High-Density Rack Liquid Cooling

Product & Application Overview

Vette Corp

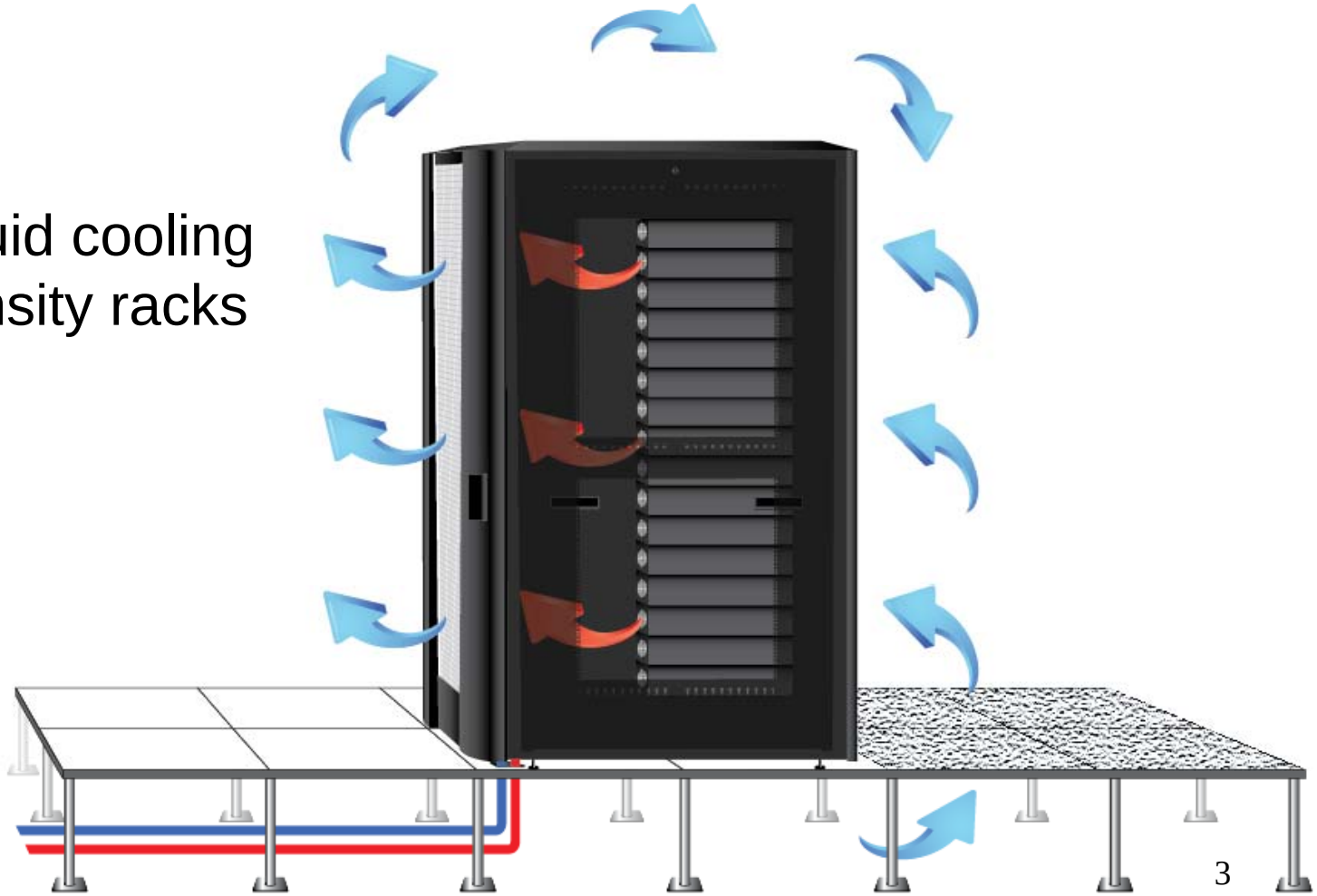
PC/Consumer

Power Semiconductor

Datacom Facilities

Rear Door Heat Exchanger

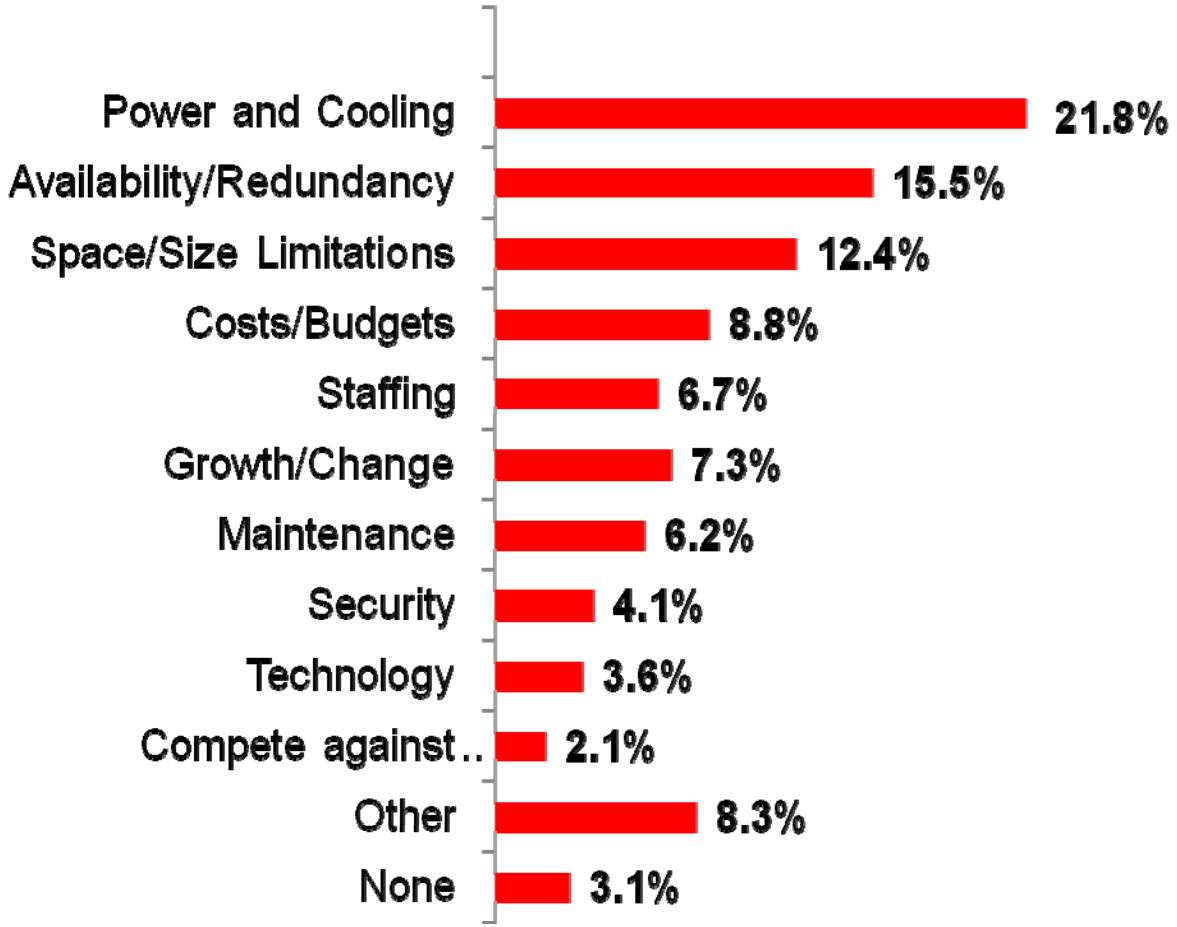
Passive liquid cooling
for high density racks



Heat Loads Increased >10X

2000	**2002**	**2006**	**2008**
28, 2U Servers	42, 1U Servers	6 Blade Centers	32+kW
2kW Heat Load	6kW Heat Load	24kW Heat Load	

