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Data Center Liquid Distribution Guidance & Reference Designs

OCP GLOBAL SUMMIT

NOVEMBER 9-10, 2021

Track: CE

Data Center Liquid Distribution Guidance & Reference Designs

Panelists:

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Data Center Liquid Distribution Guidance & Reference Designs

ADVANCED COOLING FACILITIES

Revision 0

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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

ADVANCED COOLING FACILITIES

#DontFearLiquidCooling

#PlanForIT

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Liquid Distribution Guidance & Reference Designs

ADVANCED COOLING FACILITIES

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

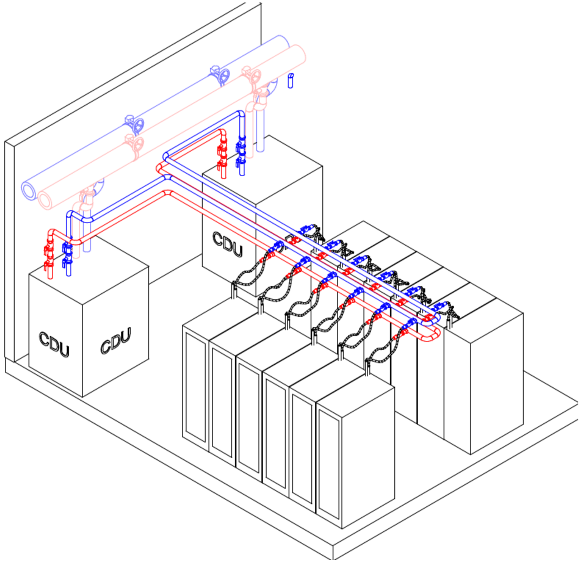
Virtual Design & Construction Delivery of Liquid Cooled ITE in Life-Cycle

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

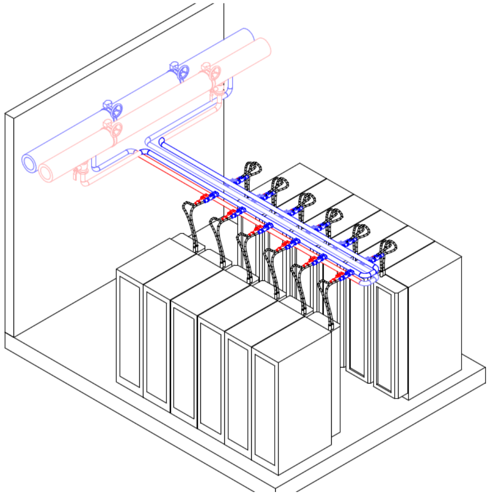
Best Practices & Reference Designs

ADVANCED COOLING FACILITIES

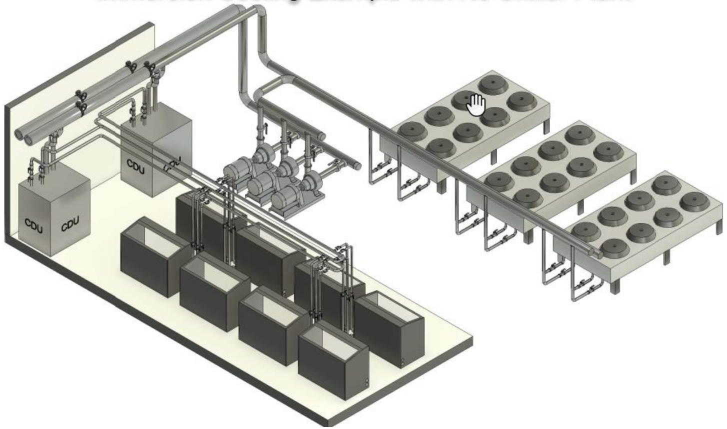
Concept Design 1 - Coldplate Addition w/CDU



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



Concept Design 2 - Elevated temperature loop Immersion Cooling Example with No Chiller Plant



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Where Will You Run The Pipes?

