? YES

Short Description

Equipment areas with high heat densities and/or significantly higher heat densities than the average density (>8) may be prime candidates for supplemental cooling, including liquid-cooled solutions. Supplemental cooling solutions are generally best suited for controlling occasional point loads rather than a large number of racks.

Long Description

Not available.

AM-020: Line up CRAC/CRAH Units with Hot Aisles

Currently Listed in Profiling Tool? NO

Short Description

The CRAC units should be placed to promote an even pressure distribution in the floor plenum. Although it may seem counter-intuitive, center them on the hot aisles rather than on the cold aisles results in better cooling performance. Turning vanes under the units are generally not necessary to redirect the supply air into the floor plenum.

Long Description

Not available.

AM-021: Ensure an Adequate Ratio of System Flow to Rack Flow

Currently Listed in Profiling Tool? YES

Short Description

Generally, the supply airflow should closely match the equipment airflow. The Return Temperature Index (RTI) is a measure of the level of by-pass air or recirculation air in the equipment room. Both effects are detrimental to the thermal and energy performance of the data center. The target is 100% whereas >100% implies recirculation air and <100% implies by-pass air.

Long Description

Not available.

AM-022: Balance the Air Distribution System

Currently Listed in Profiling Tool? YES

Short Description

Over-head ducted systems can be adequately balanced using conventional methods whereas raised-floor systems are balanced by using "enough" perforated tiles. The latter often becomes more an art rather than science, especially since the pressure difference across the floor is small.

Long Description

Not available.

AM-023: Use IT Equipment with High Design Temperature Rise

Currently Listed in Profiling Tool? NO

Short Description

A higher temperature rise across the equipment and—in turn—the equipment room allows a lower cooling airflow rate and a higher return temperature. Both effects promote lower energy utilization.

Long Description

Not available.

AM-024: Use IT Equipment with Front to Rear or Front to Top Cooling Airflow

Currently Listed in Profiling Tool? NO

Short Description

The Equipment-Cooling (EC) class describes where the entry and exit points for the cooling air are located on the equipment envelope. An optimal class moves air from the cold front aisle to the rear hot aisle, conserving the alternating hot and cold aisles. Non-optimal gear should be isolated rather dictating the cooling requirements for the entire data center.

Long Description

Not available.

AM-025: Remove Cosmetic Doors from IT Equipment Racks

Currently Listed in Profiling Tool? NO

Short Description

Such doors often impede the cooling airflow and may promote recirculation within the enclosed cabinet further increasing the equipment intake temperature. Truly cosmetic doors should not be used.

Long Description

Not available.

AM-026: Provide Adequate Free Area on Rack Doors for Air Movement

Currently Listed in Profiling Tool? NO

Short Description

If rack doors are necessary for security reasons, provide them with openings to permit adequate cooling airflow. For example, solid doors can be replaced with partially perforated doors.

Long Description

Not available.

AM-027: Maintain Tight Racks and Rows

Currently Listed in Profiling Tool? YES

Short Description

Blanking panels should be used to seal openings under and between equipment racks, between equipment shelves in partially filled racks, or completely empty racks. Managing blanking panels is especially important in hot and cold aisle environments. Blanking panels come in various heights and widths to fit almost any application, and they come in snap-on or screw-in types.

Long Description

Not available.

AM-028: Implement a Rack and Row Tightness Program

Currently Listed in Profiling Tool? YES

Short Description

Any opening between the cold aisle and the hot aisle will degrade the separation of hot and cold air. A program should be in place to minimize leakage by maintaining blanking panels and unbroken lineups.

Long Description

Not available.

AM-029: Maintain Unbroken Rows

Currently Listed in Profiling Tool? NO

Short Description

Broken lineups should be filled with empty racks with blanking panels from top to bottom. Managing unbroken equipment lineups is especially important in hot and cold aisle environments. Any opening between the aisles will degrade the separation of hot and cold air.

Long Description

Not available.

AM-030: Shut off CRAC/CRAH Units

Currently Listed in Profiling Tool? YES

Short Description

If it is determined that a lower airflow volume is desired and the CRAC/CRAH units do not have variable speed fans, adjustment is limited to shutting off individual units. This is not a precise way of controlling the air volume, but it can still yield acceptable results. Some experimentation may be required to determine which units can be shut off without compromising adequate cooling of the IT equipment.

Long Description

Not available.

AM-031: Implement an Air Balancing Program

Currently Listed in Profiling Tool? YES

Short Description

Generally, the supply flow should closely match the equipment flow. The Return Temperature Index (RTI) is a measure of by-pass air or recirculation air. Both are detrimental to the performance of the data center. The target is 100% whereas >100% implies recirculation air and <100% implies by-pass air.

Long Description

Not available.

AM-032: Control All Supply Fans in Parallel

Currently Listed in Profiling Tool? YES

Short Description

If all the supply fans serving a given space are identical and equipped with variable speed drives, fan energy is minimized by running all the fans (including redundant units) at the same speed.

Long Description

Not available.

AM-033: Get Rid of Pre-Filters

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

AM-034: Change Filters to Appropriate MERV Rating

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

AM-035: Seal Ducts or Casings to Reduce Leakage

Currently Listed in Profiling Tool? NO

Short Description

Although raised-floor systems generally leak significantly more than ducted systems, duct systems should be sealed and maintained to avoid unnecessary large airflow rates and energy costs.

Long Description

Not available.

AM-036: Fix System Effects in Air Distribution System

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

AM-037: Change CRAC/CRAH/AHU Fan Motors to Premium Efficiency

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

AM-038: Add an Airside Economizer to the AHU

Currently Listed in Profiling Tool? YES

Short Description

If the data center is served by cooling units that can be practically served with outside air, and there is a feasible exhaust air path, consider implementing airside economizing. In economizing mode, 100% outside air is drawn in to the data center and returned to the outdoors after one pass. This scheme will offset or even eliminate cooling compressor energy whenever the energy content of the outside air is less than the energy content of the return air. The higher the nominal return air temperature, the more viable economizing hours there will be. To ensure that summer peak electric demand is not increased due to fan energy, design for a low pressure drop intake and exhaust paths. Off-the-shelf air handlers and AC units can often be ordered with an economizer option direct from the manufacturer.