Data Center Challenges



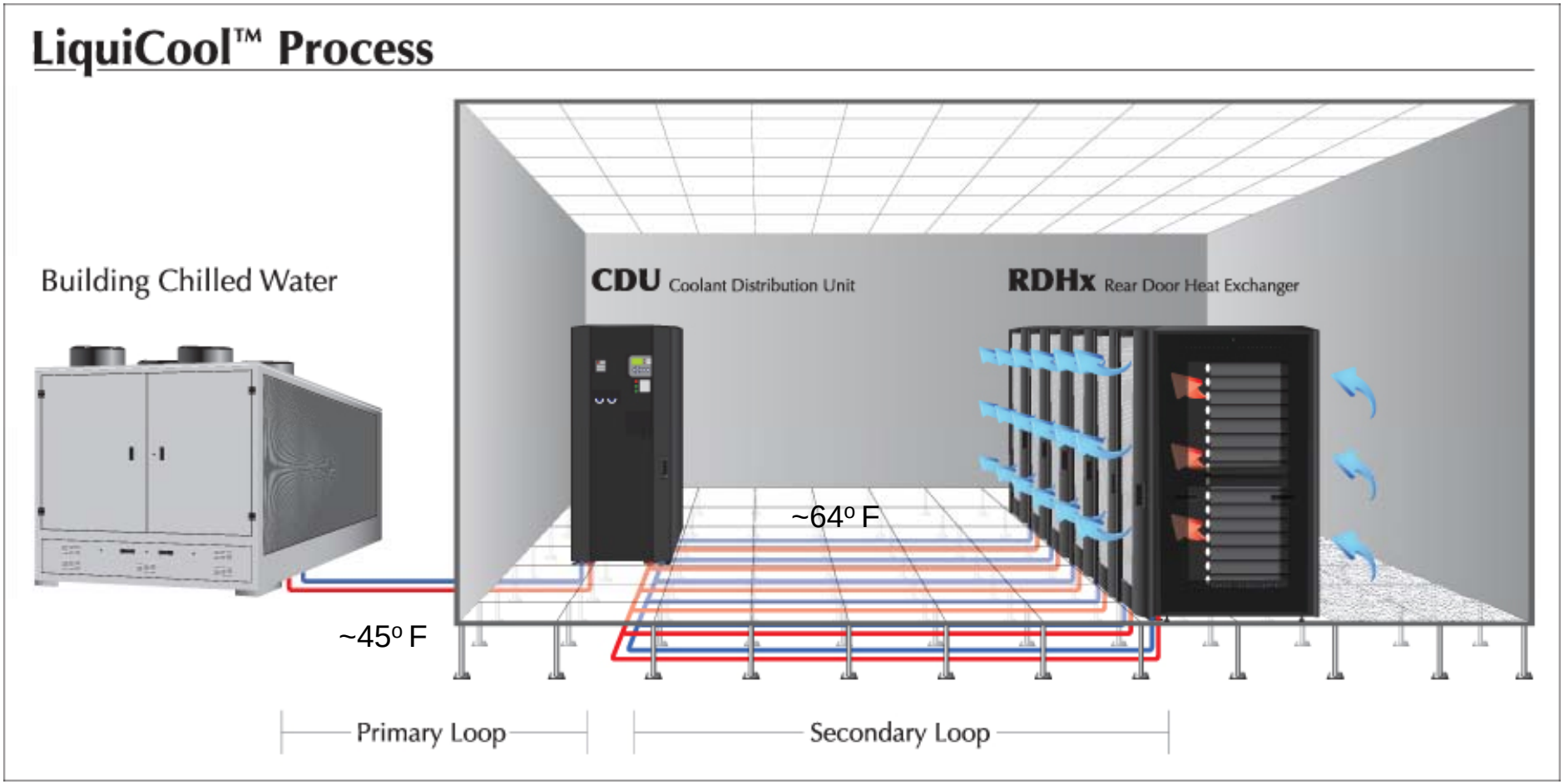
Source: IDC, 2008

Data Center Trends

- In 2008, approximately **50%** of the world's data centers will be functionally **obsolete** due to insufficient power and cooling capacity to meet the demands of **high-density** IT equipment.

Source: Gartner Inc "DC Power and Cooling Challenge Seminar 2007"

RDHx System


LiquiCool™ Process
Building Chilled Water
CDU Coolant Distribution Unit
RDHx Rear Door Heat Exchanger
~64° F
~45° F
Primary Loop
Secondary Loop

Advantages of Liquid Cooling

- Liquid cooling has been around for decades (IBM mainframes, Cray super-computers, military electronics)
- Water cools 3,400x more than air
- It is less expensive to pump liquid throughout a Data Center than air
- Liquid cooling saves valuable floor space
  - Can save 50% or more floor space vs. cooling with CRAC's
- Water cooling can save 15-25% annually in cooling energy costs
- Water cooling is highly flexible

RDHx Specifications

- Maximum Cooling Capacity: 30kW
- Coolant: Cooled water (above dew point)
- Dimensions: 76.6“ H x 4.6“ D x 23.6“ W
  (1945mm H x 117mm D x 600mm W)
- Weight - empty: 63lbs (29kg)
- Liquid Volume; 1.5 Gallons (5.7 Liters)
- Liquid Flow Rate: 6-10 GPM (23-38 L/min)
- Head Loss: 7 psi (48 kPa) at 10 GPM (38 L/min)
- System Input Power: None required

RDHx Rear Door - External View

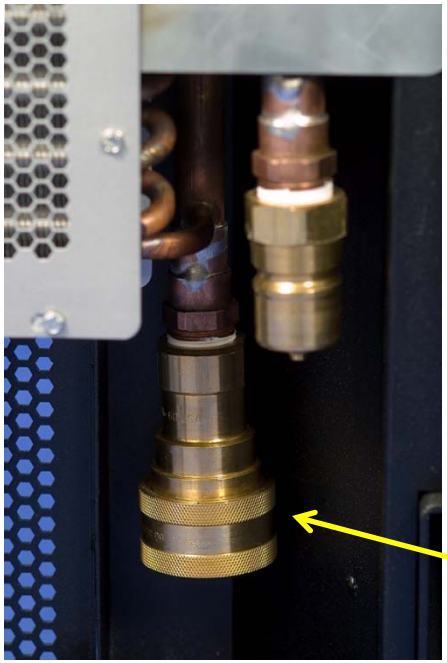
Rear Perforated Door using 64% open perf pattern