Raised Floor | **“Step” Floor, integrated CDU** | **Above Floor**

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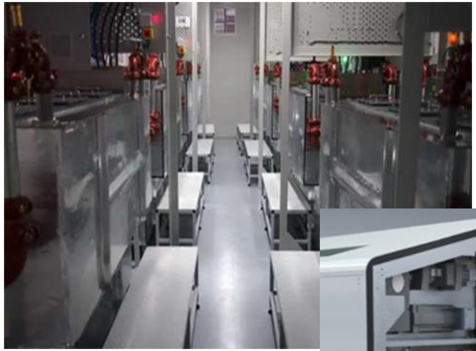

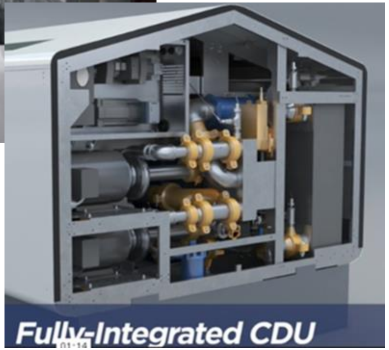

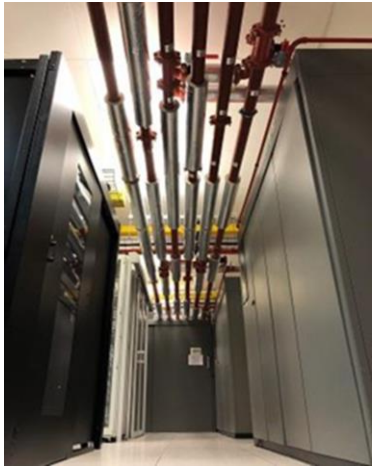

Pipe Sizing Factors – Flow, KW, ΔT

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Pipe Size		ASHRAE 90.1-2019 Table 6.5.4.6		Equiv Velocity		ΔT				
						4	6	8	10	C
						7.2	10.8	14.4	18	F
DIN	in	l/s	GPM	m/s	ft/s *	Max kW				
50	2	4.95	78	2.3	7.5	83	124	166	207	
65	2-1/2	6.94	110	2.2	7.4	116	174	232	290	
80	3	10.73	170	2.2	7.4	180	269	359	449	
100	4	20.19	320	2.5	8.1	338	507	676	845	
150	6	42.90	680	2.3	7.6	718	1077	1436	1795	
200	8	69.40	1100	2.1	7.1	1162	1742	2323	2904	
250	10	100.94	1600	2.0	6.5	1690	2534	3379	4224	
300	12	145.11	2300	2.0	6.5	2429	3643	4858	6072	

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

(yellow) Represents typical design dT for chiller-based systems

(orange) Represents dT lower than typical design/operation of FWS systems

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Prefab VDC Vision:
Concept to Dwg to BOM to Prefab Kit to Installation

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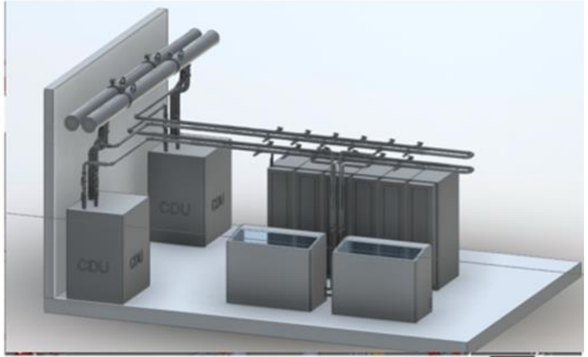
Architecture / SPEC's / Basic piping design

Ref Design + MEP Review + BIM Content



Bill of Materials, Pipe Lengths

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

Page 1 of 2

Project Name : Equinix
Project number : 74877_AAP (based on DRW 74877_AAP)
System : Cooling
Note : Pump Room B