Long Description

Not available.

AM-039: Retrocommission the Airside Economizers

Currently Listed in Profiling Tool? YES

Short Description

While airside economizers can offer large energy savings (particularly in milder climates), they need regular service to operate properly. The outside air sensors that control when the economizer opens and closes must be kept calibrated. The actuators and linkages that control the economizer louvers must be kept lubricated and in adjustment. The entire economizer system should be tested at least once a year to ensure it operates as intended.

Long Description

Not available.

AM-040: Replace the Existing CRACs/CRAHs/AHUs with More Efficient Equipment

Currently Listed in Profiling Tool? NO

Short Description

When replacing older units, in addition to specifying units with more efficient fans and fan motors, specify units variable speed drives (VFDs or EC Motors) on the fans. See action AM-009: Convert to Variable Speed Fans.

Long Description

Not available.

AM-041: Replace Dirty CRAC/CRAH/AHU Filters

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

Cooling Plant

CP-001: Add VSDs to Cooling Tower Fans

Currently Listed in Profiling Tool? YES

Short Description

Cooling towers are typically equipped with a single-speed or a two-speed fan motor. The motor cycles on and off to maintain the desired condenser water temperature. Adding a variable speed drive (VSD) to the motor offers several advantages. It saves energy by operating continuously at a lower speed rather than cycling between a higher speed and off. It saves the wear and tear that occurs with cyclic operation, and is less noisy. And it allows more precise control of the condenser water temperature.

Long Description

Not available.

CP-002: Convert Cooling Towers from Series Staging to Parallel Staging

Currently Listed in Profiling Tool? NO

Short Description

By operating as many cooling towers as possible at all times, the amount of water to be cooled is distributed across a greater number of towers. This decreases the amount of heat rejection required by each tower, which in turn reduces the required fan speed. This translates directly to energy savings. Care must be taken that no tower is starved for flow.

Long Description

Not available.

CP-003: Evaluate Chillers for Replacement

Currently Listed in Profiling Tool? YES

Short Description

Chillers are typically the greatest energy-using components in the cooling system. Recent advances in chiller technology, especially variable-speed compressors, offer more efficient operation. For these reasons, it is often worthwhile to examine the cost-effectiveness of replacing existing chillers if they are more than 5 years old or are in poor condition.

Long Description

Not available.

CP-004: Optimize Cooling Plant Controls

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

CP-005: Convert all 3-Way CHW Valves to 2-Way

Currently Listed in Profiling Tool? YES

Short Description

Older chilled water distribution systems are designed with 3-way valves at the cooling coils. A constant flow of chilled water is delivered to each coil location. Each coil is equipped with a bypass leg, and each 3-way valve modulates to divert as much water through the coil as is currently needed for cooling purposes. The remaining water bypasses the coil. This method is energy intensive. With the advent of inexpensive, reliable variable speed drives for pump motors, the preferred method is eliminate the bypasses and replace the 3-way valves with 2-way valves. The 2-way valves modulate as needed to serve the cooling load, and the pump motor speed varies in response to the demand (by maintaining a constant pressure at the far end of the distribution loop). In facilities that experience a varying load, it may be cost effective to go one step further and program the control system to vary the pressure setpoint in response to the position of the most-open 2-way valve.

Long Description

Not available.

CP-007: Select Chiller for High Full and Part-Load Efficiency

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

CP-008: Select High Efficiency Cooling Towers

Currently Listed in Profiling Tool? NO

Short Description

High efficiency cooling towers decrease energy consumption by using higher efficiency components. For example, propeller fans are typically twice as efficient as centrifugal fans. Specify a premium efficiency motor. Specify a low nominal approach temperature.

Long Description

Not available.

CP-009: Convert Primary/Secondary CHW Pumping System to Primary/Series Secondary

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

CP-010: Monitor System Efficiency

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

CP-011: Right-Size the Cooling Plant

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

CP-012: Recover Waste Heat for Heating Uses in Other Spaces

Currently Listed in Profiling Tool? NO

Short Description

In buildings that contain both data center and office space, the air distribution system can be arranged to take warm return air from the datacenter and supply it to the office space for heating purposes.

Long Description

Not available.

CP-013: Add Integrated Waterside Economizer to CHW Plant

Currently Listed in Profiling Tool? YES

Short Description

This action requires a water-cooled chilled water plant; i.e., a plant that includes cooling towers. During periods of low wetbulb temperature (often at night), the cooling towers can produce water temperatures low enough to precool the chilled water returning from the facility, effectively removing a portion of the load from the energy-intensive chillers. During the lowest wetbulb periods, the towers may be able to cool the chilled water return all the way down to the chilled water supply temperature setpoint, allowing the chillers to be shut off entirely. The air handlers see the same chilled water supply temperature at all times, allowing them to maintain the required temperature and humidity requirements. Free cooling also offers an additional level of redundancy by providing a non-compressor cooling solution for portions of the year.

Long Description

Not available.

CP-014: Improve Cooling Tower Water Treatment to Reduce Energy Use

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

CP-015: Recalibrate Chilled WaterSupply Temperature Sensors.

Currently Listed in Profiling Tool? YES

Short Description

A chiller's efficiency is directly affected by the temperature of the chilled water (CHW) it is required to produce. A colder CHW supply temperature typically results in lower chiller efficiency, all other factors held equal. An out-of-calibration CHW supply temperature sensor can cause a chiller plant to produce an unnecessarily cold CHW temperature and waste energy. In addition, a too-cold CHW temperature can cause undesired dehumidification at the cooling coils. This places an extra load on the cooling system and additional energy use.

Long Description

Not available.

CP-016: Recalibrate the Condenser Water Supply Temperature Sensors.