Door Handle

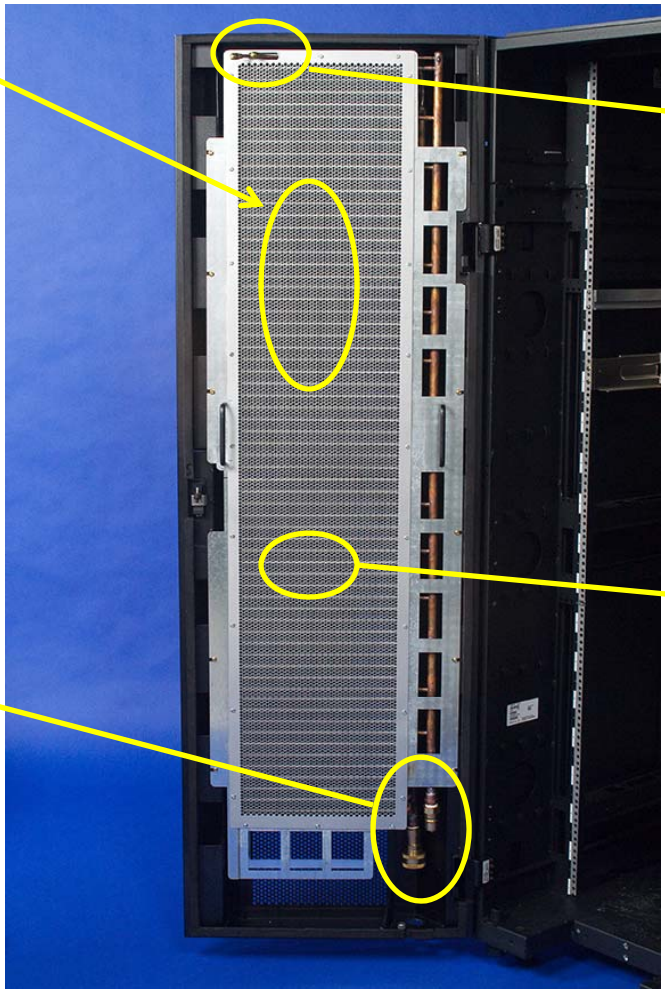
Bypass Vent

RDHx Rear Door - Internal View

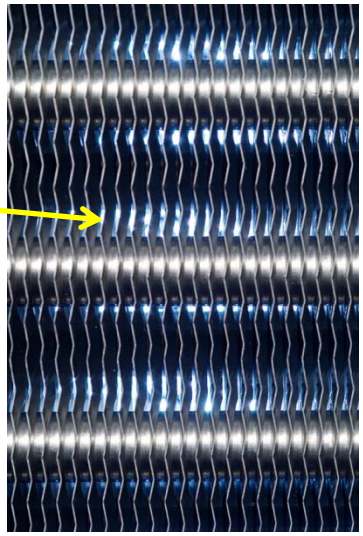
Protective Barrier



Hose Connections and Drain Valve



Air Bleed Valves

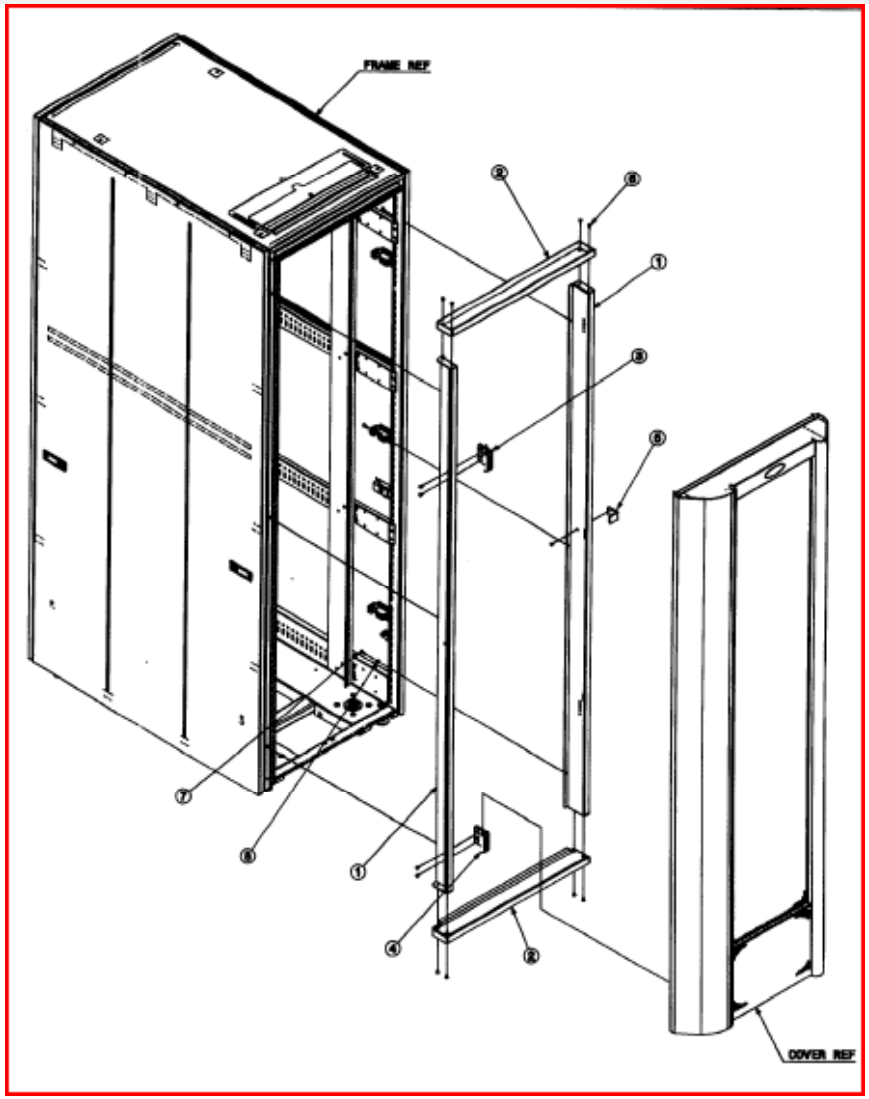


Tube & Fin Coil

Vette RDHx Compatibility

- Vette has been manufacturing RDHx for IBM NetBay 42U racks since 2007
- Vette industry standard RDHx launched July 2008 and is compatible with:
    1) HP10642, Rittal TS8 (DK7831.436, 437, 438, 439, 481, 482, 491, 492), 42U x 600mm wide **RD18WXS-02**
    2) Dell 4210, IBM 42U S2, 42U x 600mm wide **RD18WXS-03**
    3) APC SX AR3100, 42U x 600mm wide **RD18WXS-04**
    4) APC VX AR2100BLK, 42U x 600mm wide **RD18WXS-05**
    5) Wright Line Paramount, 44U x 24” wide **RD18WXS-06**
    6) Great Lakes GL840ES-3042, 44U x 30” wide **RD18WXS-07**
- All Vette P/Ns include RDHx + Transition Frame

Door and Transition Frame



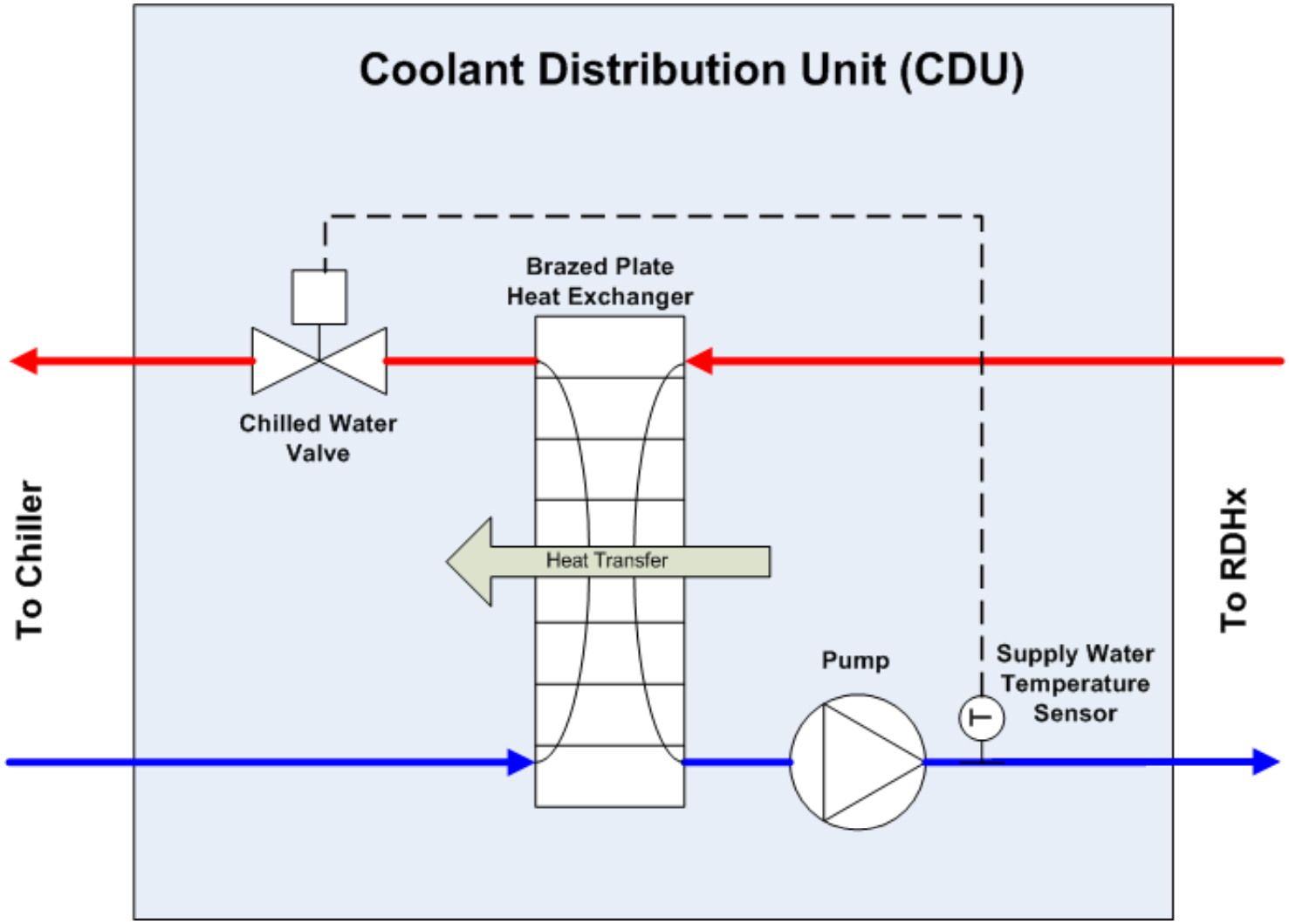
RDHx Key Advantages

- Lower TCO versus competitive systems
  - Very high COPs drive down OPEX
- CAPEX competitive
  - Typical systems cost $10-15k per IT enclosure
  - Budget includes RDHx, hoses, CDU, treated water, service
- Easy to install on new or existing enclosures
- Neutralizes heat loads at the source
- Saves valuable floor space
- Eliminates need for hot air containment systems
- Higher reliability – no moving parts
- No additional noise in data center

Coolant Distribution Unit (CDU)

- Water to water heat exchanger with pumps, controls and chilled water valve
- Uses building chilled water supply on primary side
- Creates an isolated secondary cooling loop
- Supports 6-10 RDHx (Floor mount unit)
- Supports 1-2 RDHx (Module)
- Maintain secondary loop above dew point for 100% sensible cooling and eliminate condensation
- Provides control and monitoring

CDU Simplified



CDU Specifications

- Floor-mounted units
- 120kW or 150kW Capacity
- Internal manifold for up to 6 RDHx units
- Flexible tails for external manifolds
- 2.5kW power consumption
- Pump capacity 63 GPM at 30psi (240 L/min at 207 kPa)
- Primary head loss 10.2 psi at 63 GPM (70 kPa at 240 L/min)
- Minimum approach temperature (100% load)
  - 120kW unit - 12°F (6.7 °C)
  - 150kW unit - 8°F (4.4 °C)
  - 63 GPM (240 L/min) on primary and secondary

