BELDEN
SENDING ALL THE RIGHT SIGNALS®

Innovative Solutions to Overcome the Challenges of Heat Management in the Data Center

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Data Center Cooling Challenges

According to the EPA's Report to Congress on Server and Data Center Energy Efficiency, if current trends continue, the demand for power by data centers will require an additional 10 power plants on the North American power grid by 2011. In order to minimize the impact of this phenomenon, data centers must be increasingly efficient in their use of power.

Aside from this social aspect, a major challenge faced by data center managers today is ensuring that cooling systems do not fail, but that they continue in an uninterrupted way to cool the sensitive electronic components in IT equipment enclosures. However, achieving this goal can be needlessly expensive. According to recent studies, it is estimated that cooling accounts for up to 40 percent of a data center's total energy load. What's more, the cooling process itself is accompanied by excessive energy waste, which is largely due to an oversupply of cold air to the data center by computer room air conditioner (CRAC) units that are attempting to compensate for inefficiencies in the cooling process.

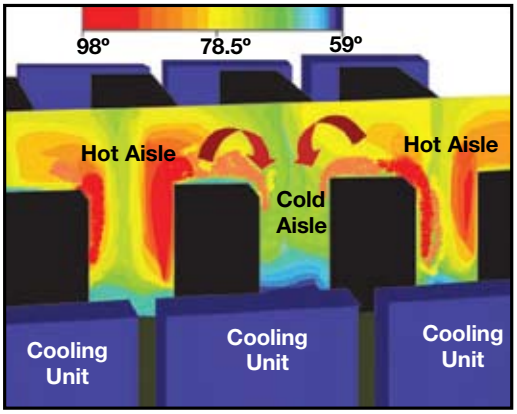
For example, a substantial amount of the cold air produced by the CRAC units does not follow a planned path to the IT load as it should, but instead bypasses IT equipment and returns to the air conditioner intake via misplaced perforated floor tiles and unsealed cable openings. As a result, a substantial amount of the cool air from the CRACs never makes it to the IT load. In addition, some of the hot air being exhausted to the rear of the enclosure by server fans leaks to the front of the servers instead of going back to the CRAC return. In this case, hot exhaust air mixes with cold room air before being drawn back into the enclosure, resulting in hot spots and reduced IT equipment performance.

According to Gartner, implementing cold or hot aisle containment in the data center dramatically improves separation of cold supply air and hot exhaust air and will be, for most users, the single largest payback of any data center best practice.

Additionally, a study conducted by the Uptime Institute on 19 large computer rooms found that, on average, the amount of cold air supplied to a data center room is 2.6 times the amount of cold air actually consumed by the IT load. The cooling system is oversupplying the room with cold air to overcome both bypass leakage and the effects of hot/cold mixing. The oversupply leads to significant energy waste and dollar expenditure.

What's more, the Uptime study found that even though the rooms are oversupplied with cold air by almost a factor of 3, an average of 10% of enclosures still experience air intake temperatures exceeding ASHRAE maximum reliability guidelines. Rooms having the most excess cooling air actually experience the worst hot spots.

Finally, there is a highly effective solution. The Belden Adaptive Heat Containment (AEHC) system offers a unique design to ensure that the entire data center space is normalized with the appropriate volume of cool air required by the IT equipment. Hot spots are also eliminated and operating costs reduced.



Containment of the hot aisle is a complex problem, even in computer rooms oversupplied with cold air. Belden's AEHC eliminates hot spot issues by providing for a defined hot air return path to the CRAC unit.

Solving Cooling System Challenges

Belden's Adaptive Enclosure Heat Containment (AEHC) system offers a solution for cooling data center enclosures in a much more efficient and cost-effective way than was previously possible.

Because of its innovative heat containment design, the Belden heat management system overcomes all of the aforementioned problems. Since it completely separates the hot and cold side of operations, the room will be normalized with cool air which never mixes with the exhaust heat from the enclosure. The bypass problem is also eliminated as the CRAC unit's intake pulls hot air from the drop ceiling. As a result, there is no longer a need to oversupply cold air to the room at several times the amount actually needed. The physical position of the CRAC unit and its proximity to the enclosures are no longer a concern, a fact which greatly simplifies the problem of data center infrastructure design.

