A White Paper from the Experts in Business-Critical Continuity™

Data Center Cooling Assessments – What They Can Do for You

EMERSON™ Network Power

Executive Summary

Managing data centers and IT facilities is becoming increasingly complicated as the push to "Go Green" is being felt worldwide. IT managers are faced with the challenge of consolidating power through virtualization, blade servers, more efficient power supplies and a number of other methods. The bottom line is this – reduce power, carbon emissions, and the utility bill while maintaining performance.

Fortunately, there are non-IT energy saving opportunities that can help ease the strain of the power reduction demands placed by company executives. Beyond the improvements that can be achieved on the IT equipment side, significant savings can be realized from the cooling side as well. Optimizing airflow and cooling distribution throughout the data center can have a significant impact including better isolation between the supply and exhaust air, longer server life and a reduction in the utility bill.

Cooling assessments provide IT managers with a customized solution that will often provide no-cost recommendations that, once implemented, will result in immediate improvements in efficiency. In many scenarios, simply relocating equipment in the data center or cleaning out unneeded clutter can improve efficiency. Additionally, as the average heat density in data centers is increasing, simply aligning racks in hot and cold aisles is not always adequate.

More advanced strategies involving cold aisle containment or extreme density (XD) cooling equipment may be deployed to ensure proper air conditions for the rack mounted servers. Cooling assessments can also expose the "hidden costs" of running a data center which arise from problems such as a poor vapor barrier allowing unconditioned air to mix in the data center, poor airflow resulting in short circuiting of air either at the server or CRAC (Computer Room Air Conditioner), and low return air temperatures to the CRAC units due to hot and cold air mixing.

The Cooling Assessment Walk-Through

Specially trained individuals perform a detailed walk-through of the data center. All vital information is gathered regarding temperature, airflow and power consumption. Existing equipment loads are documented and projected future loads are acquired from the IT managers.

Electrical and performance readings are taken at each CRAC unit to determine the actual sensible cooling capacity available in the data center. A visual inspection of the CRAC units as well as the condensers (in DX systems) is performed to ensure everything is in working order.

At times, simply adjusting belts or oil levels can make a big difference in cooling performance. In addition to the site measurements, the layout of the entire site is modeled in 3D software. This creates the framework around which cooling performance and availability will be determined.

Modeling includes everything up to under-floor obstructions and rack population, where each server is placed in virtual racks exactly as they appear in the data center. Any problem areas such as a poor vapor barrier or a congested under floor are documented and recommendations are compiled to both align the data center with the industry's best practices as well as incorporate any of the newest technologies available that fit the application.

Rack Temperatures

Air temperatures at each rack inlet are a very effective means of locating "hot spots" within the data center. A "hot spot" is defined as any inlet air temperature above the recommended temperature of 80.6 specified in the 2008 'ASHRAE Environmental Guidelines for Datacom Equipment' publication. Despite the increased efficiency of running warmer data centers, there are advantages to maintaining inlet temperatures with ASHRAE's previously recommended range of 68-77 degrees Fahrenheit – in the event of a cooling outage, a longer response time is available before servers may overheat. Also, considerations must be made when the servers being cooled utilize variable speed fans.

While higher temperatures increase the efficiency of the cooling units, the overall efficiency of the data center could go down if all of the server fans ramp up to higher speeds. The assessment includes three temperature readings at every rack in order to provide a comprehensive spatial sampling of the data center. All of these rack temperatures are documented in the report. Once a "hot spot" is located, further investigation begins to determine the cause from a number of potential sources. Another method of studying inlet temperatures as well as airflow distribution is through thermal imaging. These specialized photographs use infrared technology to provide a temperature plane across the face of a rack row. An example of this can be seen below. Note how the supply air keeps the bottom half of the racks very cool while the upper half experiences gradually increasing temperatures. The temperature readings taken during the assessment provide a snapshot of the data center's health.

One important thing to note is that an assessment provides just that – a snapshot. It is always recommended to continuously monitor rack inlet air temperatures, which will allow data center managers to be proactive instead of reactive to rising air and equipment temperatures.