120/150kW CDU Internal - Front

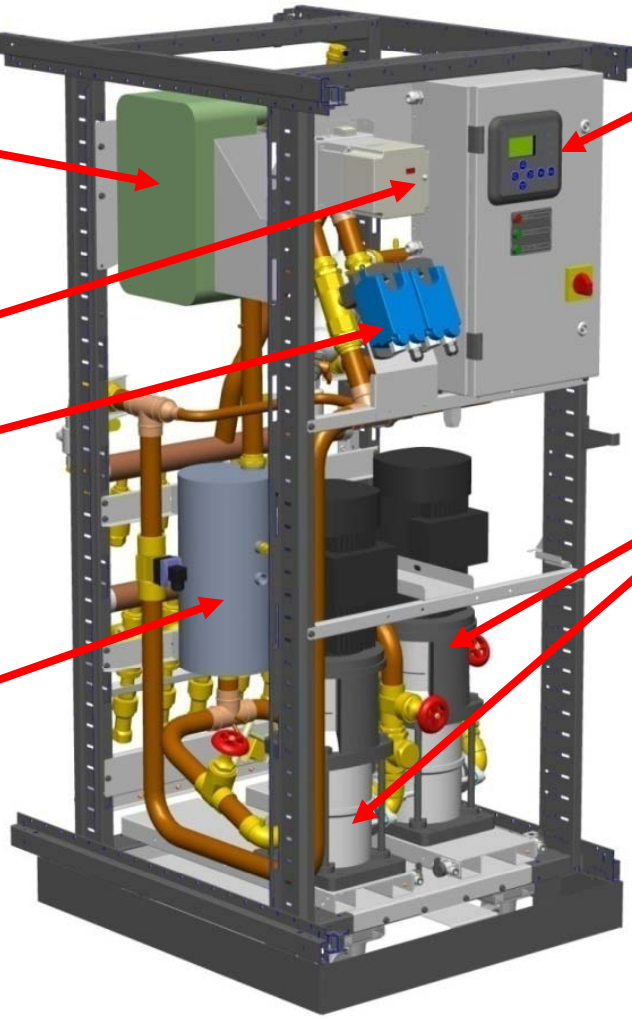
Controller

Brazed plate heat exchanger

Inverter drive

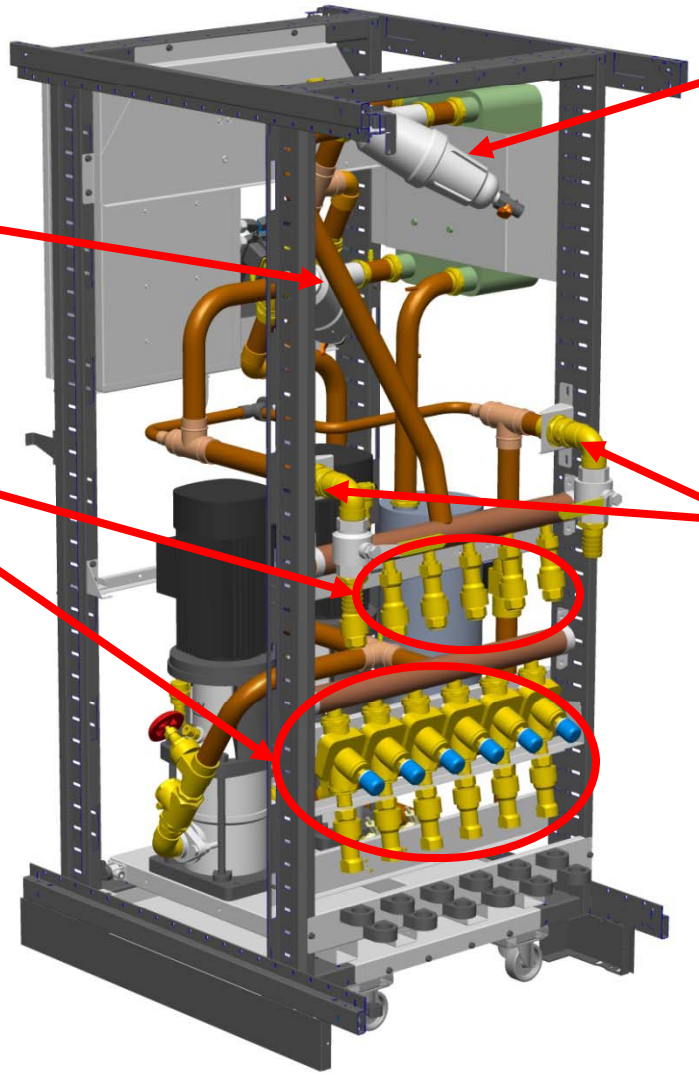
Redundant valves & actuators

Reservoir tank



Redundant variable speed pumps

120/150kW CDU Internal - Rear



Primary side water filter

Secondary loop water filter

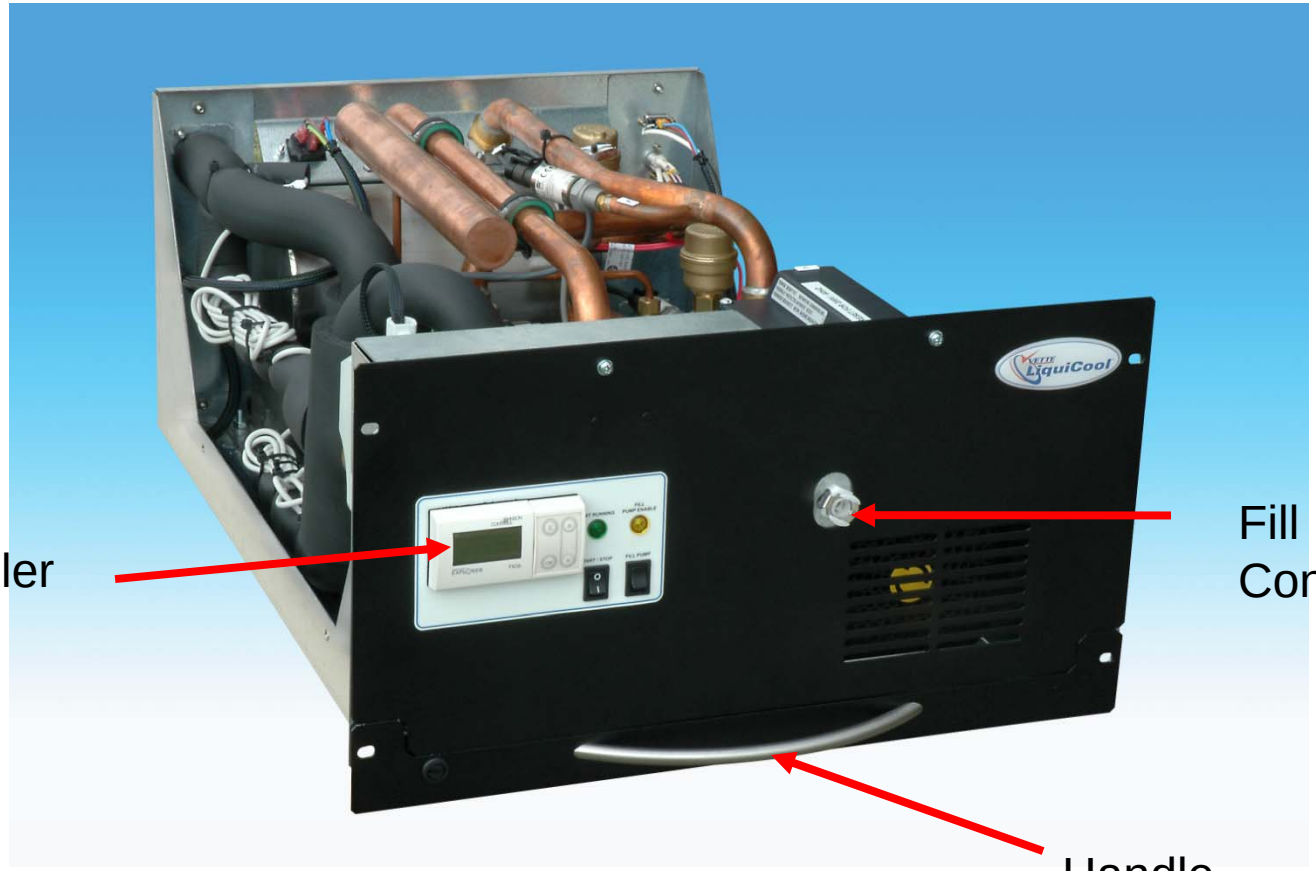
Optional Secondary loop distribution manifold

Primary supply/return connections

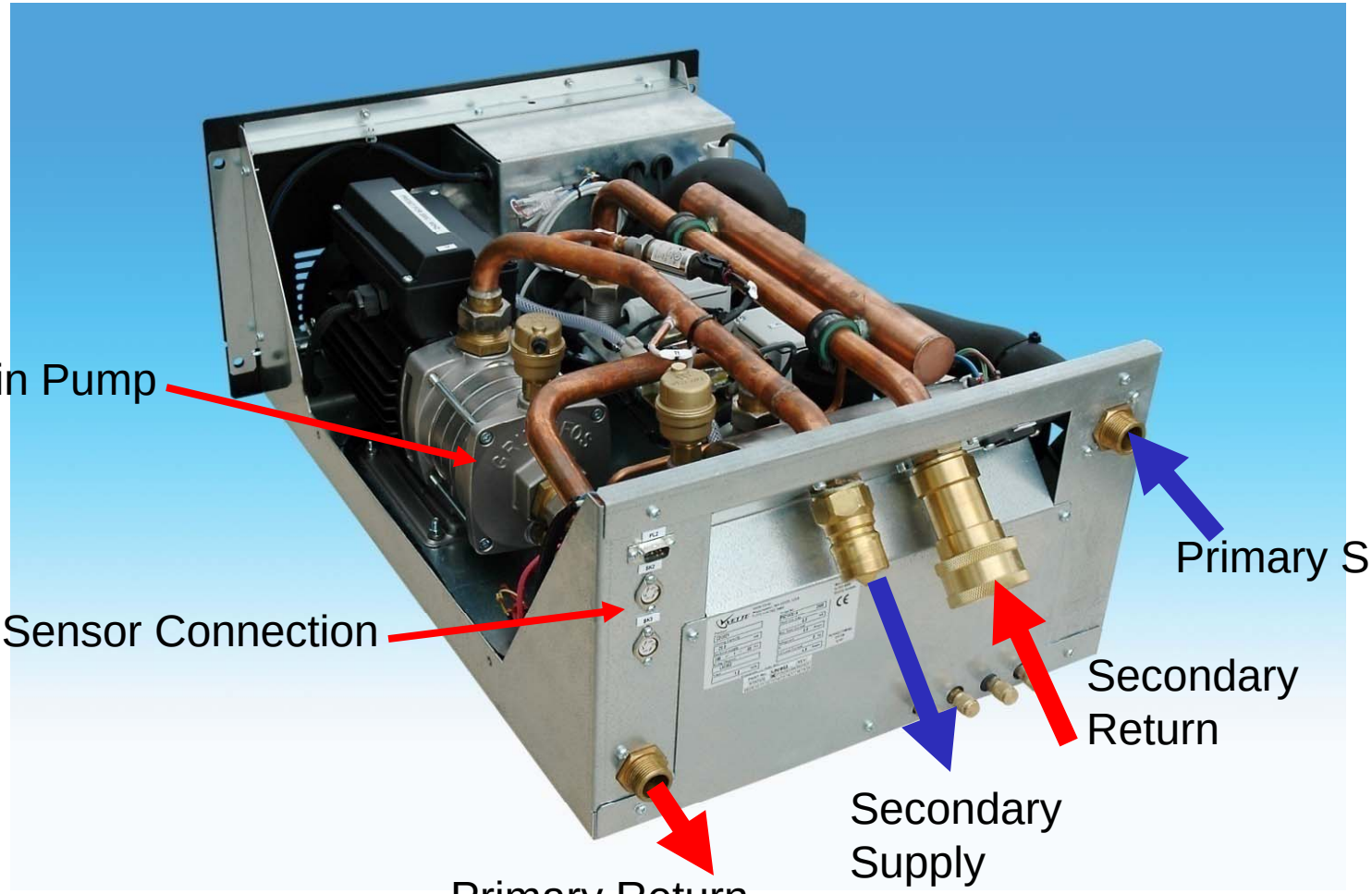
CDU Specifications

- Module unit, mounts in 19” EIA enclosures
- Consumes 6U of rack space
- 20kW capacity
- Serves 1-2 RDHx
- 690 W power consumption
- Pump capacity 10 GPM at 36psi (38 L/min at 248 kPa
- Primary pressure drop 7.3 psi at 10 GPM (50 kPa at 38 L/min)
- Minimum approach temperature
  - 13°F (7.2 °C) at 100% load
  - 8 GPM (30 L/min) on primary, 10 GPM (38 L/min) on secondary