Currently Listed in Profiling Tool? YES

Short Description

A water-cooled chiller's efficiency is directly affected by the temperature of the condenser water (CW) entering the condenser. A higher CW supply temperature typically results in lower chiller efficiency, all other factors held equal. An out-of-calibration CW supply temperature sensor can cause the cooling towers to produce a warmer than desired CW temperature and in turn cause the chiller plant to work unnecessarily hard.

Long Description

Not available.

CP-017: Convert Air-Cooled DX CRACs to Water-Cooled DX CRACs

Currently Listed in Profiling Tool? YES

Short Description

Air-cooled DX CRAC unit condensers transfer the heat collected from the data center directly to the outside air. This is a relatively simple process, but inefficient at high outdoor air temperatures. Cooling towers can produce water temperatures consistently lower than the outdoor air temperature. Using this water as the condensing medium allows the DX CRAC to operate more efficiently. CRAC manufacturers can often supply the parts needed for this retrofit.

Long Description

Not available.

CP-018: Retrofit Constant-Speed Chiller with VSD

Currently Listed in Profiling Tool? NO

Short Description

A variable-speed chiller typically offers better performance at partial loading than constant-speed chiller of the same type and capacity, all other factors held equal. Variable speed control of a chiller is complex, so this kind of retrofit is typically performed only by a qualified manufacturer's representative. Not all chillers can be retrofitted. Whether or not this is a cost-effective action depends to a large extent on the capacity of the chiller and the load profile it serves.

Long Description

Not available.

CP-019: Trim Pump Impeller and Open Triple Duty Valve

Currently Listed in Profiling Tool? NO

Short Description

Water flow is typically balanced by imposing a flow restriction via a balancing valve (one of three functions of a triple-duty valve). Fully opening the balancing valve and trimming the pump impeller to provide the desired flow can save energy.

An alternative to trimming the impeller is to add a VFD to the pump motor. If constant flow is required, the pump speed can be manually adjusted through the VFD to achieve the desired flow.

Long Description

Not available.

CP-020: Remove Suction Diffusers Where Possible

Currently Listed in Profiling Tool? NO

Short Description

Suction diffusers on pump inlets serve to straighten out the water flow before it enters the pump. While this helps avoid the drop in pump efficiency that accompanies turbulent inlet flow, it comes at the cost of increased pressure drop. A more efficient arrangement is to lay out the piping, wherever possible, to provide a straight section of pipe at the pump inlet that is at least ten pipe diameters in length. This is normally sufficient to straighten out the flow and can often be worked into the design with no pressure drop penalty.

Long Description

Not available.

CP-021: Convert Primary/Secondary Chilled Water Pumping System to Primary-Only

Currently Listed in Profiling Tool? NO

Short Description

The typical chilled water distribution system for data center facilities has a constant-volume primary loop and a variable-flow secondary loop. This arrangement ensures a constant flow through the chiller evaporator, while allowing the secondary loop to modulate according to demand.

In recent years, chillers have evolved to be more tolerant of variable chilled water flow through the evaporator. As a result, primary-only variable flow CHW pumping has become more common. This arrangement eliminates the primary CHW pumps (the pumps previously designated as secondary become the primary pumps) and typically results in energy savings. Chillers still have minimum allowable evaporator flow rates, so the control system must monitor and ensure these rates.

Even in facilities with relatively constant load such as data centers, energy savings can be realized as the constant self-balancing of the primary-only control system minimizes pump energy use.

For flow measurement, magnetic flow meters (Danfoss Magflo or equivalent) offers superior long-term stability. For a lower-cost flow measurement method, the pressure drop across the chiller evaporator barrel can be calibrated to flow and successfully used as a fixed-orifice flow meter.

Long Description

Not available.

CP-022: Install High Efficiency Pumps

Currently Listed in Profiling Tool? NO

Short Description

A thorough search of available pumps for a particular application usually reveals a wide range of efficiencies. Spending the time to do the research and then selecting the most efficient pump is usually a cost-effective activity, particularly in facilities where the pumps are continuously active.

Long Description

Not available.

CP-023: Specify an Untrimmed Impeller, Use a VFD to Limit Pump Speed, Match the Pump Motor Size to the Design Flow Rate

Currently Listed in Profiling Tool? NO

Short Description

Typical design practice calls for selecting an oversized pump for the given application, and then trimming the impeller to match actual conditions, for example specifying a maximum impeller diameter of 85%. This tends to decrease the efficiency of the pump (losses at the larger gap at the cutwater).

A more energy-efficient alternative is to retain the full impeller size and use a VFD to limit the maximum pump speed to the value that provides the design flow.

Long Description

Typical design practice calls for selecting an oversized pump for the given application, and then trimming the impeller to match actual conditions, for example specifying a maximum impeller diameter of 85%. This tends to decrease the efficiency of the pump (losses at the larger gap at the cutwater).

A more energy-efficient alternative is to retain the full impeller size and use a VFD to limit the maximum pump speed to the value that provides the design flow. Note that while the impellor is untrimmed, the pump must still be selected to operate at its peak efficiency point at turndown. This is done by scaling the design conditions up to the untrimmed impellor point using the pump laws (the same method pump manufactures use to translate a single efficiency curve test for a pump at 1800 rpm to 1180 rpm). Most pumps are already available in differing motor speeds, and comparisons of curves for a single pump at 1800 rpm and 1180 rpm will quickly show that lower speeds do not adversely impact efficiency. This selection approach ensures that there are no losses from off-curve operation and will yield the highest possible efficiency. Losses in the VFD are minimal compared to the efficiency improvement that can be realized in the pump as long as the VFD and motor are sized to the operating power (not the full speed operating power requirement). The pump motor is selected to provide the necessary power to produce the design flow.

This approach does have reliability implications that should be considered, and may be deemed only appropriate for pump systems with N+1 redundancy. In particular, note that the pump motor VFD can no longer be put on bypass, or the motor will overheat and trip off. Modern VFD's are robust and reliable, so the lack of bypass capability is becoming less of a concern. Cost concerns must be evaluated on a job by job basis, but frequently a quality VFD is only marginally more costly than a good quality motor starter. Significant flexibility is gained from having additional pump capacity available with a simple motor and drive

replacement (or by turning up the speed, even into the service factor in a temporary, emergency situation).

