REFERENCE DESIGN #506

HIGH-EFFICIENCY COOLING FOR THE 250 MW AI FACTORY

Scalable Direct-to-Chip Liquid Cooling Coupled with Air-Cooled Chillers

Integrated Free Cooling, Simplified Deployments

INTRODUCTION

Artificial intelligence is driving massive growth in data center demand — and advanced cooling is critical to keep innovation running. Trane leads the way with proven thermal management solutions for AI factories and data centers of all sizes.

This reference design provides:

- ✓ A 250 MW cooling blueprint for AI factory applications
- ✓ Integrated air- and liquid-cooling configurations for NVIDIA racks
- ✓ Guidance on CDUs, fan coil walls, chillers, pumps, and facility piping
- ✓ A foundation for mechanical design that complements electrical and controls systems

The NVIDIA DSX AI Factory Platform unifies AI factory design and operations across compute, networking, power, cooling, facilities, and software. In support of that approach, LiquidStack's GigaModular™ CDU has qualified as NVIDIA DSX Ready CDU, meeting the applicable NVIDIA DSX reference design requirements for his reference design.

DESIGN OVERVIEW

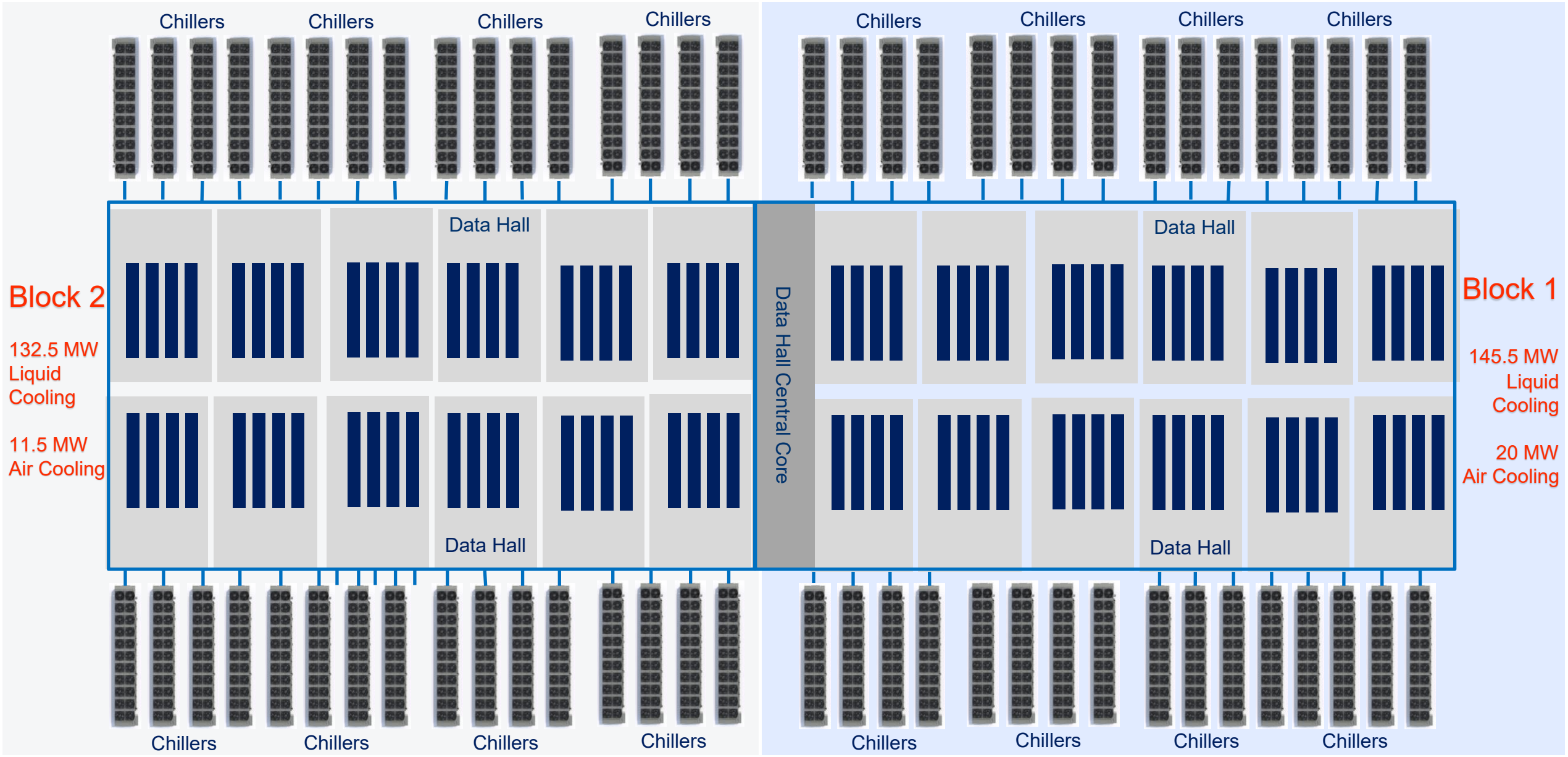
Temperature and Flow Rates

The following table summarizes the air-cooled chiller temperature and flow rate requirements for this reference design. Based on a 16-rack-per-Scalable-Unit AI factory with the Vera Rubin MaxLPS Architecture in Chicago, IL, these values can be adjusted for specific applications

	Medium Temperature (Airside)	High Temperature (Liquid Direct to Chip)
Block 1 (2 Data Halls + Core)	19.87 MW (5,650T)	145.5 MW (41,372T)
Block 2 (2 Data Halls)	11.37 MW (3,233T)	132.5 MW (37,676 T)
Load Requirement/Chiller	2.25 MW (640T)	2.5 MW (712T)
Evaporator Flow Rate/Chiller	3,245 LPM (857 GPM)	2,131 LPM (563 GPM)
Facility Loop Temperature (Return)	32°C (89.6°F)	47°C (116.6°F)
Facility Loop Temperature (Supply)	22°C (71.6°F)	*30°C (86°F)
Technical Loop Supply Temperature		41°C (105.8°F)
Technical Loop Return Temperature		51°C (123.8°F)
Supply Air Temperature	27°C (80.6°F)	
Max Ambient (Chicago, Il)	40°C (104°F)	

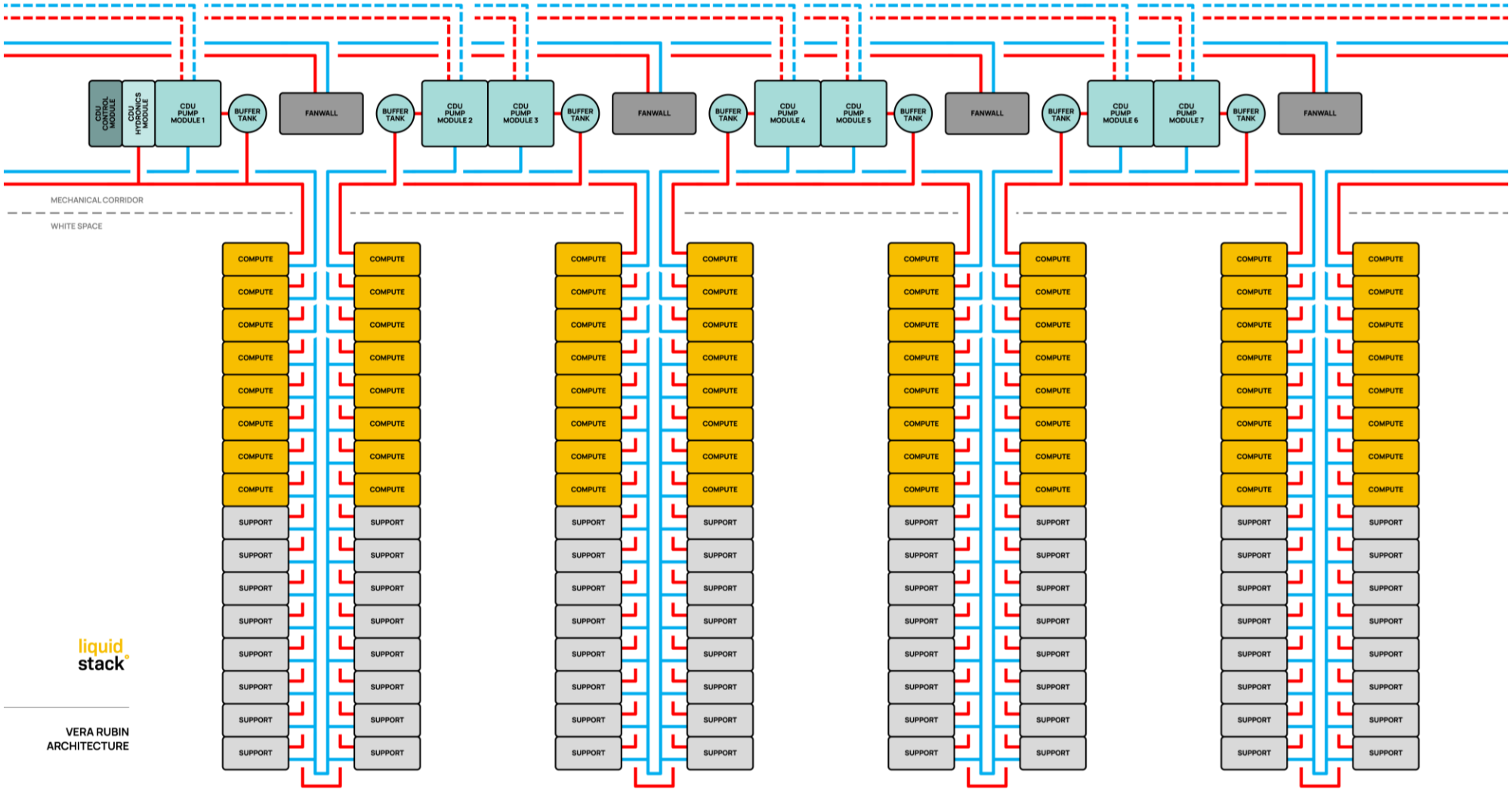
** A 30°C chiller plant supply stream is blended with 47°C primary return water to achieve a 37°C primary supply temperature at the CDU.*