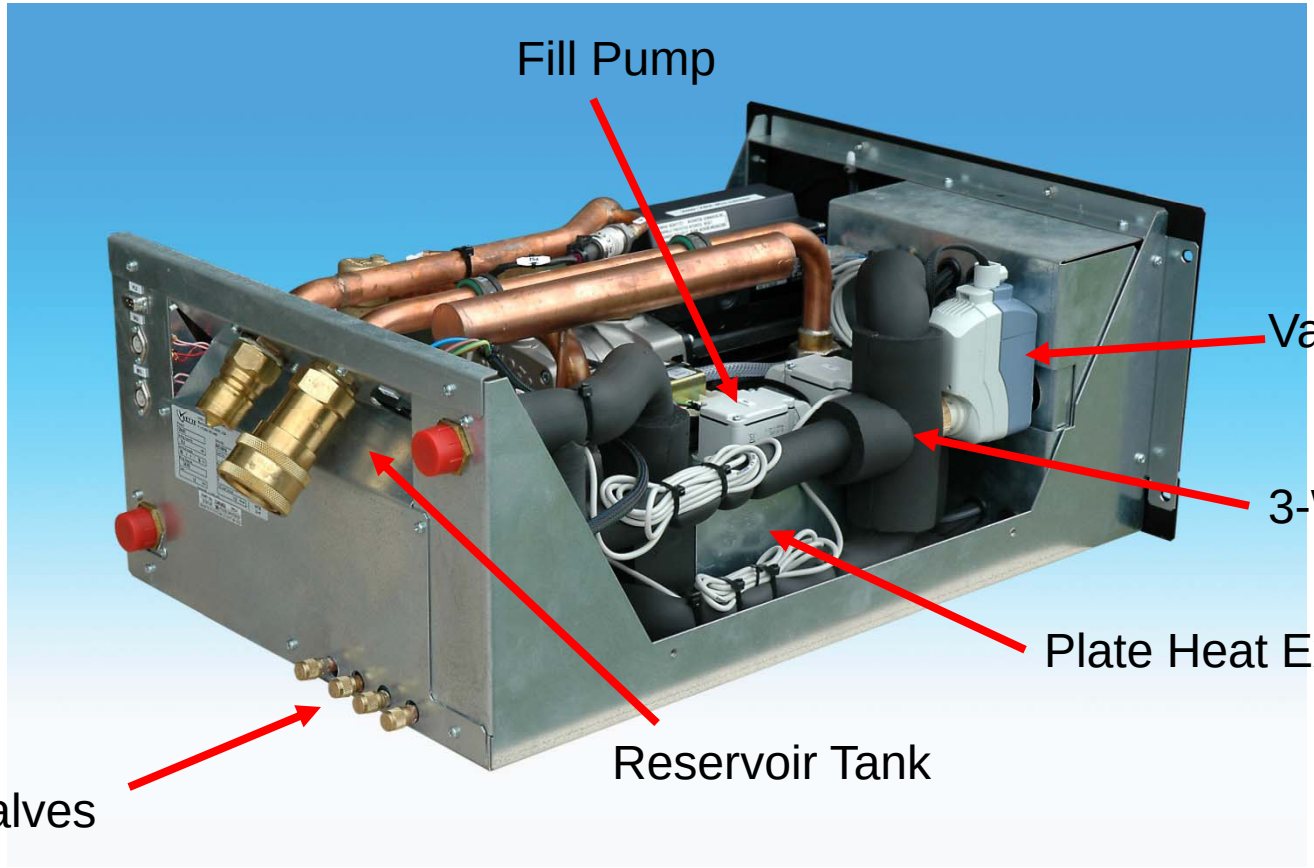
20kw CDU Internal - Front



20kw CDU Internal - Rear



20kw CDU Internal - Rear



Advantages of a Secondary Cooling Loop

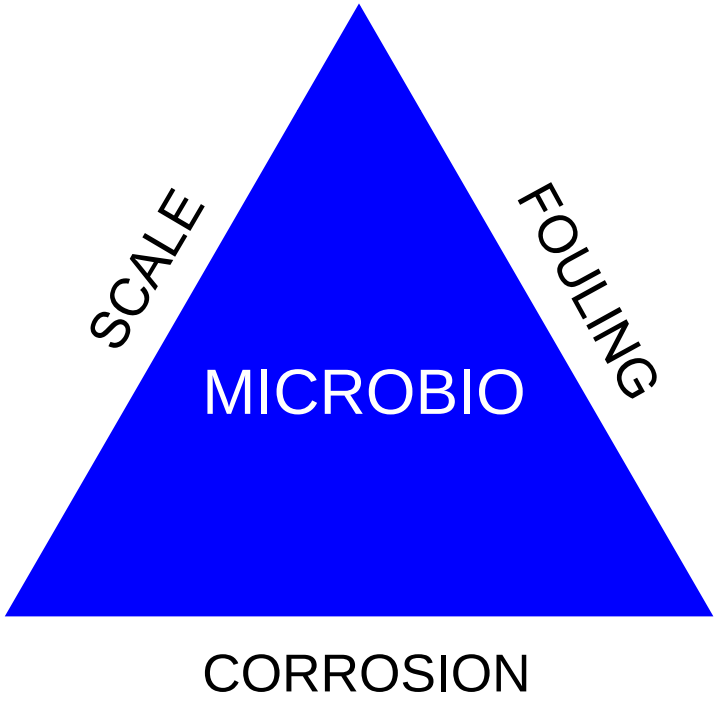
- Spill Limitation
  - Small volume of water, tens of gallons instead of hundreds/thousands
- Dew Point Control
  - Stay just above room dew point to ensure 100% sensible cooling, no condensation
  - No need to control entire facility CW loop
- Water Quality
  - Reduces potential for introduction or development of corrosives
  - Tailored water treatment for specific metallurgy
- Flexibility for Expansion
  - When scaling up, allows easy deployment of additional units without having to shut down entire system or perform hot taps
- Increased Redundancy
  - Multiple pumping units can be provided to cover a single secondary cooling loop

Hose Kits

- Each Hose Kit consists of a flexible supply hose and return hose
- Factory assembled and tested
- Leak-tested using helium to 200 psi (normal operation is 10-20 psi)
- Quick-connect couplings on either one or both ends
- Straight hoses for raised floor environments
- Right angle hoses for non-raised floor environments

Water Treatment

Common Cooling Water Problems



Potential Effects of Non-Treatment

- Loss of heat transfer
- Reduced system efficiency
- Reduced equipment life
- Equipment failures or leaks
- De-ionized water without inhibitors is corrosive!

