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Over the last several years, FEA has done a lot of work in the area of optimized cooling solutions for data centers. Projects included centralized air-handlers, air-to-air economizers, variable speed fans, off-the-shelf CRAC units, out of the box controls and standard controls. Components and designs were tailored to match the specific project requirements. As we match the right design to a specific project, our designs may take on different looks but all are rooted in a fundamental understanding of data center air conditioning with the objective to meet the reliability and performance objectives. In this issue of designPLUS, we briefly compare the typical CRAC unit with an AHU approach and also discuss cooling coil optimization. Finally, in our management feature, we provide some food for thought to help you plan for and cope with a future crisis at your facility. We hope you find this latest edition of designPLUS helpful and informative.

PROFESSIONAL ENGINEERING SERVICES FOR *MISSION CRITICAL* INDUSTRIES

AHUs vs CRAC Units for Data Centers

By Lewis J. Stanio, P.E.

Managers of today's Data Centers are very focused on energy consumption, carbon footprints, construction and operational costs. The method chosen to provide critical cooling can have a dramatic effect on these concerns and a data center's performance. Conditioning the data center has fallen to both the computer room air conditioning unit (CRAC) and the air handling unit (AHU). In the initial design stages, factors such as square footage, raised floor or slab, hot and cold aisles, chilled water availability, geographical location, control schemes, etc., are used to help develop designs that will be efficient, cost effective and meet operational goals. Traditionally, data center rack rooms have been constructed with raised floors, and CRAC units were designed specifically for these raised floor applications. Today's Data Centers with under-floor air distribution are being challenged as the kW/rack is trending upward and demanding a new focus on air flow alternatives. Higher watt densities and higher overall demand can also challenge CRAC unit applications. The range of sizes for CRAC units is somewhat limited, especially at the top end, where 50 tons is usually a maximum. This, in turn, affects the number of units

needed which could require more raised floor space resulting in less area for racks. In considering AHUs, larger incremental sizing is available allowing a closer match to the total load requirements. A separate mechanical room near the rack room will help in reducing raised floor space dedicated to cooling equipment allowing rack space to increase or total floor space to decrease. In addition, fan performance and cooling coil parameters can be selected allowing performance improvement; whereas, CRAC units have predetermined parameters which might not match as well. Also, in considering utilizing outdoor air or an air-to-air heat exchanger to reduce cooling energy costs, AHUs lend themselves very well to this application. From a controls point of view, the CRAC unit's control package is standard and less costly but can limit design options in addition to being difficult to integrate with a Building Automation System (BAS). On the other hand, AHU's controls can interface with a BAS with less difficulty.

In the design of air conditioning systems for data centers, the type of equipment and system design will impact both construction and operational costs. Even though CRAC units can still be the right solution for a given situation, it is now necessary to consider other alternatives that offer some needed design flexibility. It is to the client's benefit to understand all the advantages and disadvantages so a fully informed decision is possible.

Cooling Coil Optimization

By Edward L. Gutowski, P.E., LEED AP

Higher rack inlet temperatures are being touted as a way to reduce cooling costs and improve Power Utilization Effectiveness (PUE). The biggest savings by using high inlet temperatures will be realized when outside air is used for economizer cooling followed by raising the chiller plant leaving water temperature so that CRACs or AHUs will produce supply air that is no cooler than necessary. What if your facility has not accepted the higher risk that comes with bringing outside air into your data center? Or perhaps your chiller plant serves other cooling loads that need 45 deg F supply water temperature. Can you still save energy by raising your rack inlet temperature up to the ASHRAE TC9.9 maximum of 81 deg F? The answer is yes. Higher rack inlet temperatures will save you energy. For the moment, put aside the legitimate concern of crossing the 81 deg F operating setpoint while operating on the line. And, let's also say that you are willing to accept a short term rise in rack inlet temperature while your cooling system recovers from a hiccup like a chiller plant restart during a transition to emergency generators. To understand how you might save energy, let's examine a chilled water cooling coil which is a classic heat transfer problem. The key to understanding how you save is in the fundamentals of heat exchangers. The variables that can be manipulated in this problem are:

- Cold fluid flow rate (the GPM of chilled water)
- Cold fluid temperature entering and leaving
- Hot fluid flow rate (the CFM of air)
- Hot fluid temperature entering and leaving
- Size of the heat exchanger (sur-

face area of the coil)

To keep the analysis simple we are going to vary only one parameter, the temperature of the air leaving the coil which in some cases can also be the rack inlet temperature. For this example we'll use a legacy data center with constant speed CRACs. The "Size of the heat exchanger" and the "Hot fluid flow rate" remain constant because VFDs have not been added to slow the fan down and no changes are made to the cooling coil. Also assume the facility has installed basic containment curtains to eliminate hot spots with proper temperature control modification so the CRAC setpoint is no longer a function of one problem area in the data center. Containment eliminates air mixing and evens out the temperature in the cold aisle so you are free to adjust rack inlet temperature between 65 deg F and 81 deg F by simply changing the setpoint. By changing the leaving air temperature of a typical 25 ton constant speed CRAC from 70 deg F to 80 deg F you can lower the chilled water flow rate by 50%. The discharge air temperature off a cooling coil is very near the rack air inlet temperature in a contained room, and since the rack load didn't change when you raised the cold aisle setpoint then the hot aisle temperature will track nearly the same +10 deg F rise in temperature. This hotter return air temperature entering our cooling coil heat exchanger creates a greater temperature spread between the hottest air and the coldest chilled water. This elevated temperature difference is the driving force for greater heat transfer between hot and cold fluid streams. The same amount of room heat is carried away with fewer GPM because each gallon of chilled water we pumped to the coil leaves hotter. A 20% reduction in GPM flow will reduce the pump horsepower by 50%. A 50% reduction in GPM flow such as the example above will reduce pump horsepower by 87%. Reducing your pumping energy by