DESIGN OVERVIEW THERMAL MANAGEMENT (OR COOLING) BLOCKS



DEPLOYMENT OF INTEGRATED AIR AND LIQUID COOLING

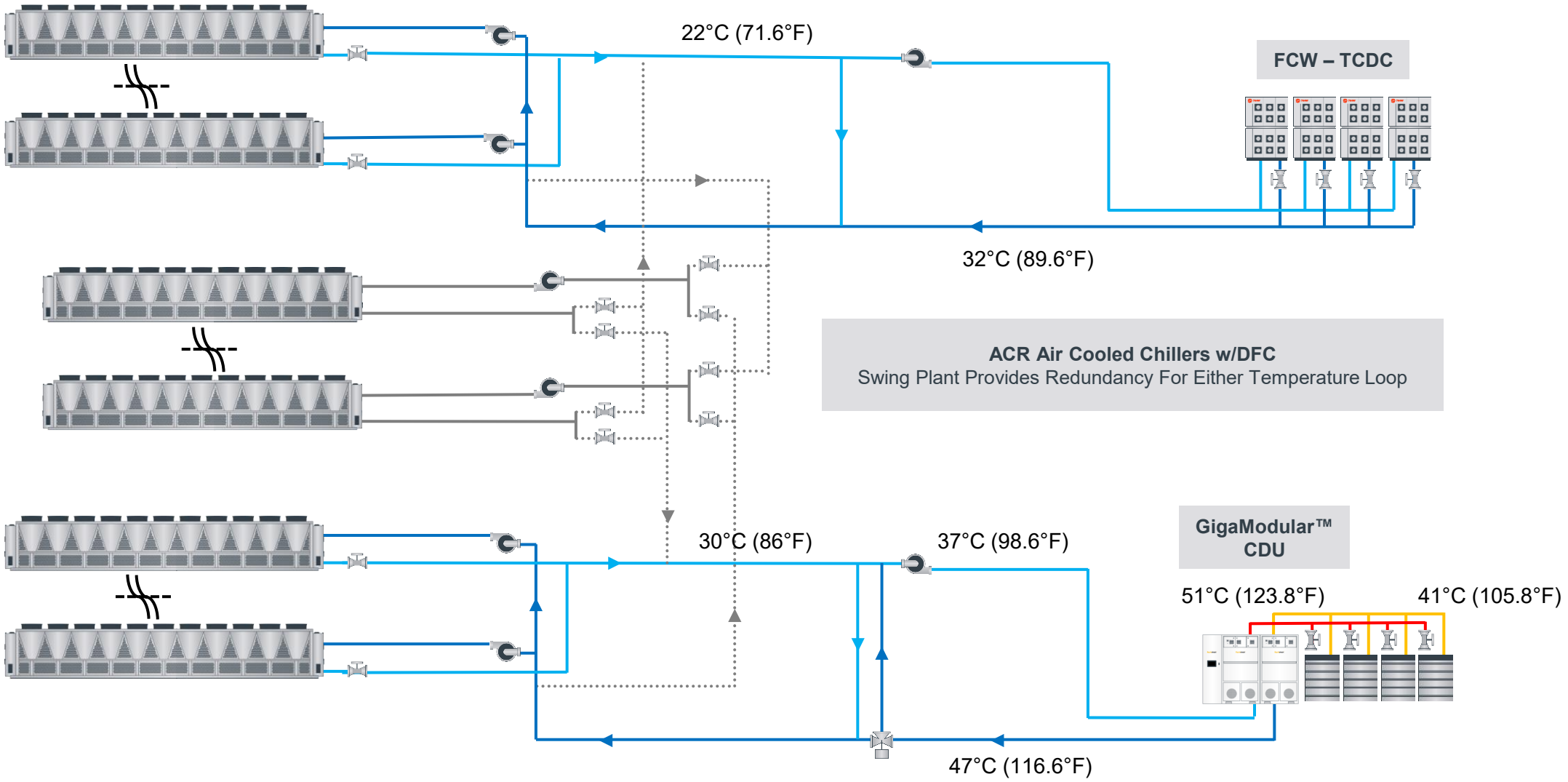
6 Deployments per data hall



DESIGN OVERVIEW

Reference Diagram

- ✓ **Integrates air- and liquid-cooling systems**
- ✓ **Streamlined, low-complexity system - easy to commission**
- ✓ **Integrated Free-Cooling**



DESIGN OVERVIEW

Customer Outcomes

Help reduce power use

- Dedicated high temperature loop reduces chiller power.
- Integrated Free-Cooling reduces annualized power use
- Advanced controls enhance chiller lift and pump energy to help maintain superior PUE.

Help reduce time to full performance

- Fully packaged air-cooled design requires no cooling towers or condenser-water systems.
- Factory-tested controls and a factory-installed waterside economizer help reduce commissioning, design complexity, and construction scope.
- Simplified piping, electrical, and chilled-water connections help reduce onsite labor.

Help balance total cost of ownership (TCO), redundancy and resiliency

- Modular Coolant Distribution Units (CDUs) scale to support larger liquid-cooling deployments while reducing CapEx and footprint.
- Wide chiller plant delta T helps reduce piping infrastructure costs while decreasing the required ride-through thermal energy storage capacity
- Swing chillers can serve high- or low-temperature loops, reducing the total chillers needed.
- LiquidStack's GigaModular CDU, qualified as DSX Ready CDU for this reference design, helps customers evaluate liquid-cooling infrastructure with greater confidence.

SYSTEM SUSTAINABILITY

Air-cooled chiller thermal management systems offer high efficiency and fully packaged solutions with the ability to be commissioned and scaled quickly. In addition, air-cooled chillers require no water and are simpler to operate in large-scale AI data centers supporting more sustainable infrastructure strategies alongside LiquidStack's approach to efficient, environmentally conscious data center cooling.

- Integrated free cooling for lower annualized Power Usage Effectiveness (PUE)
- Air-cooled chillers eliminate water use — Water Usage Effectiveness (WUE) = 0