SVLG 'Chill Off' Results

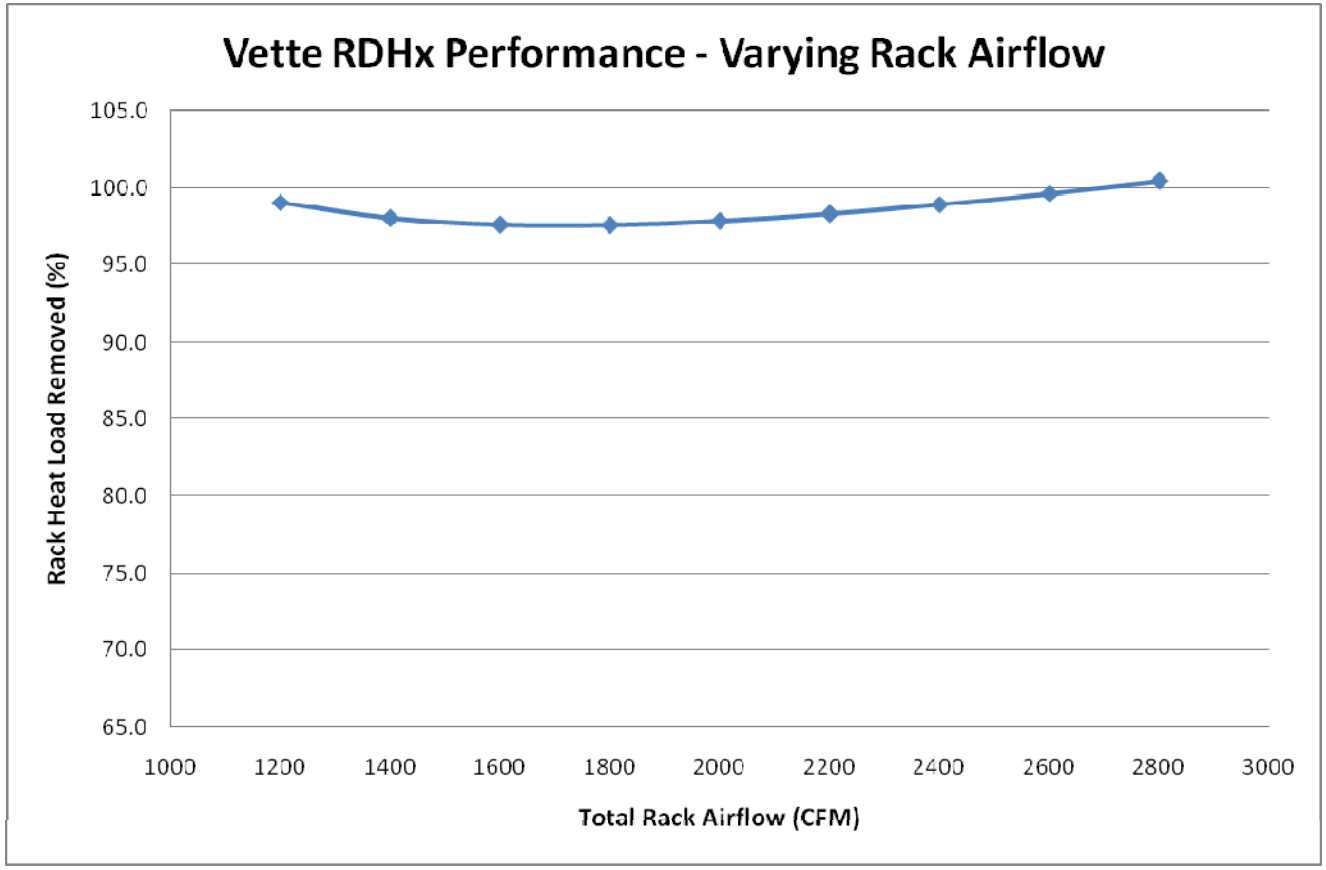
- Chill Off sponsored by SVLG and staged at Sun Microsystems data center in Santa Clara to compare efficiency of liquid cooling solutions from Vette/IBM, Rittal, APC, Liebert.
- Vette installed the Rear Door Heat Exchanger (RDHx) solution with 20kW Vette CDU
- Vette/IBM solution the most efficient by a significant margin
  - Coefficient of Performance: 64 – 229

"These values indicate dramatically higher energy efficiency than the other systems"

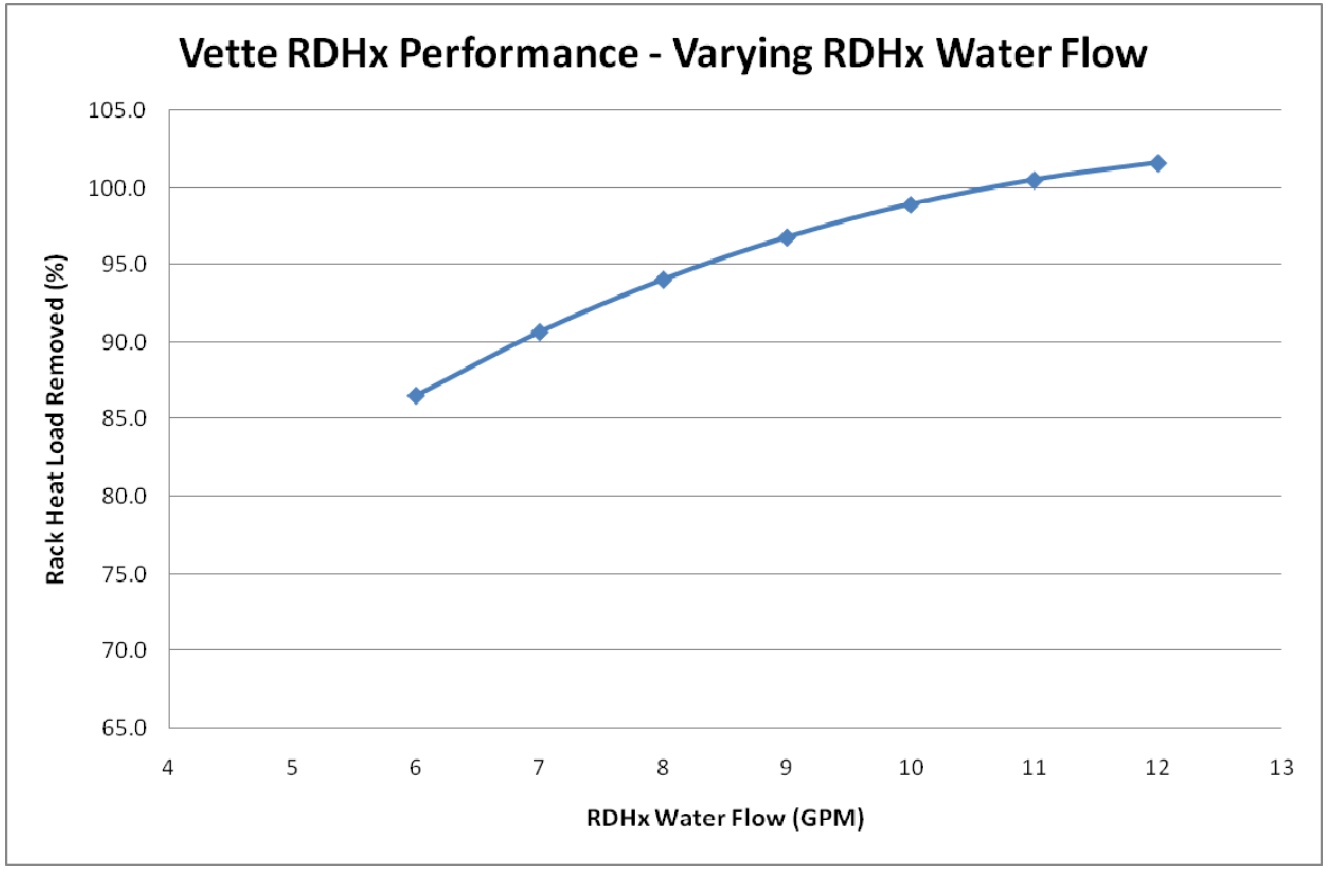
Parametric Curves

- The performance of a RDHx depends on several variables or parameter:
  - Rack Airflow
  - RDHx Water Flow
  - Rack Inlet Air Temp
  - RDHx Inlet Water Temp
- Starting with following conditions
  - Room air of 80°F (27 °C), 30%RH, 46°F (7.8 °C) dew point
  - 2400 CFM (4077 m^3/hr) per rack
  - RDHx supplied with 10 GPM (38 L/min) of 100% water at 48°F (8.9 °C)

