Data Center Liquid Distribution Guidance & Reference Designs

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- **John Menoche**, Solutions Architect, Vertiv
- **John Musilli**, Solutions Architect, CPS

Moderator:
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**OPEN POSSIBILITIES.**
DATA CENTER LIQUID DISTRIBUTION
GUIDANCE & REFERENCE DESIGNS

Revision 0

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OPEN POSSIBILITIES.
OCP Advanced Cooling Facilities

Data Center Facility

Sub-Projects:
- Modular Data Center
- *Advanced Cooling Facilities - Incubation*
- OCP Ready™ Facility Recognition Program
- Operation Technology Security - Incubation

Rack & Power

Sub-Projects:
- ACS Immersion
- ACS Cold Plate
- ACS Door Heat Exchanger

Advanced Cooling Facilities
the Bridge between DCF and ACS
#DontFearLiquidCooling
#PlanForIT

OPEN POSSIBILITIES.
Liquid Distribution Guidance & Reference Designs

Design Considerations
Case 1 - Addition to existing Facility Water System (Chiller Plant Loop)
Case 2 - Addition to Elevated Temperature Loop (no Chiller Plant)

Beyond Design - Procedures & Commissioning Impact on Operational Success

Virtual Design & Construction Delivery of Liquid Cooled ITE in Life-Cycle

Appendix A. Recommendations for BIM definition and detail content of Vendor solutions
Appendix B. Cooling Distribution Systems
Appendix C: Keys to Success in Data Center Liquid Loops
Appendix D: Risk Analysis (FMEA)
Appendix E. Closed Loop Cleaning Best Practices
Best Practices & Reference Designs

Concept Design 1 - Coldplate Addition w/CDU

Concept Design 1A Existing FWS: Rear Door HX, No CDU

Concept Design 2 - Elevated temperature loop Immersion Cooling Example with No Chiller Plant
Where Will You Run The Pipes?

- Raised Floor
- “Step” Floor, integrated CDU
- Above Floor

OPEN POSSIBILITIES.
Pipe Sizing Factors – Flow, KW, ΔT

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>ASHRAE 90.1-2019 Table 6.5.4.6</th>
<th>Equiv Velocity</th>
<th>ΔT</th>
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<tr>
<td></td>
<td></td>
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<td>4</td>
</tr>
<tr>
<td>DIN</td>
<td>in</td>
<td>l/s</td>
<td>GPM</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>4.95</td>
<td>78</td>
</tr>
<tr>
<td>65</td>
<td>2-1/2</td>
<td>6.94</td>
<td>110</td>
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<tr>
<td>80</td>
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<td>10.73</td>
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<td>320</td>
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<td>150</td>
<td>6</td>
<td>42.90</td>
<td>680</td>
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<td>200</td>
<td>8</td>
<td>69.40</td>
<td>1100</td>
</tr>
<tr>
<td>250</td>
<td>10</td>
<td>100.94</td>
<td>1600</td>
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<tr>
<td>300</td>
<td>12</td>
<td>145.11</td>
<td>2300</td>
</tr>
</tbody>
</table>

Based on flow rates per ASHRAE 90.1-2019 Table 6.5.4.6 for Variable Flow

* - Values are based on standard weight carbon steel pipe dimensions, ASTM A53

- Represents typical design dT for chiller-based systems
- Represents dT lower than typical design/operation of FWS systems
Prefab VDC Vision:
Concept to Dwg to BOM to Prefab Kit to Installation

Architecture / SPEC's / Basic piping design

Ref Design + MEP Review + BIM Content

Lean Install

Bill of Materials, Pipe Lengths

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

- **Prefab “kits”**
  - precision design, self aligning
  - minimal labor hours
  - Lean construction

- **Spool Pieces**
  - precision design, self aligning
  - Valves installed
  - simplified assembly, minimize labor

- **Catalog Items**
  - Single SKU for complex assemblies
  - Reduce on site labor hours & issues

- **Modular Skids**
  - Complete pump rooms, optimized design
  - Minimal on site labor