CP-024: Reduce the Chilled Water Supply Pressure Setpoint

Currently Listed in Profiling Tool? NO

Short Description

Standard control system design calls for the chilled water pump serving the chilled water distribution system to maintain a constant pressure at a given location (usually at the most remote cooling coil), regardless of the current cooling load. The pressure setpoint is selected to ensure that adequate flow is delivered to every coil at the peak load condition, when all the cooling coil valves are wide open.

The setpoint may currently be set higher than necessary. This can occur for several reasons – improper initial balancing; overestimation of peak load; load growth projections were too aggressive; changes were made to the distribution system but it wasn't rebalanced; etc.

A pressure setpoint that is higher than necessary can cause the chilled water pump motor to draw more power than is necessary. Optimizing the setpoint for current conditions can save energy, particularly in systems where the CHW pump is continuously active.

Long Description

Not available.

CP-025: Implement a Chilled Water Pumping Pressure Setpoint Reset

Currently Listed in Profiling Tool? NO

Short Description

Standard control system design calls for the chilled water pump serving the chilled water distribution system to maintain a constant pressure at a given location (usually at the most remote cooling coil), regardless of the current cooling load. The pressure setpoint is set to a value that ensures adequate flow through all the coils under the highest possible load condition.

Under lower load conditions the coils require lower flow rates and the pressure needed to supply the flow is also much lower. With constant pressure control, the CHW control valves at the coils are required to throttle closed to prevent overflowing the coil at low loads. When all the coil control valves are operating at a partially closed throttling position, it is because the chilled water pump is supplying more pressure than is necessary. Rather than maintaining a constant pressure across the chilled water loop, the pressure setpoint can be lowered during periods of low load.

The usual method is to continuously poll the control valves on the loop for their position. The highest valve position is then used as an input to a control loop that resets the chilled water loop pressure setpoint down until the maximum valve position equals 85% - 90% open. This control approach continuously optimizes the setpoint to reduce energy usage and, in some extreme cases, even noise by reducing the throttling required during low load periods. The chilled water pump pressure setpoint is essentially self-balancing and continuously optimized to the system's operating conditions.

This action assumes a variable pumping chilled water system is already implemented, either a variable flow primary-only system or a more typical primary-secondary system with variable secondary loop. The controls cost is sensitive to whether the controls contractor has implemented this type of system before, ie whether or not they already have a "canned" routine available for the control.

This action will yield more savings in those cases where there is significant variability in the cooling load, and/or where the cooling system is oversized for the load.

Long Description

Not available.

CP-026: Optimize the Number of Pumps Running in a Bank of Variable-Speed Pumps

Currently Listed in Profiling Tool? NO

Short Description

Some installations have a bank of variable-speed pumps plumbed in parallel, where it is often the case more than one pump is active at a time.

Given the interaction of the pump flow vs pressure curve, the pump efficiency curve, and the pump operating speed, it is not always obvious what number of operating pumps minimizes the energy use of the pump bank as a whole.

This is best investigated by simply commanding all the pumps on, recording the total pump motor kW, and then taking successive pumps off line and recording the new total kW each time. If the flow demand varies significantly over time, each test should be run for an appropriate amount of time.

Long Description

Not available.

CP-027: Use VFD to Adjust Condenser Water Flow Rate

Currently Listed in Profiling Tool? NO

Short Description

Condenser water pumps are typically constant-speed, one per chiller, and turned on and off in tandem with their associated chiller. This arrangement provides a constant condenser water flow rate through each chiller's condenser.

Condenser water pumps are typically selected to be slightly oversized, and the desired flow rates are achieved by restricting the flow of each pump with a balancing valve. This wastes energy, as the pumps continuously work against the obstruction of the balancing valves.

A more efficient method of controlling the condenser water flow rate is to install a VFD on the condenser water pump motor, completely open or remove the balancing valve, and then manually adjust the pump motor speed to obtain the desired flow.

Long Description

Not available.

CP-028: Increase Cooling Tower Capacity

Currently Listed in Profiling Tool? NO

Short Description

The cooling tower plant is typically sized to handle the peak design load at the 99% wetbulb condition.

Oversizing the cooling tower plant allows it to reject heat to the environment more efficiently at all load and wetbulb conditions, with less fan energy. It will also be able to produce lower CW temperatures, an important consideration in several other water-side actions.

Long Description

Not available.

CP-029: Specify High Efficiency DX Cooling Units

Currently Listed in Profiling Tool? NO

Short Description

The efficiency of a direct expansion (DX) cooling unit is indicated by the unit's Energy Efficiency Ratio (EER). Computer Room Air Conditioners (CRACs) are typically not rated; units designed for commercial applications (office buildings, etc) typically are. The latter can successfully cool a data center as easily as CRAC units. Commercial DX units are available in a range of efficiencies and the higher the EER value for a given unit, the less overall average energy it uses for a given cooling load profile.

High DX unit efficiency can be achieved in several ways.

1. High efficiency components (such as the compressor motor and fan motors), and coils with large surface areas for better heat transfer.

2. Multi-stage compressors. Two or more smaller compressors are staged as needed to more closely match the load on the cooling system.

3. Variable-speed compressors. These allow even closer load matching than units with multi-stage compressors.

Long Description

Not available.

CP-030: Specify a High Efficiency Air-Cooled Chiller

Currently Listed in Profiling Tool? NO

Short Description

Air cooled chillers are generally less efficient than water-cooled chillers. However, there is a range of performance available in air-cooled chillers. If you are about to install an air-cooled chiller, specify the highest efficiency unit that meets your criteria.

Long Description

Not available.

CP-032: Specify a Low Approach Temperature Cooling Tower

Currently Listed in Profiling Tool? NO

Short Description

Every cooling tower can produce a water temperature that approaches, but is never lower than, the ambient wetbulb temperature. The difference between these two temperatures is called the "approach" temperature.