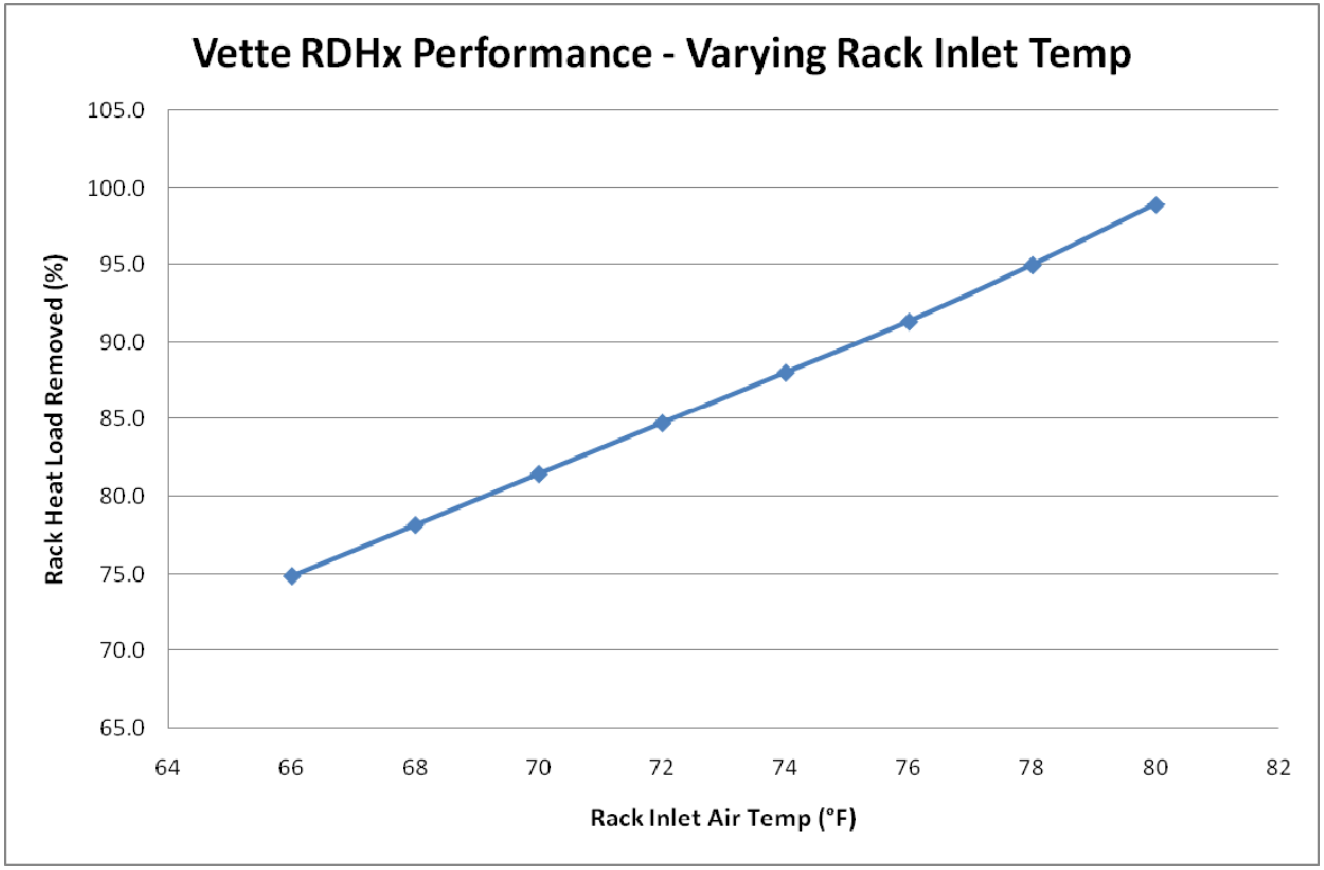
Airflow Through Rack



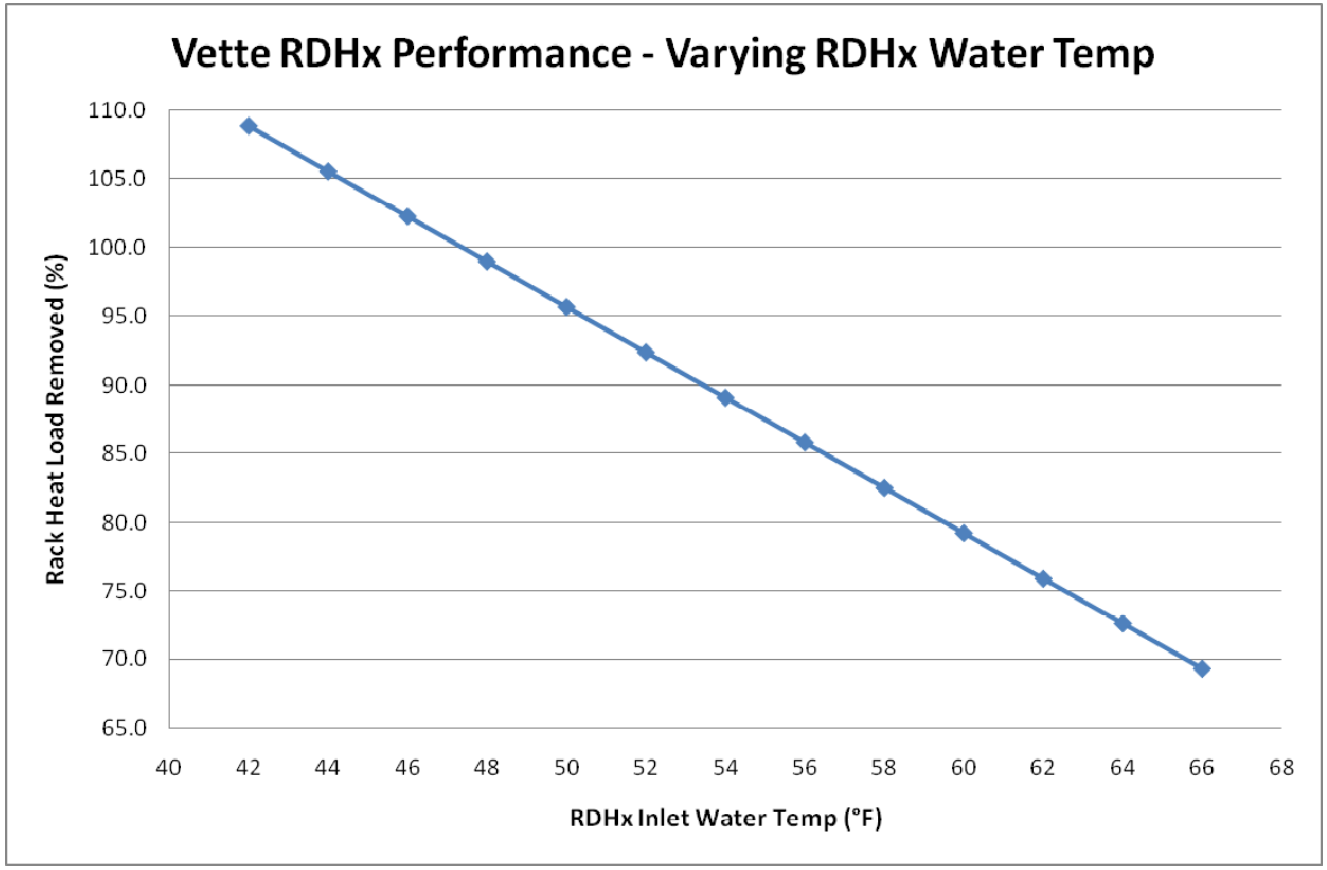
RDHx Water Flow



Inlet Air Temp



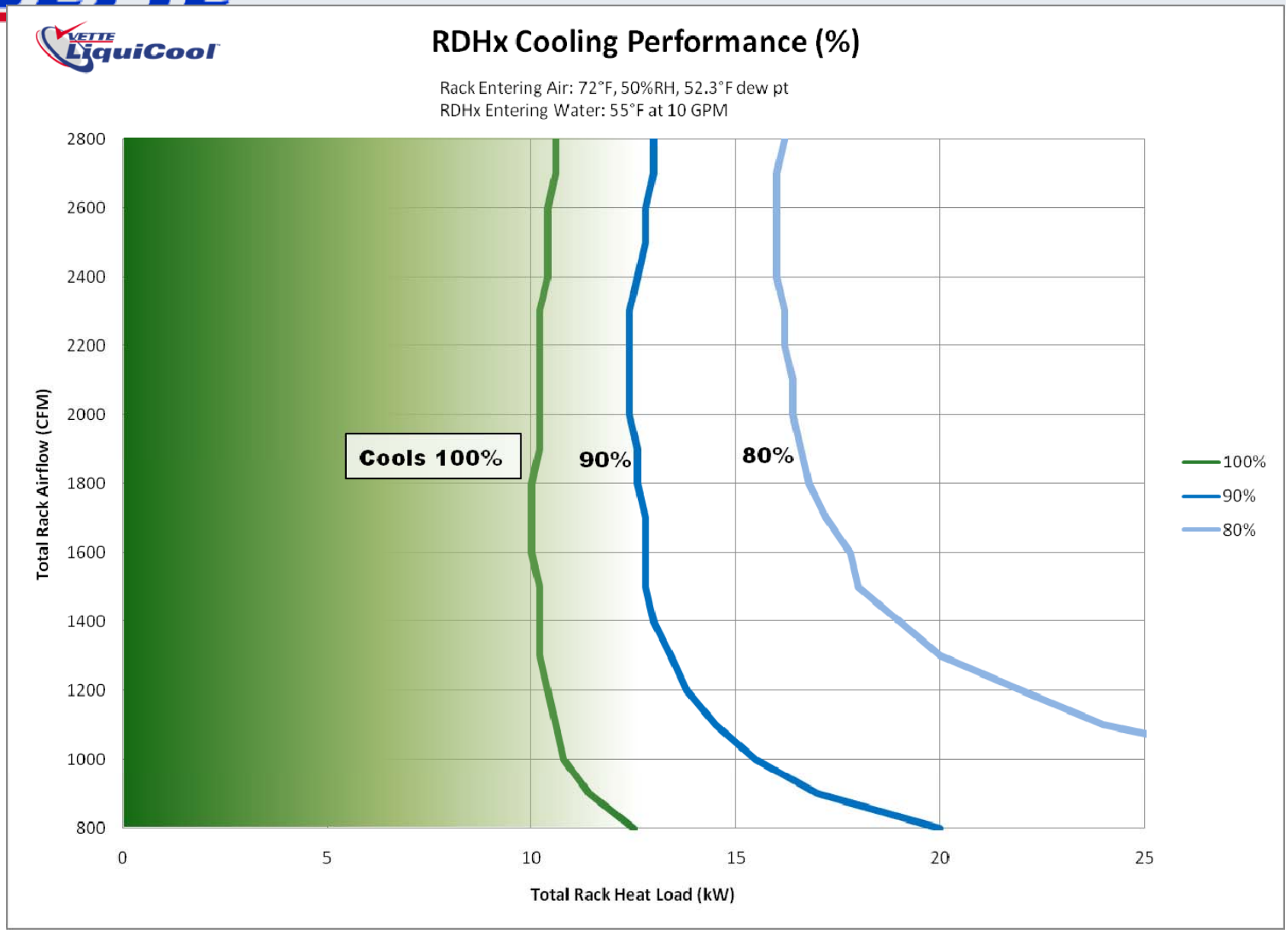
RDHx Inlet Water Temp



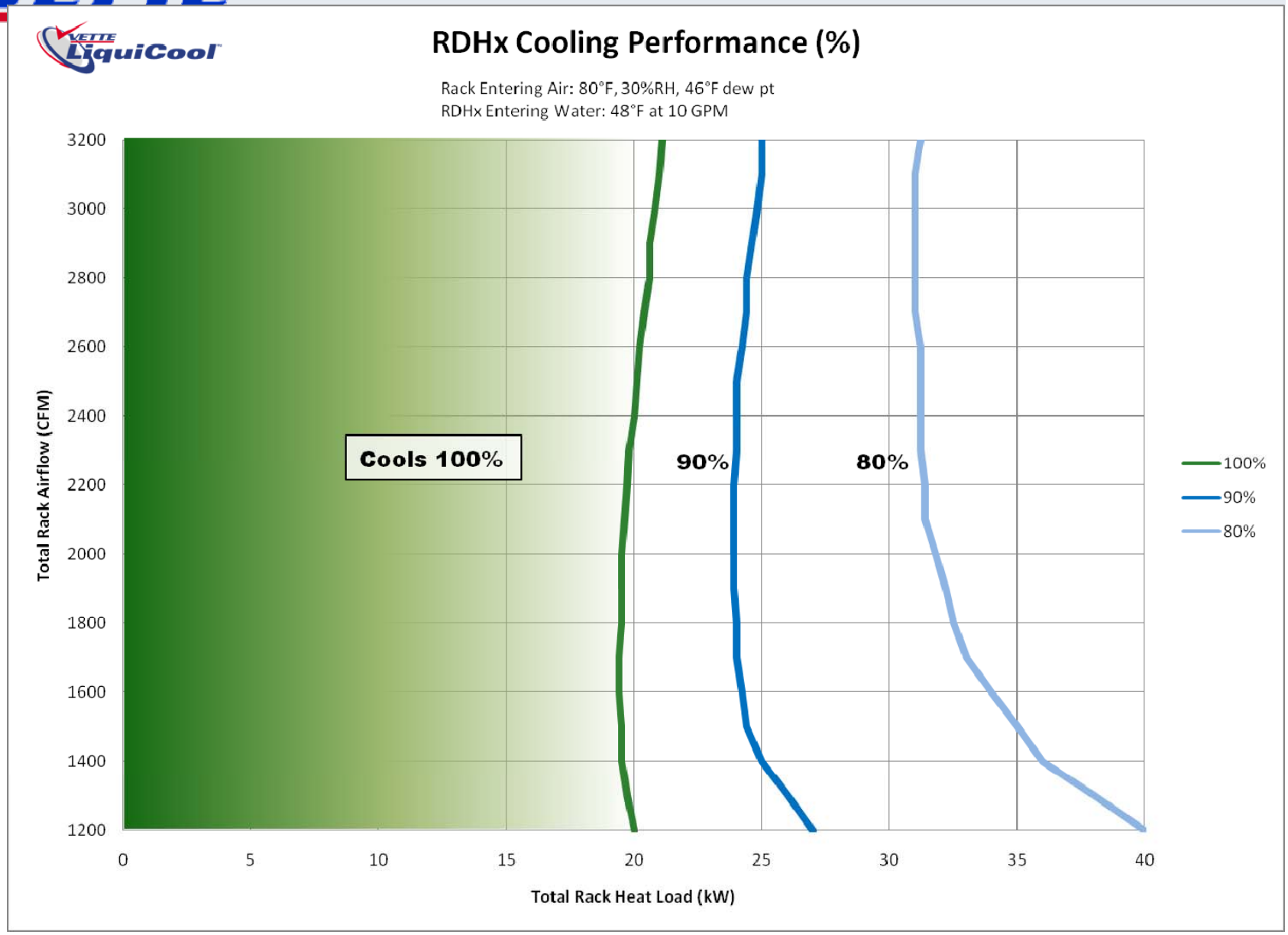
Neutral Zone Chart

- Operating area that the Rear Door Heat Exchanger can cool 100% of the heat load within a rack.
- Rack is thermally neutral to the data center.

Neutral Zone Chart



Neutral Zone Chart



RDHx Installation

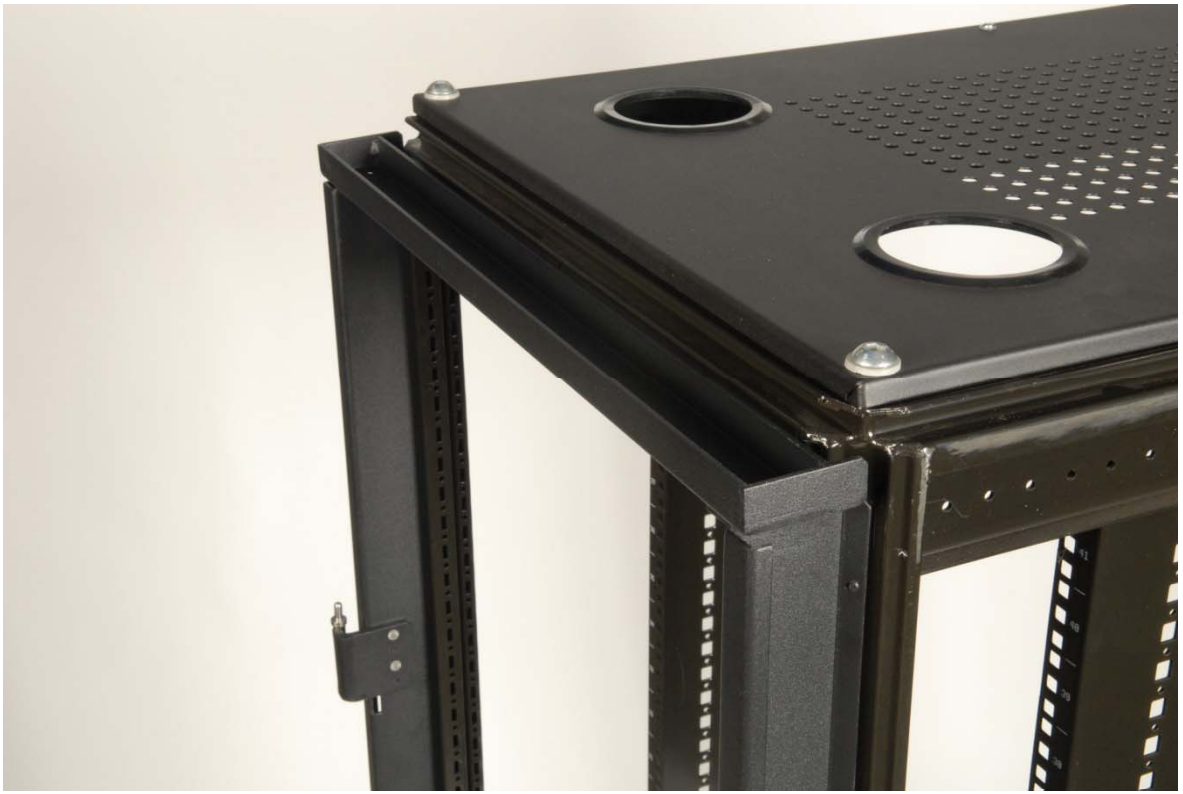
- RDHx can be retrofitted on deployed enclosures without disturbing operations
- Attaches to a variety of standard IT enclosure
- Quick connections for easy deployment

RDHx Installation

Industry Standard Enclosure

