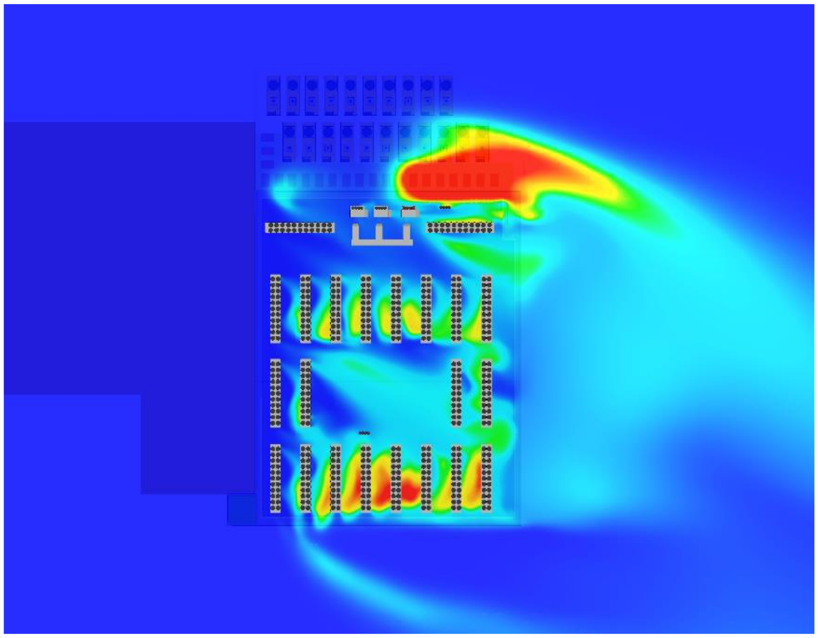
Data Center Operational Reliability

CASE STUDY:

Hot Air Recirculation | Hot Exhaust Air | CFD | Condenser Air Inlet Temperatures



Introduction: Does hot exhaust air or hot air recirculation threaten the operational reliability of your data center's air-cooled chillers? Data center designs are increasing the density of air-cooled chillers and often placing them close to hot-air-exhaust-producing generator sets. The resulting hot exhaust air and/or hot air recirculation at these facilities increases the risk of air-cooled chillers performing below their design capacity and failing to meet the cooling requirements for the server rooms. Whether in the design phase or at an operating data center, Peak+'s evaporative pre-cooling technology can mitigate these risks and ensure optimal air-cooled chiller performance.

Situation: A data center in California required a dense array of air-cooled chillers set near backup generator sets. Computational Fluid Dynamics (CFD) modeling indicated that a portion of the 22 x 500 Ton nameplate capacity chillers would experience unacceptably high condenser air inlet temperatures during peak ambient conditions due to a combination of hot exhaust air and hot air recirculation (see Figure 1 below). Temperature modeling indicated these temperatures would occur at 66” above the bottom of the chiller, so the high temperature air would feed into the chillers’ condensing section.

Ambient Dry Bulb (°F)	Ambient Wet Bulb (°F)	Condenser Air Inlet Temperature (°F)
107.6	72.0	140.0

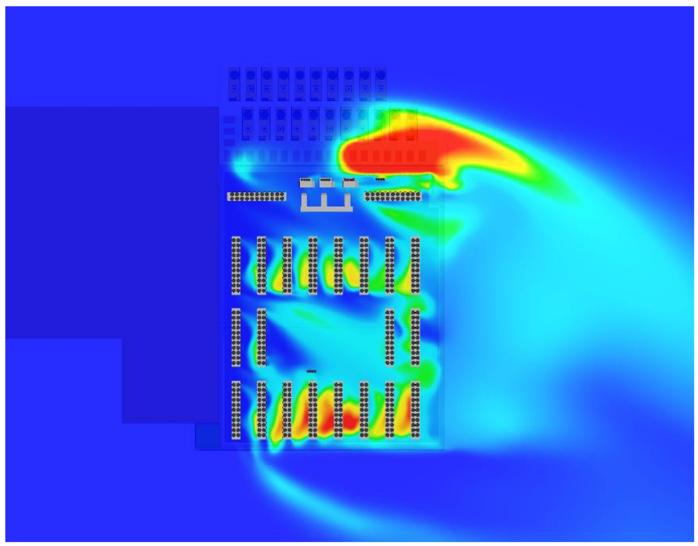


Figure 1: CFD analysis showing high ambient temperatures during peak summer conditions on a portion of this data center’s air-cooled chillers (areas with orange and red coloration); the problem was exacerbated by the possibility of nearby generators coming online.

The engineer of record for this data center approached Peak+ to determine how Peak+’s evaporative pre-cooling technology might lower the condenser air inlet temperature enough to allow these units to operate reliably and at the required cooling capacity.