When designing a totally new data center, users of the Belden AEHC system can now install larger and fewer CRAC units, instead of relying on many smaller units that are less efficient. And when retrofitting an existing room with the Belden AEHC system, they can use the same cooling equipment that is currently installed. In either scenario, Belden's advanced management software can provide better control of the IT environment by providing a real time assessment of enclosure cooling load or demand.

Deploy Greater Load

In addition, Belden AEHC system users gain the opportunity to deploy even more load in the same room, a great efficiency benefit in today's economy. If there is unoccupied space left in enclosures that are not housing more devices simply because the cooling system is already at full capacity, the heat containment system can be retrofitted on those enclosures having the highest heat loads to gain more functionality in the room — and the ability to host more IT equipment.

Increase Operational Efficiency

The Belden AEHC system will increase the temperature differential between the inlet and outlet temperatures of the CRAC unit, giving it much greater operational efficiency and providing an important savings in energy consumption. Not only does the system reduce the amount of cold air needed by the IT room (since there is no mixing of hot and cold air within the room) but it also becomes possible to raise the temperature of the cooling air supplied to enclosures closer to the ASHRAE recommended upper limit. The cold/hot air paths are fully separated by the Belden system so the CRAC can supply less air to the room at a higher temperature and still assure better cooling with no hot spots.

Fully Autonomous and Network-ready

Embedded software allows each AEHC unit to be fully autonomous. The AEHC controllers have their own IP address, which enables network connectivity. The AEHC then allows for real-time monitoring of the heat load, temperature and alarm conditions for each IT enclosure.

A Closer Look at the Belden AEHC System

Based on a pressure reading from a sensor inside the enclosure plenum, the rotational speed of the fans in the two cartridges mounted atop the enclosure is modulated so that they pull out exactly the correct amount of air from the enclosure and send it back to the air conditioner return via a ceiling plenum.

If the cooling load in the IT equipment rises causing the pressure to increase in the enclosure plenum, the AEHC system fan speed will increase, and the fans will exhaust more air into the ceiling plenum. If the load drops, fan speed will decrease accordingly. The Belden system does not focus on the precise temperature within the enclosure, but rather on achieving a balance between the amount

Dashboard

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of air consumed by the IT load and the air returned to the CRAC unit via the ceiling plenum. The system does not permit mixing of hot and cold air in the room so sufficient cold air will always be available for intake into the enclosure to cool the active load.

Belden's AEHC system utilizes pressure sensing to dynamically adjust for speed, resulting in perfect balance between intake and exhaust air volume.

Intelligent hot swappable fan cartridges allow for ease of maintenance and system scalability.

Belden's AEHC system features external displays for quick and easy assessment of system load and alarm conditions.

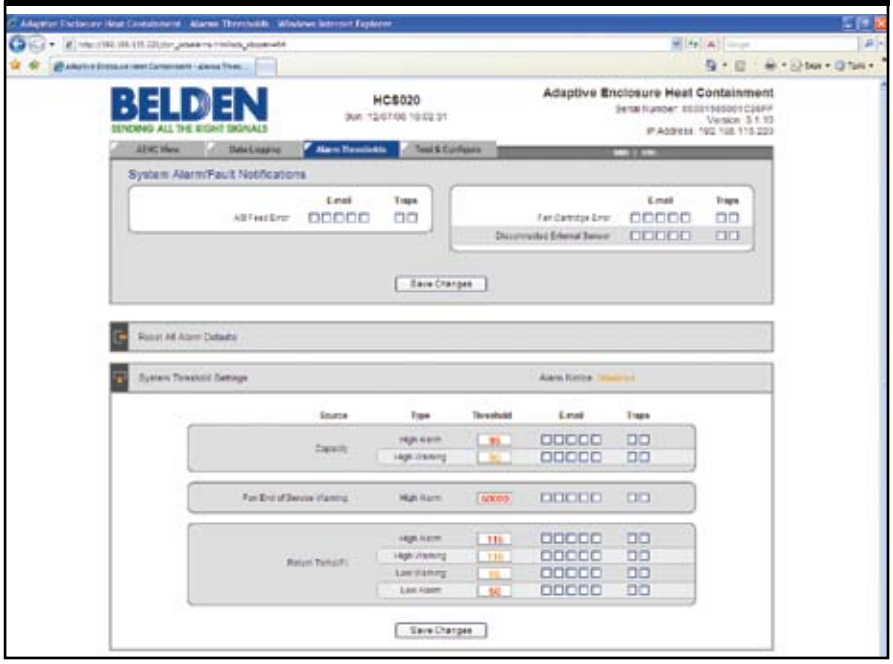
System Control

The system's control is based on sensing pressure as opposed to temperature, since, depending on the type of active equipment present, the temperature inside the enclosure plenum can vary quite a bit from place to place. On the other hand, even though pressure is changing inside the plenum, as well, it changes essentially in a uniform way throughout the interior of the enclosure.