During operation the approach temperature will vary as a result of several factors – the tower water flow rate, the temperature of the water entering the tower, the current wetbulb temperature, the cooling tower fan speed, etc. To allow comparisons between different tower models, manufacturers report the approach temperature at a single, specific operating condition. This nominal condition may not be the same from one manufacturer to the next, so exercise care when making comparisons.

A tower with a smaller approach temperature is more efficient and enjoys the same advantages of an oversized tower. A low approach temperature tower is in fact often merely an oversized tower, but it can also be a different design that produces a lower approach temperature without increasing the physical dimensions of the unit.

A lower approach temperature can improve chiller efficiency. For example, see action CP-036: Decrease the Condenser Water Temperature Setpoint.

Long Description

Not available.

CP-033: Specify an Evaporatively Cooled-Chiller

Currently Listed in Profiling Tool? NO

Short Description

Evaporatively-cooled chillers are essentially water-cooled chillers in a box. The hot gaseous refrigerant is condensed by water flowing over the condenser tubes and evaporating. This ties the condensing temperature to the ambient wetbulb temperature, like a water-cooled chiller. The condenser, water, sump and pump, etc., are all integral to the chiller. Whereas a water-cooled chiller requires a cooling tower, condenser water pump, and field-erected piping, an evaporatively-cooled chiller generally comes as a complete package from the factory. Evaporatively-cooled chillers offer a relatively low cost, low maintenance chiller with a compact footprint. Though not as efficient as water-cooled chillers, evaporatively-cooled chillers are both smaller and quieter than comparable air-cooled reciprocating chillers, and since they are based on evaporative condensing, they require significantly less energy to operate than air-cooled versions.

Long Description

Not available.

CP-034: Replace the DX Cooling System with a Chilled Water Cooling System

Currently Listed in Profiling Tool? NO

Short Description

Chilled water (CHW) based cooling systems consist of one or more chillers that supply CHW to a set of air handling units (AHUs). This type of system is usually more energy efficient than one based on DX cooling units. Both CHW and DX based systems use a vapor compression cycle for cooling, but because the CHW system is centralized, it uses larger, more efficient equipment.

The efficiency of a CHW system depends largely on the type of chiller used. In general order of increasing efficiency (and increasing first cost), the chiller types are:
- Air-cooled
- Evaporatively-cooled
- Water-cooled, with corresponding cooling towers

A CHW based cooling system can result in significant energy savings compared to an existing DX based system. If the existing DX system is being expanded, there are several options:

The option with the largest energy savings and largest first cost would be to install a chiller plant large enough to meet present and future cooling needs, specify CHW AHUs to serve the new loads and also replace all existing DX units with CHW units.

A second option would be to specify the similarly sized chiller plant, specify CHW AHUs instead of DX units to serve all of the new cooling loads and then plan to replace the older DX units with CHW AHUs as the DX units reach the end of their service life.

A third CHW option would be to to simply size a chiller plant to meet all of the new cooling load and specify CHW AHUs instead of DX units to serve these new loads.

Long Description

Not available.

CP-035: Implement a Chilled Water Storage System

Currently Listed in Profiling Tool? NO

Short Description

Adding thermal storage to a chilled water plant allows the chillers to be partially decoupled, or "time-shifted", from the cooling load.

There are several storage technologies available – ice, eutectic salts, and chilled water. All of these can offer the following advantages:

1. The chillers can be turned off during peak electric demand periods, saving significantly on electric cost. (This requires that chiller plant has a maximum cooling capacity that significantly exceeds the cooling load, so that the cooling plant can store enough "coolth" during non-peak hours to allow coasting through the peak hours.)
2. During chiller runtime, the cooling load can be adjusted to have the chiller plant operating at peak efficiency.
3. The chillers will spend a greater percentage of their runtime during night hours, when ambient temperatures are cooler and the cooling plant can reject heat more efficiently.
4. A thermal storage system offers another level of redundancy to the cooling plant.

For a given storage capacity, ice and salt storage tanks are smaller than a chilled water tank. However, the chillers must be able to produce colder temperatures. Your existing chillers may not be capable of this, in which case new chillers would be required. Chillers that produce sub-freezing temperatures are generally less efficient than the standard chilled water variety. It is common for ice and salt storage systems to use more annual energy than an equivalent, non-storage chilled water plant, but they still have the advantage of allowing peak demand charges to be avoided.

A chilled water storage system can offer significant annual energy reduction over an equivalent, non-storage chilled water plant, but it usually requires a very large tank. Siting the tank can pose a challenge. Often the tank is placed underground, for example under a parking lot.

Long Description

Not available.

CP-036: Decrease the Condenser Water Temperature Setpoint

Currently Listed in Profiling Tool? NO

Short Description

Electric chillers tend to offer better performance as the cold condenser water temperature (CCWT) is reduced. Typically, chiller efficiency improves by about 1.5% for every 1 deg F the CCWT is reduced, all other factors held equal.

Reducing the CCWT reduces the temperature difference between the chilled water return (the heat source) and the CCW (the heat sink). The lower 'lift' required from the chiller compressor results in more efficient chiller operation.

The cooling tower fans will draw more power to produce the colder CCWT, but this is typically more than offset by the chiller power reduction, resulting in net savings.

All chiller manufacturers provide a lower acceptable limit on CCWT for their products. This lower limit varies between chiller makes and models. Selecting chillers that can accept lower CCWTs helps maximize the savings attainable with this measure.

Long Description

Not available.

CP-037: Eliminate Low Chilled Water Delta-T Syndrome if Present

Currently Listed in Profiling Tool? NO

Short Description

For a description of this problem and possible remedies, see the ASHRAE Symposium Paper "Degrading Chilled Water Plant Delta-T: Causes and Mitigation", June 2002, by Steven T. Taylor. It is available on line at http://www.taylor-engineering.com/publications/articles.shtml.

Long Description

Not available.

CP-038: Implement Variable Condenser Water Flow

Currently Listed in Profiling Tool? NO

Short Description

The standard operating procedure for water-cooled chillers is to have a constant condenser water (CW) flow and a constant temperature of water entering the condenser, also referred to as the cold condenser water temperature (CCWT). Reducing the CW flow will save CW pump energy, all else held equal.