CONSTRUCTION BOM

Area	Quantity	Article Code	Description
[illegible] chillers	16	[illegible]	437.0 mm/18 Style W07 AGS Rigid Cplg Orange FlushSeal EPDM Gskt
[illegible] chillers	6	[illegible]	437.0 mm/18 No W10 90° AGS Elbow Orange
[illegible] chillers	1	[illegible]	437.0 mm/18 No W20 AGS Tee Orange
[illegible] chillers	2	[illegible]	437 mm/18 AGS Vic-300 MasterSeal Butterfly Valve Black EPDM Gear Op Dew Block
[illegible] chillers	1	[illegible]	813 mm x 457 mm / 32" x 18" Reducer flanged (PN6) - grooved (AGS)
[illegible] cracks	10	[illegible]	333.6 mm/14 Style W07 AGS Rigid Cplg Orange FlushSeal EPDM Gskt
[illegible] cracks	12	[illegible]	437.0 mm/18 Style W07 AGS Rigid Cplg Orange FlushSeal [illegible]

Lean Install

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Forms of Prefab

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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

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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

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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

Failure Mode Effect Analysis

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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

$R = S \times P \times D$

#DontFearLiquidCooling - #PlanForIT

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

Mission Critical Systems: Apply SUBSAFE to Data Centers

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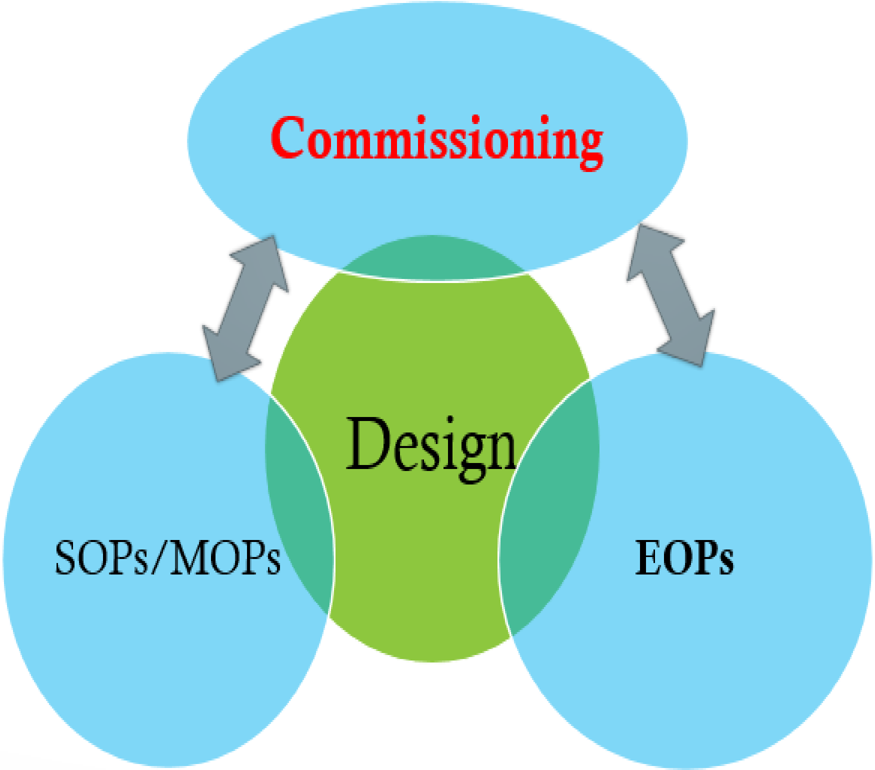
Design - Holistic solution, to include temperatures, pressures Flexibility and movement.

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

ADVANCED COOLING FACILITIES

ASHRAE TC 9.9 Table 3.1 2021 Thermal Guidelines for Liquid Cooling				
Liquid Cooling Class	Typical Infrastructure Design			Facility Water Supply Temperature, °C (°F)a
		Primary Facilities	Secondary/ Supplemental Facilities	
W17	}	Chiller/cooling tower	Water-side economizer	17 (62.6)
W27				27 (80.6)
W32	}	Cooling tower	Chiller or district heating	32 (89.6)
W40				40 (104)
W45	}	Cooling tower	District heating system	45 (113)
W+				>45 (>113)

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

Table 2: Dewpoint Limits Per ASHRAE

ASHRAE Class	Max Inlet Temp °C	Max Dewpoint Temp °C
A1-A4 Recommended	27	15
Allowable Limits		
A1	32	17
A2	35	21
A3	40	24
A4	45	24
B	35	28
C	40	28

ASHRAE TC 9.9 © 2015

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