**BIM Content = Key to Prefab Success**
BIM Content: Vendor Requirement

Key Requirements to support Reference Designs

1. **Revit RFA format**

2. **Specific geometry modeled (including clearances)**, 500KB-700KB target size

3. **Connections for piping, power and drain (if applicable) modeled in dimensionally accurate locations and sizes.**

4. **Electrical connections should have voltage, phase, kVA and load classification parameters as a minimum.**

Additional input of design and lifecycle value

1. Water-side pressure drops and flow rates identified.
2. Telecomm connectors identified and specified
3. End user data recommendation:
4. All models should be hosted to the floor on which they are placed in the model.
5. **Designers/engineer “nice to have”**: Weight, Floor Load (PSF)
   1. Maximums: fluid temperatures, pressure drops, flow rates, working pressures
Risk….Science Vs Mythology

Liquid Cooling Mythology ….. VS Liquid Cooling Reliability Science –

FMEA – Failure Mode & Effects Analysis
MTBF – Mean Time Between Failure
MOPs, SOPs

Failures are famous …..Reliability is unnoticed

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Failure Mode Effect Analysis

Detect Failure Mode
Assign Risk Factors
- Severity
- Probability
- Detection

Mitigate Risk Factors
- Optimize Design
- Increase MTBF
- Improve Detection
- Procedures
- Isolation strategy

(Minimize)
Risk Priority Number
\[ R = S \times P \times D \]

Mitigate Risk Factors
- Optimize Design – Location, reduction of risk points
- Increase MTBF – Require high MTBF of critical components
- Improve Detection – Visual, leak detection
- Procedures – MOPs, SOPs, EOPs
- Isolation Strategy – Isolation valves, redundancy

#DontFearLiquidCooling - #PlanForIT

OPEN POSSIBILITIES.

ADVANCED COOLING FACILITIES

OPEN POSSIBILITIES.
Mission Critical Systems: Apply SUBSAFE to Data Centers

**Design** - Holistic solution, to include temperatures, pressures Flexibility and movement.

**Quality Control** - Traceable to date, location of manufacture and associated quality tests

**Installation Performance** – leak-proof, maintenance free for 20+ years based on auditable verification of proper installation + pressure test.

Leak Detection & Protection and maintenance plan recommended for components or connections not meeting the mission critical guidance above with 20+ year performance expectation.
Good Design is Key….But Just Part of Success
SLA Considerations

**ASHRAE TC 9.9 Table 3.1 2021 Thermal Guidelines for Liquid Cooling**

<table>
<thead>
<tr>
<th>Liquid Cooling Class</th>
<th>Typical Infrastructure Design</th>
<th>Facility Water Supply Temperature, °C (°F)a</th>
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<tbody>
<tr>
<td>W17 W27</td>
<td>Chiller/cooling tower</td>
<td>17 (62.6)</td>
</tr>
<tr>
<td>W32 W40</td>
<td>Cooling tower</td>
<td>32 (89.6)</td>
</tr>
<tr>
<td>W45 W+</td>
<td>Cooling tower</td>
<td>45 (113)</td>
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</table>

**Table 2: Dewpoint Limits Per ASHRAE**

<table>
<thead>
<tr>
<th>ASHRAE Class</th>
<th>Max Inlet Temp °C</th>
<th>Max Dewpoint Temp °C</th>
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<tbody>
<tr>
<td>A1-A4</td>
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<td>27</td>
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<tr>
<td>Allowable Limits</td>
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</tr>
<tr>
<td>A1</td>
<td>32</td>
<td>17</td>
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<td>A2</td>
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<td>A4</td>
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<td>B</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>C</td>
<td>40</td>
<td>28</td>
</tr>
</tbody>
</table>

ASHRAE TC 9.9 – Stay 2 degrees C above dewpoint in ITE space
Call to Action

• Get involved in OCP Advanced Cooling Facility Sub-Project:

  • Weekly OCP ACF calls Tuesdays 1100 ET (UTC-4)
    https://global.gotomeeting.com/join/952298085
  • https://www.opencompute.org/wiki/Data_Center_Facility/ACF-Advanced_Cooling_Facilities

• Mail List: https://ocp-all.groups.io/g/ocp-acf
Open Discussion