However, reducing the CW flow increases the chiller's condensing temperature, causing it to run less efficiently. If low CCWT's can be produced by the cooling tower then the chiller's condensing temperature can be reduced again, restoring efficient chiller operation and retaining the benefit of reduced CW pump energy. This must be compared against the increased cooling tower fan energy needed to produce the lower CCWT's to determine if there are net energy savings.

Long Description

The standard operating procedure for water-cooled chillers is to have a constant condenser water (CW) flow and a constant temperature of water entering the condenser, also referred to as the cold condenser water temperature (CCWT). Reducing the CW flow will save CW pump energy, all else held equal.

First determine if a reduced CW flow is viable. It usually is, for the following reasons:

- ASHRAE recommends a minimum condenser water flow velocity of 3.3 fps to maintain turbulent velocity and prevent formation of deposits in the condenser. This value is well below the 6 to 8 fps found in most modern chiller designs.
- The condenser water velocity is only a small factor in the overall heat transfer.   The main factor controlling refrigerant condensation is the condenser surface area; i.e., the number and size of the condenser tubes.
- Tests by major chiller manufacturers demonstrate that many chillers can operate at low CW flow velocities and high CW delta-T's without effecting the stable operation of the chiller.

Second, will reducing the CW flow help optimize the efficiency of the entire chilled water plant? The plant is a series of linked loops. Reducing the energy requirement of one loop may merely shift the energy demand to another loop, for zero or even negative net savings. The proper approach is to optimize all the loops together in order to achieve the best plant efficiency.

Reducing CW flow will save CW pump energy, but it tends to increase chiller lift, which in turn decreases chiller efficiency. The chiller is typically the greatest energy-using component in the plant. If the CW flow rate and/or CW dP are too high, the CW pump energy will be disproportionately large. Decreasing the CW flow rate will provide CW pump savings that may or may not outweigh the increased chiller energy use.

We want to keep the cold condenser water (CCWT) as low as possible in order to keep the chiller lift low, in order to maintain high chiller efficiency. Maximizing the CW flow provides the lowest CCWT, everything else held equal.

1. Start with the maximum CW flow.
2. Set the CCWT setpoint to a low value. The actual CCWT will usually be well above the setpoint, as it is limited by the ambient wetbulb temperature. The cooling tower fan will run at 100% during these times.
3. If the chiller lift reaches its minimum allowed value and the CCWT is still dropping, automatically decrease the CW flow to maintain the minimum lift.

Note the following:

- Reducing the CW flow tends to improve cooling tower performance.
- We can not reduce the CW flow below the minimum flow needed by the cooling towers.
- Reducing the CCWT setpoint will increase the CT fan energy, which will reduce and perhaps even eliminate the CW pump savings.

CP-039: Increase the Chilled Water Supply Temperature Setpoint

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

The chilled water supply temperature (CHWST) setpoint selected during the design of a cooling system has wide-ranging implications.

- It affects the operating efficiency of the chiller. As a rule of thumb, chiller efficiency improves by 1% for every 1 deg F the evaporator leaving water temperature is raised, all other factors held equal. This holds only to a point; if the chiller lift is reduced too much, it will no longer operate. The room for adjustment varies among chiller make/models, and depends largely on the chiller loading.

- For new construction, it affects the resulting size and efficiency of the hydronic system components (pumps, piping, valves, and coils). An elevated CHWST implies a smaller water-side delta-T, and therefore a greater chilled water flow rate to handle a given load. This means increased pumping energy for a given system pressure drop, and/or increased material cost for increased pipe and valve sizes. A decreased CHW delta-T can yield more efficient heat transfer at the cooling coils, if the size of the coils is increased appropriately.

- A lower CHWST causes greater air dehumidification at the cooling coil via condensation. The dehumidification may be a desired feature of the design, or it may occur unnecessarily, by default. In either case, this latent cooling represents a load on the chiller, and therefore an energy expense.

A typical CHWST setpoint for facilities with normal space humidity control requirements is about 45F. This setpoint is typical even in facilities that have relaxed or even no humidity requirements, due to the persistence of design "rules of thumb".

For energy savings due to changes in the CHWST in an existing facility, there are two basic scenarios to consider.

1. The CHWST setpoint is raised, but the CHWRT must remain roughly the same as before (CHW delta-T decreases).

This is the more common scenario. The space or process being served must be maintained at a certain temperature, which limits the maximum possible CHWRT. If the CHWRT is

already near its upper practical limit, the only way to keep it there when the CHWST increases is to increase the CHW flow rate.

For this action to be viable, there must not be an existing zone that is ever maxed out (CHW valve at full open). If there is such a zone, permanently raising the CHWST will cause this zone to overheat. If the zone maxes out intermittently, an automatic CHWST reset may still be a viable option.

If the CHWST setpoint can be permanently raised in an existing facility, while still meeting all humidity and load requirements, it will have the effect of saving chiller energy, and increasing pump energy. The chiller is typically the largest energy-using component in a chilled water plant, so chances are the net energy savings will be positive, but this needs to be checked on case-by-case basis. The savings tend to be proportionally higher in smaller plants where the hydronic system pressure drop is lower. In larger plants, it is possible that the increased pumping energy will outweigh the chiller savings. In fact, in larger plants, it is possible that energy savings can be obtained by *reducing* the CHWST setpoint below the design value in mild weather.

If water-side economizing is implemented, it will improve the energy savings picture.

A higher CHWST has the benefit of reducing unintentional dehumidification on the cooling coil.

A decreased CHW delta-T can lead to the undesirable "Low Delta-T Syndrome". See action CP-037: Eliminate Low Chilled Water Delta-T Syndrome if Present.

2. The CHWST is raised, and the CHWRT can be allowed to rise by some amount (CHW delta-T decreases less than in Scenario 1, or even remains the same as before).

