Managing Barbeques in Data Centers

Agenda

High Density Data Center Facility Challenges
Liquid Cooling Opportunities
• Types of Liquid Cooling
• Energy Opportunities
  • Optimizing PUE
  • Energy ReUse
Simplifying Liquid Installation, Reliability
How Many Barbeques Fit In A Data Center?

**Avg IT Loads = < 10KW/rack**
(note - one barbeque = 10KW of heat)

**AI / HPC Applications = > 40KW/Rack**

**Crypto-Currency => 200KW/tank**

**Data Centers =**
- 30 yr Buildings, 3 year Vision
- Adapt or Perish

“Liquid Cooling” (ASHRAE TC9.9)

ASHRAE TC 9.9 Liquid Cooling Guidelines for Datacom Equipment Centers (©2014)

Liquid Cooling Types–

- Liquid Cooled Rack (Rear Door, etc)
- Liquid Cooled IT (Chassis cooling, Cooled Plate…)
- Liquid Cooled Electronics (immersion cooling)
  - Single phase
  - Dual phase

Sources

- Facility Water – i.e. CW system
- Condenser Water
- DiElectric with HX to Facility, Condenser, or external
Chilled-Water Cooling to Row & Rack
Inrow
RearDoor

Image Source – Schneider Electric
Liquid Cooling to server, immersion
Server
Immersion

Single Phase Example (GRC)

2 Phase - Image fm Zutacore

Single Phase - Image fm CoolIT

Dual Phase Example Allied Control)
Optimizing Energy Usage Via Liquid Cooling

Optimizing PUE

• **Minimum PUE as Density and Diversity Increase**

• **Cascade Cooling** – (Optimizing PUE)
  • rejection temperature from CRAH units provides supply temp for cold plate, immersion cooling

**Energy ReUse** – ReUse waste heat from data center for building, district or agriculture applications
Table 5.1  ASHRAE Liquid Cooling Guidelines

<table>
<thead>
<tr>
<th>Liquid Cooling Class</th>
<th>Typical Infrastructure Design</th>
<th>Facility Water Supply Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>Chiller / Cooling Tower</td>
<td>2°C – 17°C</td>
</tr>
<tr>
<td></td>
<td>Water Side Econ.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(with Dry Cooler or Cooling Tower)</td>
<td></td>
</tr>
<tr>
<td>W2</td>
<td></td>
<td>2°C – 27°C</td>
</tr>
<tr>
<td>W3</td>
<td>Cooling Tower</td>
<td>2°C – 32°C</td>
</tr>
<tr>
<td>W4</td>
<td>Water Side Econ.</td>
<td>2°C – 45°C</td>
</tr>
<tr>
<td></td>
<td>(with Dry Cooler or Cooling Tower)</td>
<td></td>
</tr>
<tr>
<td>W5</td>
<td>Building Heating System</td>
<td>&gt; 45°C</td>
</tr>
</tbody>
</table>
Figure 5.3  ASHRAE liquid cooling classification, typical infrastructure design schematics.
High Density + Reuse Simplified

No chiller required
Incoming "cool" fluid can be as high as 45°C

Option 1:
Direct External Heat Removal

Option 2:
Heat Recovery for Building Heating

Drawing supplied by LiquidCool Solutions, Cloud9 Edge Technologies LLC. Noel Wideberg
Creative Energy Options - “Cascade Cooling”

Chilled-Water Temperatures, Rack Door
- Supply (20-25 C) (TC9.9 W1, W2)
- Return (30-35 C)

Liquid Temperatures, Cold Plate
- Supply (25-35 C) (TC9.9 W2, W3)
- Return (35-45 C)

Liquid Temperatures, Immersion Cooling
- Supply (30-60 C) (TC9.9 W3, W4, W5)
- Return (45-70 C)

Energy Reuse Application
PUE Vs ERE

- **PUE** (Power Usage Effectiveness)
  
  "Perfect" PUE = 1.00

- **ERF** (Energy Reuse Factor)
  
  "Perfect" ERF = 100%

- **ERE** (Energy Reuse Effectiveness)

  \[
  ERE = (1-ERF) \times PUE
  \]

*Increased focus on IT industry energy usage drives need for energy reuse metric*
Enabling Liquid Distribution Success