With the detailed analysis of an assessment, special attention can be given to the specific racks experiencing elevated temperatures in order to prevent any server failures due to overheating. There are a number of products that can provide this real-time monitoring including USB data loggers that will send an email or text message in the event of a hot spot.

Supply Air Measurements

A specially designed air hood is used to take airflow readings at each perforated floor tile (or ceiling supply grille in the case of an up-flow ducted system) in the data center. These measurements provide an indication of how air is being distributed around the data center.

The airflow measurements are compared to the localized heat loads in order to ensure there is sufficient cooling for the servers. When any discrepancy arises, the source of the problem can be investigated to see whether it is in the under-floor or the arrangement of equipment and perforated tiles on the raised floor.

From this point, changes can be made to reallocate cold supply air to specifically where it is needed. Attention is also given to any inefficient use of supply air including oversized cable cutouts, miscellaneous or unintentional holes in the raised floor and leakage through the tiles. Airflow through cable cutouts is measured by acquiring airstream velocity and penetration face area.

This way a comparison can be made between total air supplied and air supplied to perforated floor tiles. Many IT managers don't realize just how much supply air is actually leaking out through cable cutouts. By eliminating these issues, better under floor air pressures and supply air availability can be achieved with little to no cost.

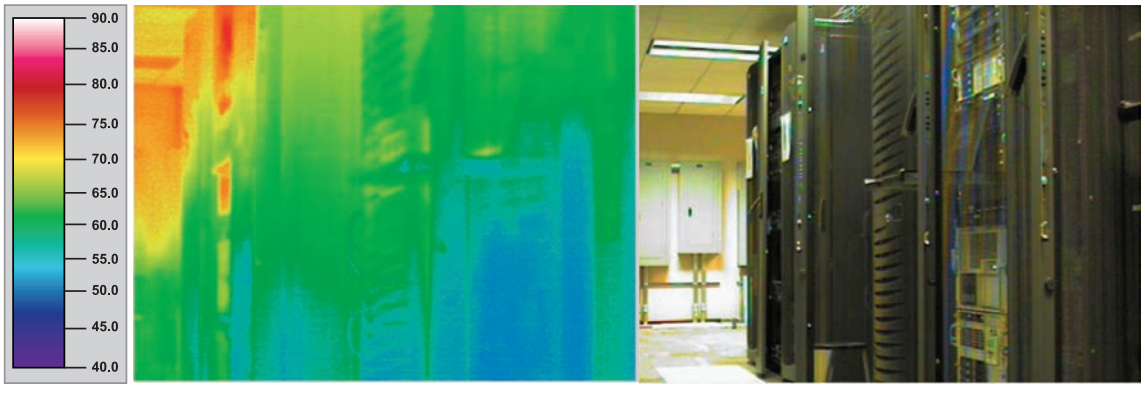

Figure 1: Thermal Imaging of Rack Inlets

CRAC Unit Performance

Several factors affect the performance of CRAC units. Three parameters are measured at every CRAC unit in the data center. The first two are temperature and humidity. Return air conditions must be optimized in order to prevent wasting power and unnecessarily increasing the utility bill.

Return air temperatures should be as high as possible but within safe conditions as to not cause high head pressures (for DX systems) or other negative impacts on the cooling units. Ideally, the data center will be sealed from any outside or building air influence. This will minimize any unwanted levels of humidity from being introduced into the room. Any fluctuations in humidity outside of the set point +/- the dead band require the CRAC units to use power to offset the influence.

This will result in a reduction in sensible capacity when humidity climbs or additional required power to humidify a dry data center. Finally, airflow measurements are taken using two methods in order to compare values and get the most accurate results possible. Voltage and current readings are used in conjunction with an rpm measurement of the motor shaft. This information is used to determine an airflow value from a blower curve. Additionally, airflow readings can be taken at the return air grille similar to the method used at the perforated floor tiles.