This is the less common scenario. In this case, the original CHWST setpoint is unnecessarily low for the load being served. All of the CHW control valves are closed to some degree, limiting the flow. The CHWRT is significantly lower than required to maintain the desired space or process temperature in all zones.

If the CHWRT can be allowed to rise in addition to raising the CHWST, then the CHW flow rate does not have to increase as much, or even at all. This limits the increase in pump energy, while still allowing more efficient chiller operation.

An increased CHWRT in turn improves the viability of water-side economizing, as there will be more hours in the year where the cooling tower plant can effectively pre-cool the CHW return flow.

CP-040: Reduce the Condenser Water Flow Rate

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

The standard operating procedure for water-cooled chillers is to have a constant condenser water (CW) flow and a constant temperature of water entering the condenser, also referred to as cold condenser water temperature (CCWT). Reducing the CW flow will save CW pump energy, all else held equal.

First determine if a reduced CW flow is viable. It usually is, for the following reasons:

- ASHRAE recommends a minimum condenser water flow velocity of 3.3 fps to maintain turbulent velocity and prevent formation of deposits in the condenser. This value is well below the 6 to 8 fps found in most modern chiller designs.
- The condenser water velocity is only a small factor in the overall heat transfer.   The main factor controlling refrigerant condensation is the condenser surface area; i.e., the number and size of the condenser tubes.
- Tests by major chiller manufacturers demonstrate that many chillers can operate at low CW flow velocities and high CW delta-T's without effecting the stable operation of the chiller.

Second, will reducing the CW flow help optimize the efficiency of the entire chilled water plant? The plant is a series of linked loops. Reducing the energy requirement of one loop may merely shift the energy demand to another loop, for zero or even negative net savings. The proper approach is to optimize all the loops together in order to achieve the best plant efficiency.

Reducing CW flow will save CW pump energy, but it tends to increase chiller lift, which in turn decreases chiller efficiency. The chiller is typically the greatest energy-using component in the plant. If the CW flow rate and/or CW dP are too high, the CW pump energy will be disproportionately large. Decreasing the CW flow rate will provide CW pump savings that may or may not outweigh the increased chiller energy use.

We want to keep the cold condenser water (CCWT) as low as possible in order to keep the chiller lift low, in order to maintain high chiller efficiency. Maximizing the CW flow provides the lowest CCWT, everything else held equal.

1. Start with the maximum CW flow.
2. Lower the CCWT setpoint until the chiller lift is as low as permitted.

Up to this point, we have not yet reduced the CW flow. If there are a significant number of hours per year that a colder CCWT can be achieved, then lower the CCWT setpoint further and manually reduce the CW flow to maintain the minimum lift. Note the following:

- Reducing the CW flow tends to improve cooling tower performance.
- We can not reduce the CW flow below the minimum flow needed by the cooling towers.
- Reducing the CCWT setpoint will increase the CT fan energy, which will reduce and perhaps even eliminate the CW pump savings.

IT Power Distribution Chain

ED-001: Reconfigure the UPS Topology for More Efficient Operation

Currently Listed in Profiling Tool? YES

Short Description

UPS technology continues to evolve. If the existing UPS is scheduled for replacement, be sure to specify a high-efficiency UPS topology. If the existing UPS more than 10 years old it may be cost-effective to replace it with a new system right away.

Long Description

Not available.

ED-002: Install a Modular UPS

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

ED-003: Shut Down UPS Modules and PDUs when Redundancy Level is High Enough

Currently Listed in Profiling Tool? YES

Short Description

In some facilities, the array of UPS modules and/or PDUs has more than enough capacity to serve the load. It may be possible to shut down some modules and still retain the required level of redundancy. This will allow the remaining units to operate at a higher load factor, which usually translates to higher efficiency.

Long Description

Not available.

ED-004: Use UPS without Input Filters

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

ED-005: Right-Size the Datacenter Power Equipment

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

ED-006: Use High Efficiency MV and LV Transformers

Currently Listed in Profiling Tool? YES

Short Description

Medium Voltage (MV) and Low Voltage (LV) transformers are available in a range of efficiencies. Specify high efficiency transformers when any existing units are scheduled for replacement. If inspection reveals that any existing transformers are operating with particularly poor efficiency, analyze the cost-effectiveness of replacing them with high efficiency, appropriately-sized units immediately.

Long Description

Not available.

ED-007: Reduce the Number of Transformers Upstream and Downstream of the UPS

Currently Listed in Profiling Tool? NO

Short Description

Energy is always lost at each active transformer. Minimizing the number of transformers in a power distribution system will help minimize energy loss.

Long Description

Not available.

ED-008: Locate Transformers Outside the Datacenter

Currently Listed in Profiling Tool? NO

Short Description

If an active transformer is located in an air-conditioned space, the waste heat it generates becomes an additional load on the cooling system. Moving the heat source to the outdoors reduces the energy demand of the cooling system.

Long Description

Not available.

ED-009: Maintain Total Harmonic Distortion at Main Feeder Panel at Less Than 8%

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

ED-010: Maintain Power Factor at Main Feeder Panel at 0.90 or Higher

Currently Listed in Profiling Tool? NO

Short Description

Not available.

Long Description

Not available.

ED-011: Retrofit IT Equipment to Maintain High Power Factor and Low Total Harmonic Distortion

Currently Listed in Profiling Tool? NO

Short Description

Low power factor (PF) and high total harmonic distortion (THD) cause the power distribution system to operate inefficiently. Correcting the PF and THD saves energy.

Long Description

Not available.

ED-012: Use 480V instead of 208V Static Switches

Currently Listed in Profiling Tool? NO

Short Description

A higher voltage equates to a lower current, all else held equal. Less current implies less heat generation in the circuit, which means less energy loss.

Long Description

Not available.

ED-013: Use Alternate Power Source to Warm Generator Blocks

Currently Listed in Profiling Tool? YES

Short Description

In many areas of the country the engine blocks of the emergency backup generators are kept warm with electric resistance heat to help promote rapid, reliable starting. If another source of heat is available, preferably waste heat, the energy use of the electric heater can be saved.

Long Description

Not available.