Pipe Solution Needs

- Adaptable
- Rapid Deployment, Simplistic Alignment
- BIM Precision, Reference Designs
- Mission Critical Performance
Reference Design

VDC / Detail design / Cut length

Lean Installation

A-BOM / BOQ and list of pipe lengths

Coordination in an early stage with warehousing and allocation of the material

<table>
<thead>
<tr>
<th>Area</th>
<th>Quantity</th>
<th>Article Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation</td>
<td>16</td>
<td>OA89706018602</td>
<td>CONSTRUCTION-600 40&quot; Duct Asbestos Gypsum 600°</td>
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<tr>
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Dwg provided by Asperitas, @ asperitas.com
Simplicity in Alignment is Key Challenge

The Flange Challenge

- Centerline Hi/Low
- Rotational-Two Hole
- Parallelism
- Excessive Spacing or Gap

The Coupling Solution

- Contraction
- Expansion
- Deflection

Eliminate alignment issues – rotational, angularity, pipe movement
Adaptable, Reliable Liquid Distribution

- Precision Design (BIM LoD 400)
- Fast
- Low Risk, No Hot-work
- Low Labor
- Extended Warranties Available – 30 years
- Mission Critical Compliant
Call to Action – Defining Mission Critical Pipe Solution

Origins of “3 Pillars of Mission Critical” ……..
April 10 1963, USS Thresher, SSN 593

“the loss of the Thresher should not be viewed solely as the result of failure of a specific braze, weld, system or component, but rather should be considered a consequence of philosophy of design, construction and inspection”

Admiral Rickover
## Three Pillar Mission Critical Performance Summary

<table>
<thead>
<tr>
<th>Pillar 1: Holistic Engineered Design</th>
<th>Coupling Design</th>
<th>&quot;installation ready&quot; for direct stab installation without field disassembly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seismic performance –</td>
<td>Performance data verified for seismic movement</td>
</tr>
<tr>
<td></td>
<td>Expansion/Contraction Performance</td>
<td>Performance data for thermal, building movement</td>
</tr>
<tr>
<td></td>
<td>Vibration response, reduction analysis</td>
<td>Performance data verified for vibration mitigation</td>
</tr>
<tr>
<td></td>
<td>Temperature, pressure, liquid types</td>
<td>Gasket material performance data for liquid type, temperature and pressure</td>
</tr>
<tr>
<td>Pillar 2: Vertically integrated Quality Control</td>
<td>Single manufacturer of product solution</td>
<td>Couplings &amp; gaskets from same manufacturer</td>
</tr>
<tr>
<td></td>
<td>Quality/performance testing, traceability</td>
<td>Gaskets and housings traceable from installation back to manufacture date, location, test date</td>
</tr>
<tr>
<td></td>
<td>Revit Design Support</td>
<td>Content libraries accurate to +/- 0.01 inch to enable construction grade design accuracy</td>
</tr>
<tr>
<td></td>
<td>Global Access and Quality Control</td>
<td>Certification of all production sources globally to ISO9001 standards</td>
</tr>
<tr>
<td>Pillar 3: Certified Inspection &amp; Installation</td>
<td>Simplified Installation Process</td>
<td>Simplified installation without disassembly. Factory training/certification program</td>
</tr>
<tr>
<td></td>
<td>Visual Inspection Process</td>
<td>Verification of proper installation and performance via visual inspection</td>
</tr>
<tr>
<td></td>
<td>Certification of installation inspectors</td>
<td>Manufacturers shall provide installation certification training to all installers.</td>
</tr>
</tbody>
</table>
Recommended Actions and Timelines–

• DCF - Define “mission critical grade” standards for liquid distribution – June 2020
• DCF - Integrate energy reuse into OCP goals - Dec 2020

Links:
• [https://www.cooldc.co.uk](https://www.cooldc.co.uk)
• [https://www.victaulic.com](https://www.victaulic.com)
• TheGreenGrid – [http://thegreengrid.org](http://thegreengrid.org)
• ASHRAE TC9.9 - [http://tc0909.ashraetcs.org/](http://tc0909.ashraetcs.org/)

Additional thanks to input from GRC, LiquidCool, Asperitas, Motivair, Submer, Iceotope, Allied Control, 3M, Dell, HP, Schneider, Vertiv, Stulz, Engineered Fluids, Lenovo, Qcooling, Asetek for public concepts and images.
Open for All.

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