With these measurements, each CRAC unit can be individually analyzed and opportunities to improve room air conditions can be identified. Improvements are often achieved by relocating CRAC units, changing set points, turning units off or a combination of these.

Detailed Under-Floor Modeling

Airflow and pressure distribution in the under-floor (in raised floor plenum applications) is a critical aspect of running an efficient data center. Large under-floor obstructions can restrict airflow, cause undesired areas of low pressure or even completely channel supply air away from critical areas of the data center.

The intent of this part of the assessment is to document obstructions in order to understand how the supply air from the CRAC units is affected. Special attention is given to the location of obstructions near CRAC unit supply grilles, perforated floor tiles and any other areas where air flow is critical. This information is used in conjunction with rack temperatures and airflow measurements in order to get to the root cause of the problems found in the data center.

Often times, data center managers are unaware of the extent to which abandoned

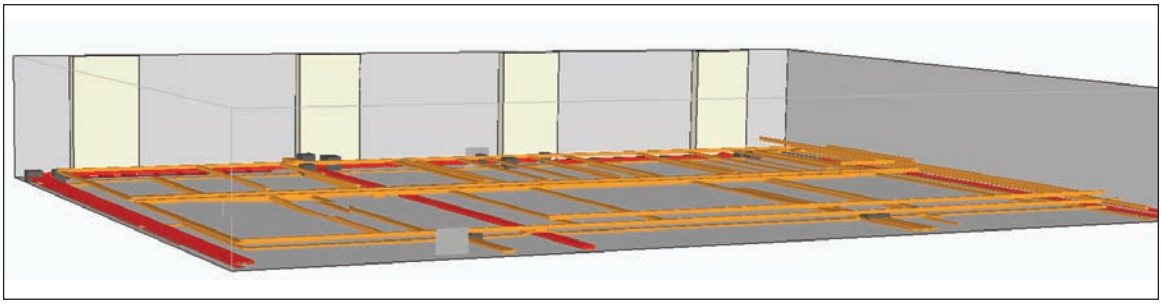

Figure 2. Under-Floor Obstructions.

cabling is building up in the under-floor of their data center. As time goes on, this can turn into a critical problem. A cooling assessment will help bring these problems "to the surface" and pinpoint particularly problematic areas.

Vapor Barrier Analysis

A poor vapor barrier can have a very significant impact on the data center when building air or outside air conditions vary from the temperature and humidity set points of the equipment space.

Part of the assessment process includes taking an in-depth look at all penetrations in the data center perimeter with regards to size, differential pressure and air conditions of outside space. This information is used to evaluate the "effective" room conditions based on an enthalpy analysis.

From this a cooling and humidifying/ dehumidifying load can be calculated and converted to a utility cost for the data center. Beyond increasing the cost of running a data center, a poor vapor barrier can also lead to other problems. If the space becomes too humid, moisture can condense on the equipment and cause damage to sensitive electronics. When humidity drops too low, electro-static discharge becomes a risk and can cause server failure. Both of these scenarios can result in significant unexpected costs and business disruption in the data center. A cooling assessment will often identify these issues before they become financial problems for the data center.

Rack Population

It is beneficial for all data center managers to have a record of their resources. Part of the assessment process involves recording server location, manufacturer and model number in each rack. This allows both the data center operators to locate specific servers or applications quickly as well as the assessment team to pinpoint areas of concentrated equipment. Besides having an accurate list of the equipment, the data center is also more accurately modeled. Each server placed in the virtual racks of the model has their own specified heat load and fan characteristics. Attention is also given to the use of blanking plates in the racks. Blanking plates are essential in promoting effective airflow throughout the data center.

Technological Benefits of Data Center Assessments

One great feature that accompanies a data center assessment is a 3D model of the data center that uses CFD (computational fluid dynamics) software to analyze thermal, airflow and pressure characteristics through the room. This provides an "As-Is" model that can be calibrated to match actual conditions in the data center. The results of the CFD model illustrate how airflow is accomplished throughout the under floor, through servers and through CRAC Units. It also helps locate potential thermal and airflow problems throughout the data center that may have not been spotted while on site. This is accomplished by using temperature and pressure planes throughout the room as well as streamline plots.