Belden's concept of pressure sensing is clearly the best way to go. Other enclosure heat containment systems on the market, whether passive or active, have serious drawbacks in their approach. Passive systems, since they are pressurized, leak and create conditions not recommended by IT equipment manufacturers. "Uncontrolled, full-on" fan-assisted systems or temperature-based systems will starve the room of precious air that should be used for cooling.

With Belden's AEHC approach, since the room is normalized with cool air and all heat is contained, the cooling source can be located anywhere in the room. Cool air can be fed from a duct or raised floor, resulting in an increase in room infrastructure flexibility. Whatever the means of delivery of conditioned air for a normalized room, the Belden system works to perfectly match the correct amount of air for the IT load.

Systems Threshold



The threshold setting in Belden's AEHC system software provides early warning alarms for problem conditions. Alarms are automatically reported. Supported Network Protocols: DHCP, HTTPS, SMPT/POP3, HTTP, ICMP, TCP/IP, SNTP, DNS.

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Summary of Benefits

Increased Efficiency/ Greening of the Data Center

- Eliminates over-supply of cold air in the data center, allowing the data center to run with a reduced number of CRAC units
- In a new data center, permits use of larger, more efficient CRAC units to achieve highest cooling per unit of power
- Entails higher temperatures in the air returned to CRAC, improving efficiency
- Allows raising of supplied air temperature, resulting in more hours of free cooling
- Intelligent hot swappable fan cartridges allow for ease of maintenance and system scalability

Reduced Initial Capital Expense

- Lowest total cooling equipment cost available per kW of IT load
- No piping; vastly reduced electrical and sensor networks
- Reduced and simplified engineering
- Rapid installation and training

Increased Availability

- Fewer, larger cooling systems means reduction in components and interconnects
- No hot-spots, even with very high density enclosures; up to 20kW
- Having single, not multiple, cooling systems in operation improves availability and simplifies maintenance programs
- Water or glycol loops are isolated to perimeter of facility; no danger of leakage into enclosures
- Easy maintenance: "Smart Fans" embedded memory keeps track of run hours, allowing for preventative maintenance
- A single fan cartridge failure or repair does not affect an enclosure's cooling
- Provides early warning alarms for problem conditions
- Same system can be used in both existing and new facilities
- Cartridge installation/service does not interrupt existing operations
- All components are "hot swappable" to reduce human interactions
- System will issue reports on combined IT cooling enclosure loads for accurate assessment of new server and circuit deployment
- Involves low maintenance and service costs

Increased Flexibility

- IT enclosure load location is divorced from cooling source locations
- Cooling can be dynamically scaled from 0 to 20kW per enclosure, by a simple change of fan cartridges, ranging from 1-10 or 1-20kW per enclosure
- System reduces the quantity of CRAC units required on floor of new data center, or fully utilizes those in existing facilities
- Adaptable to existing enclosures and easily allows IT adds, changes and removals without disrupting IT operation or the environment
- Maximizes enclosure space on the floor, due to fewer CRAC units taking up space
- Same stable cooling environment, even with low slab-to-slab ceiling heights
- Allows higher power density per enclosure rack with no effect on intake air temperatures
- Extends operation during utility failure by routing load heat across CRAC coils and concrete floor slab

Embedded software allows each AEHC unit to be fully autonomous. The AEHC controllers have their own IP address, enabling network connection. The AEHC then allows for real time monitoring of the heat load, temperature and alarm conditions for each IT enclosure.

- System automatically scales fan speed to match IT load and reports cooling load in real time for each enclosure
- Complete management software; software is embedded in the controller so each unit is fully autonomous

References

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6. **ASHRAE TC 9.9 Mission Critical Facilities, Technology Spaces and Electronic Equipment ASHRAE ISBN 978-1-931862-443-1, Thermal Guidelines for Data Processing Environments.**