The Goal: Install Peak+ on all air-cooled chillers to ensure no chiller at the facility experienced a condenser air inlet temperature greater than 104.5 °F.

Challenges: This customer faced two challenges in attempting to solve this problem: (1) keeping static pressure below the air-cooled chiller’s maximum allowable rating and (2) minimizing the use of water as they are a “no water” use data center firm for cooling purposes.

Static Pressure Drop: Peak+ technology encases the entire condensing section of the air-cooled chiller in its patented precooling frames (see Figure 2 below).

Figure 2: Peak+ installed on two air-cooled chillers.

The lab-tested pressure drops across the Peak+ system is 0.11" water column dry and 0.15" water column wet at 220,000 CFM at 362 feet per minute. The chiller manufacturer stated that the maximum allowable pressure drop at these conditions is 0.23" water column to maintain its rated capacity and not risk putting undue stress on the condenser fans. Since the pressure drop across the Peak+ system is minimal, it had no impact on the chiller's ability to operate. In fact, when Peak+ is in operation, this pressure drop is mitigated because with the lower condenser air temperatures, the chillers do not require as much airflow across the condenser coils.

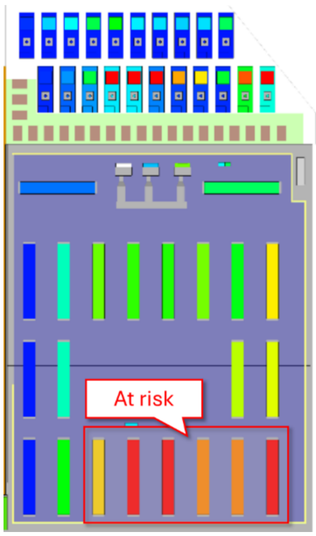
No Water Usage: Many data center firms are moving to a no water use policy for their new facilities; moving away from water-cooled chillers to air-cooled designs. As we have seen, challenges can arise with the air-cooled design that still needs to be mitigated. Using a small amount of water to precool the condenser air goes a long way to ensure air-cooled chiller reliability. With this in mind, Peak+ suggested the customer only engage the system when ambient conditions warranted. Thus Peak+ would only spray when needed to keep the condenser air temperature below 104.5 °F when the air-cooled chillers were running. Peak+'s technology can lower the condenser air temperature below 104.5 °F, but to conserve water, Peak+ put this boundary in place. This type of precise scheduling is made possible by Peak+ industry-leading controls and web interface.

To put this in context, the Peak+ system would use a maximum of 627,000 gallons of water per year to achieve its risk mitigation goal, compared to the average single-family home in the United States which uses between 110,000 and 300,000 gallons per year.

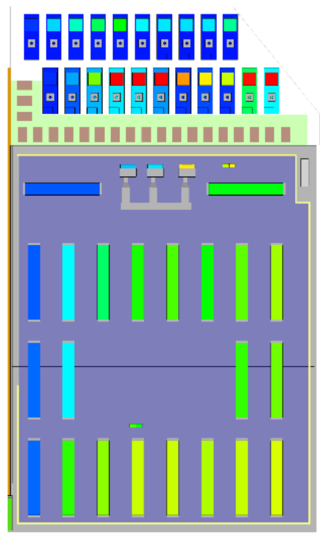
The customer can frame this reasonable tradeoff so that water is not used directly for cooling but only for peak ambient temperature reduction to reduce operational risk. Data center owners make this tradeoff all the time. Think of the installation of generator sets at a data center as backup power. These generator sets must run at frequent intervals to ensure they are ready to power the data center in case of an electrical outage. This run time burns costly fuel and produces large amounts of CO2 that the data center feels are an acceptable tradeoff to ensure reliability. The use of a Peak+ system is a comparable tradeoff, but without the harmful emissions. Water evaporated during Peak+ operation re-enters the regional water cycle completely unpolluted.

The Result: With the addition of Peak+, this data center was able to effectively manage the hot air recirculation temperatures in the chiller yard. Using the equivalent of 2-3 single family homes worth of water annually, condenser air inlet temps were held to under 104.5 °F. The solution was endorsed by the chiller manufacturer as an effective means to help their air-cooled chillers run reliably throughout the summer months.

Before Peak+



After Peak+



Before Peak+		After Peak+
140.0 °F	**Max Entering Air Temp**	**< 104.5 °F**

Figure 3: CFD analysis of maximum condenser air inlet temperatures before and after Peak+ installation.

Key Metrics:

Peak Temperature Reduction	40 °F
Annual Water Usage	627,000 gallons
Peak Demand Savings	3,866 kW
Annual Energy Savings	111,616 kWh
Annual CO2 Reduction	86 Tons

Interested? Contact Peak+ at contactus@peakplus.energy or call (901) 382-7809.