From this information, recommendations can be made to eliminate hot spots, improve efficiency and lower operating costs. Not only can recommendations be determined from the CFD analysis for existing data centers, but reliable information can be achieved for expansion plans by modeling future data center space. Another benefit of obtaining a cooling assessment is gaining access to

knowledge of the most advanced cooling strategies for critical equipment floor space. As data centers are seeing heat densities creep up higher and higher, more efficient cooling methods are required to keep up. By having an assessment, the best and most advanced cooling methods available can be compared and designed to best suit the demands and resources of each data center.

Financial Benefits of Data Center Assessments

Improvements made from the recommendations of cooling assessments produce significant increases in efficiency and will ultimately reduce the utility bill. This increased efficiency can come in the form of higher cooling capacities for the CRAC units on site or less cooling needed due to improved airflow. The improvements can allow additional IT equipment to be deployed with essentially no increase in cooling costs or provide the option of turning CRAC units off. However, many times there is the opportunity for more savings than the utility bill alone. In some cases, companies are paying penalty fees for using more power than allowed by state regulations.

Improvements in data center efficiency can bring power usage down to non-penalized levels and eliminate these extra fees. Additionally, many utility companies offer rebates for customers who can keep power usage below specified values, show an improvement in efficiency, or obtain a certain efficiency rating. These programs vary by state and should be verified with your local utility company.

Conclusion

The aim of data center cooling assessments is to convert today's data centers into eco-friendly sites that are scalable and operationally cost efficient with maximum availability. All on-site measurements are used to optimize equipment layout and airflow patterns throughout the data center. With the CFD technology available today, the "snapshot" acquired from an onsite study can be combined with thermal computational analysis of existing as well as future floor plans. This creates the means to confidently move forward in the design of the data center with maximized utilization of space, power and cooling capacity and the most efficient cooling scenario possible.

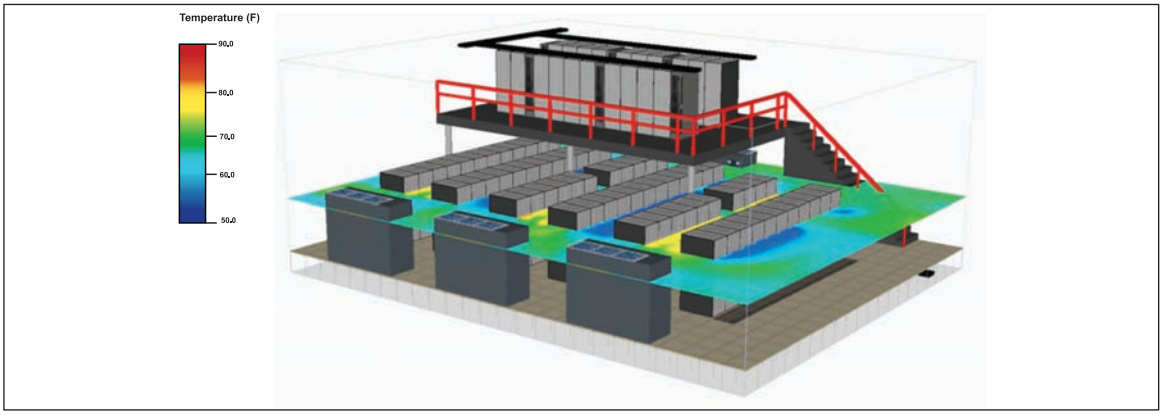

Figure 3. Data Center Temperature Plane

Emerson Network Power
1050 Dearborn Drive
P.O. Box 29186
Columbus, Ohio 43229
800.877.9222 (U.S. & Canada Only)
614.888.0246 (Outside U.S.)
Fax: 614.841.6022

EmersonNetworkPower.com
Liebert.com

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