ED-014: Use Chilled Water Return to Warm Generator Blocks

Currently Listed in Profiling Tool? NO

Short Description

In many areas of the country the engine blocks of the emergency backup generators are kept warm with electric resistance heat to help promote rapid, reliable starting. If your facility has a chilled water (CHW) plant, consider routing the return CHW to the generators and using it for block heating before returning it to the chillers. This has the additional benefit of pre-cooling the return CHW, which reduces the load on the chiller plant.

Long Description

Not available.

ED-015: Apply Thermostat Control to Generator Block Heaters

Currently Listed in Profiling Tool? YES

Short Description

In many areas of the country the engine blocks of the emergency backup generators are kept warm with electric resistance heat to help promote rapid, reliable starting. Often these heaters are very simple devices that provide continuous heat without any thermostat control. Adding a thermostat will help minimize the electric use of the heater.

Long Description

Not available.

ED-016: Install Power Analyzer Meters at Critical Components

Currently Listed in Profiling Tool? NO

Short Description

Efficient performance of the electric distribution system can not be consistently maintained without having a means of monitoring what it is doing. Make sure you have the ability to see input power, output power, power factor, and total harmonic distortion at each major power conversion step in the chain.

Long Description

Not available.

ED-017: Specify High Efficiency Power Supplies

Currently Listed in Profiling Tool? NO

Short Description

This action addresses the final step in the chain of power conversions that occurs between the main power feed to the data center and the end-point of the IT equipment. It can be an effective strategy for reducing load in existing servers that have hot-swappable power supply capability, but most servers are not so equipped. This action is usually most effective for new equipment. A customer has more clout to specify efficient power supplies when placing a large order with a supplier.

Long Description

Not available.

ED-018: Eliminate Redundant Power Supplies

Currently Listed in Profiling Tool? NO

Short Description

Some pieces of IT equipment are equipped with dual power supplies. The power supplies run in parallel at low load factor, which is inefficient. If this is not absolutely necessary, consider disconnecting one of the power supplies.

Long Description

Not available.

ED-019: Eliminate UPS Systems

Currently Listed in Profiling Tool? NO

Short Description

If an uninterruptible power supply (UPS) is not needed for a particular operation, consider eliminating it. This applies especially to UPS systems connected in series, such as a main UPS serving a rack-mounted non-switching UPS. If the main UPS works as designed, the rack UPS will never experience a loss of input power. Yet the rack UPS will continuously lose energy.

Long Description

Not available.

ED-020: Bypass the UPS

Currently Listed in Profiling Tool? NO

Short Description

If an uninterruptible power supply (UPS) is not needed for current operations, consider bypassing it. UPS systems are less than 100% effiicient. They are usually located in an air-conditioned space, and the waste heat they generate creates an additional load on the cooling system.

Long Description

Not available.

ED-021: Supply DC Voltage to IT Rack

Currently Listed in Profiling Tool? NO

Short Description

In a typical data center, AC power is first delivered to the uninterruptible power supply (UPS). It is converted to low-voltage DC and fed to the battery bank. The power is taken from the batteries and converted back to AC, then distributed to the power distribution units (PDUs) on the data center floor. There may be a voltage step-down at the PDUs before the AC power arrives at the racks. The IT equipment accepts the AC power and converts it to DC to run the circuitry. Each of these conversions is less than 100% efficient, so some energy is lost in each step. A more energy-efficient arrangement is to maintain the power as DC all the way from the UPS to IT equipment.

Long Description

Not available.

ED-022: Perform an Infra-Red Test

Currently Listed in Profiling Tool? NO

Short Description

Infra-red scans of power conversion equipment will reveal hot spots. Overly warm equipment is undersized for the load it is serving and is operating inefficiently. Reduce the load or upsize the equipment.

Long Description

Not available.

ED-023: Perform Routine Maintenance and Testing of the Electric Distribution System

Currently Listed in Profiling Tool? NO

Short Description

The entire electric distribution system should be maintained on a regular basis and monitored for performance. Doing so will minimize the energy losses associated with the system.

Long Description

Not available.

ED-024: Maintain Balanced PDU Loads

Currently Listed in Profiling Tool? YES

Short Description

Unbalanced electric loads in 3-phase systems cause higher current flows between the legs of the transformer, resulting in waste heat and less efficient transformer operation. Redistribute the loads to improve the balance. If the transformer is in an air-conditioned space, the reduced waste heat will also reduce the load on the cooling system.

Long Description

Not available.

ED-025: Change UPS DC Capacitors

Currently Listed in Profiling Tool? YES

Short Description

The DC capacitors in typical UPS systems tend to lose effectiveness over time. This can result in the inverter failing to operate under load, and increased ripple current in the batteries. Not only does this result in less efficient operation, it becomes a safety issue as well. The DC capacitors usually have the same design lifetime as the batteries; approximately 5 years. The capacitors should be checked regularly.

Long Description

Not available.

ED-026: Look for the Simple Energy Saving Actions First

Currently Listed in Profiling Tool? NO

Short Description

A first-pass assessment of the power-consuming systems will often reveal simple energy-saving actions that can be performed with relatively little effort and expense.

Long Description

Not available.

ED-027: Account for Operating Cost As Well As First Cost

Currently Listed in Profiling Tool? NO

Short Description

When evaluating a proposed energy efficiency action, perform a life-cycle cost analysis of the alternatives (the alternative may simply be the "do nothing" case). This will reveal the true relative value of the different options.

Long Description

Not available.

Lighting

LT-001: Install Energy-Efficient Lamps and Ballasts

Currently Listed in Profiling Tool? YES

Short Description

New lighting technologies can save a significant percentage of the energy use of existing, older lighting systems.

Long Description

Not available.

LT-002: Install Occupancy Sensors to Control Lights

Currently Listed in Profiling Tool? YES

Short Description

Many data centers are unoccupied for long periods of time. Controlling the data center lights with occupancy sensors directly saves lighting energy. This also reduces the heat load, saving cooling system energy.

Long Description

Not available.

On-Site Power Generation