87% is a great accomplishment but keep in mind that the holy grail of energy reduction is to lower the sum total of all your components that consume cooling energy. It is important to understand which variables you can change while you move down the path of improved energy efficiency. The goal of optimization is to find which variables you can change and which ones will have the biggest effect on lowering the bottom line energy usage. When it comes to cold aisle setpoints, always weigh the benefits of energy savings with the risks associated with hotter rack inlet temperatures.

Crisis Management

By Brian, T. Soucy, P.E.

Japan's crisis at the Fukushima Daiichi nuclear reactors has reminded the world of how vulnerable our nuclear power plants can be to natural disasters and catastrophic failure. With the whole world watching, plant operators, contractors and emergency personnel have worked tirelessly, and in many cases, heroically, to control a desperate situation. While our thoughts go out to the men and women working at the plant, and the Japanese people in general, it is also a good time to reflect on our own organizations' preparation for a critical event or crisis. The goal of a crisis management plan is to contain and stabilize an event and position the organization for an expeditious recovery to normal operation. A crisis event may include an extended run on emergency generators due to a prolonged power outage or failed equipment. This may go beyond or complement a disaster recovery plan and could be part of an overall business continuity plan.

A crisis event may not have the dire consequences of a nuclear meltdown or natural disaster but may cause a severe business interruption.

Executing the right plan may help prevent a situation from spiraling out of control. Often times the event that caused the outage is over in an instant but a team's response can go a long way to mitigate the effects.

The following are a few suggestions and tips to help shore up your existing crisis management program or help plan a new one.

Prior to the event

- Organize teams with defined roles and responsibilities – These will most likely fall along the same lines as the normal organizational structure with groups and sub-groups for facilities, IT, business process owners, etc. Depending on the nature of the crisis this may also involve customer facing groups such as a call centers, account managers, executive committees and other stakeholders.

- Identify a crisis manager and team point-of-contacts for sending out and receiving information. Mis-information or no information can hamper efforts to effectively respond. Having a team point-of-contact can help manage the flow of information both to the team and out to the greater organization and stakeholders.

- Identify subject matter experts, engineers and service technicians and create and post a list with 24 hour contact information.

- Develop the plan for a "crisis center" where the "crisis manager" is stationed and key personnel congregate. Develop a plan for extended on site coverage – food, sleep accommodations, etc.

- Establish pre-defined communication protocols – both frequency and methods such as a teleconference bridge for re-occurring status updates, distribution lists and automatic paging.

- Train and Re-Train – Train operators so they are comfortable operating equipment in standard and non-standard configurations.

- Document everything – provide comprehensive documentation on all aspects of the systems including current as built drawings, standard and non-standard configurations, normal

and emergency operating procedures, sequence of operations and maintenance records.

- Evaluate system alarming, reporting and monitoring capabilities for early warning, detection and post-partum investigation. Tools like waveform capture and BAS trending can help diagnose the cause and effect. Train the staff to decipher, comprehend, and correctly respond to each alarm.

- Finally don't forget about logistics and human factors. It's important to recognize the effects fatigue can play on critical thinking and decision making. Make sure plans include adequate staffing, breaks and if necessary lodging and meals to help keep staff focused.

- Publish the plan and review with key stakeholders indicating how information will be distributed to interested parties. Emphasize that personnel not directly involved in the crisis are not to be at the site of the crisis.

During the event

- First and foremost, assess personnel health and safety and determine if safe working conditions can be maintained.

- Next determine the system status.

Is the plant in a stable configuration? Is manual intervention required to stage on reserve capacity or activate alternative distribution paths? Has the event been properly contained and isolated? Are communication channels and alarm reporting operational? The main objective is to stabilize the plant to limit damage and make an initial assessment as to the cause and effect of the event.

- Maintain open communication channels to provide status updates and pertinent information for those responding to the event. Vet out all information and data so the team is not distracted nor do they apply focus to non-essential or inaccurate information.

- Whenever possible, follow processes and procedures that help preserve and collect data, event logs and other forensic evidence to help diagnose the event and the ultimate effect of the systems.

Obsolete Controls

Electrical and generator paralleling switchgear began using electronic processors in the late 1980's. Since that time, we have witnessed major advances in system architecture but in most cases the manufacturers continued to support the original products. Recently, we received notice from a major control vendor that they will no longer support some of their earliest products. You need to continuously review system obsolescence to ensure that your critical systems are properly supported.

Policy
designPLUS Newsletter is published to keep the readers current with the latest trends in mission critical systems.

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