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ASHRAE Now Requires Economizers in Data Centers: The Challenges Ahead

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This technical whitepaper provides some history behind the new ASHRAE 90.1 requirement for waterside economizers in data centers. It also outlines the impact of this requirement on the design, cost, and operation of large data centers.

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In 2009, ASHRAE set an aggressive target of net-zero energy use for all new buildings by the year 2030. With that objective in mind, innovative energy saving ideas were sought from the various ASHRAE committees, particularly those associated with ASHRAE's Standard 90.1, the "Energy Standard for Buildings Except Low-Rise Residential Buildings". As a referenced standard of practice in essentially all building and mechanical codes in the United States, the impact of any change to this Standard is understandably immense.

The initial draft of the proposed economizer changes to ASHRAE Standard 90.1 required data center cooling towers to be sized to accommodate 100% of the cooling demand once the outdoor wetbulb temperature dropped to 40°F. This raised the following concerns, which CCG conveyed by formal comment to ASHRAE's 90.1 Mechanical Sub-Committee assigned to review the proposed changes:

- The proposed economizer design point of 40°F wetbulb will require gross oversizing of cooling towers, with correspondingly increased requirements for electrical service, and physical area.
- Unlike commercial facilities, computer rooms loads are basically constant. Thus, chilled water supply temperatures cannot be increased during economizer operation without adversely affecting cooling operation. A 4°F rise (often seen in commercial economizer applications) would result in a potentially crippling 20-25% reduction in CRAH capacity.
- The only valid appreciable decrease in cooling tower load during winter economizer operation is due to the elimination of "chiller heat". Unfortunately, with a computer room environment, this decrease is not sufficient to overcome the tower's significant decrease in operating efficiency at the lower outdoor temperatures.
- Without an exhaustive lifecycle cost analysis, the payback for utilizing oversized summer cooling towers is unclear. The carbon footprint for exercising this option is also unknown. A reasonable compromise would be to require 100% economizer operation at 30°F. This would still likely result in a summer tower with an oversized motor, but likely not an oversized footprint.

CCG's early discussions with ASHRAE's Project Committee representative for this Standards Action did not find a receptive audience. In the end however, ASHRAE's Project Committee compromised by dropping the economizer wetbulb requirement from initially proposed 40°F to 35°F, and ultimately publishing the new requirements in the latest 2010 ASHRAE Standard 90.1. Accordingly, if a new data center is located anywhere other than ASHRAE's climate zones 1A, 1B, 2A, 3A, or 4A it must incorporate a waterside economizer.

To comply with the new Standard, cooling towers must now be selected for the more demanding winter economizer operation at ASHRAE's 35°F wetbulb rather than summer operation. This

selection will result in towers that are oversized for peak summer duty. It will also open up options to reduce tower quantities and increase summer and mid-season operating efficiencies.

Careful consideration will be required in the selection and configuration of the heat exchangers required for waterside economizer operation to optimize their availability for both pre-cooling and 100% free cooling. Although it may be less expensive to simply install one or two large heat exchangers to accommodate ASHRAE's 100% economizer operation, this configuration will likely severely limit availability of the economizer system during partial loading conditions.

Of prominent consideration will be the control system, which will require control logic with a level of sophistication that may not be readily apparent to many design engineers and controls contractors.

The additional economizer equipment, piping, controls, electrical conduit, building structure, and real estate costs money. One preliminary estimate pegs that increased cost at around $800-$1000 per ton of chiller plant capacity. With only full economizer capability, the return on this investment could be on the order of thirteen years. However, with properly designed and controlled integrated economizer operation, the return on this investment could be seen in as little as three years.

So, with some additional capital for the extra space and equipment, coupled with creative engineering design, the data center industry will be another step closer to that net-zero energy use target.