Remove the Rear Door and Hinges

RDHx Installation

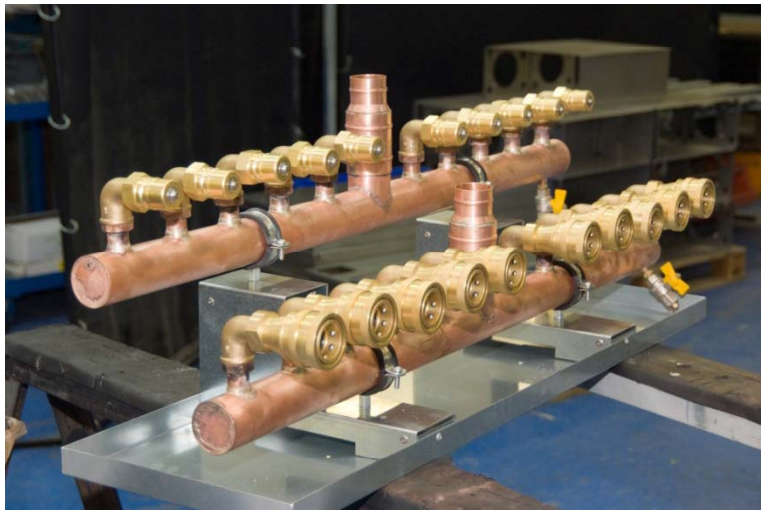


Assembly the Transition Frame to the Enclosure

RDHx Installation

Attach the RDHx Door to the Transition Frame.

Under Floor Manifolds



- Multiple RDHX and/or CDUs
- Full drip trays

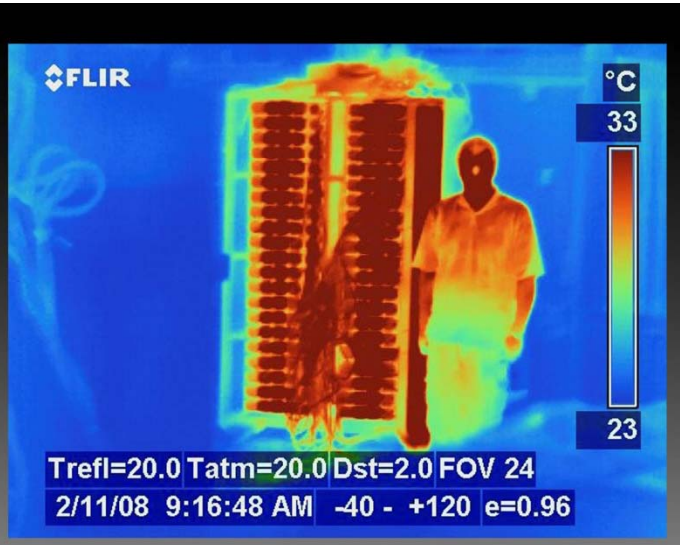
Georgia Tech Installation

Front view

Rear view

Georgia Tech super computing facility - 12 racks at ~25kW each

Thermal Image Before & After



Executive Summary

- RDHx neutralizes heat at the rack level
- Easy to deploy and implement
- Offers compelling OPEX and space savings
- Extends life of existing data centers

- Easy to design into new and existing facilities
- Solve hot spot issues or can be basis of design

Q&A

- Questions?