- R-513A (Low GWP), R-1234ze (Ultra-Low GWP) refrigerant significantly reduces carbon impact
- Complements LiquidStack sustainability by helping reduce water consumption and overall environmental impact in AI data center operations

GigaModular™ CDU Platform – NIVIDIA DSX Ready

Scalable Capacity with Centralized Controls for a Simplified Infrastructure

Modular building blocks scaled to suit a wide range of data hall layouts and deployment strategies

- Reduced infrastructure footprint compared to traditional CDUs enables more cooling capacity per square foot
- Up to 20% lower CapEx versus traditional row CDU deployments

Centralized system-level controls and instrumentation architecture

- Dual concurrently maintainable controllers
- Resilient 2-way ring network communications architecture
- Eliminates redundant onboard controls in each pump module
- Ensures stable and balanced group control

Service-forward design supports maintainability across the system

- Concurrently maintainable components
- Simplified service model: front and rear, or front and side, access allows for flexible module placement within the data hall or gray space
- Hot-swappable components (controllers, pumps, filtration)

LiquidStack's GigaModular CDU has qualified as NVIDIA DSX Ready CDU. It meets the applicable NVIDIA DSX reference design requirements for this reference design, helping AI factory builders select liquid-cooling infrastructure with greater confidence.

GigaModular™ CDU Platform – NIVIDIA DSX Ready

Built and Validated for the Future of AI Infrastructure

Supports evolving GPU platforms

- Designed for high-density AI environments
- Scales to meet next-generation GPU deployment requirements
- Designed to meet NVIDIA Vera Rubin specifications and beyond

Flexible placement options for any data hall

- Pump modules can be distributed (as shown on previous TCS Loop Design slide), grouped, or skidded
- Suitable for white space, mechanical corridors, or gray space

Flexible, scalable hydronic architecture

- Optional hydronic modules include an expansion tank and make-up reservoir
- Replicable modular deployment model
- Scales beyond standard header configurations through site-level hydronic design

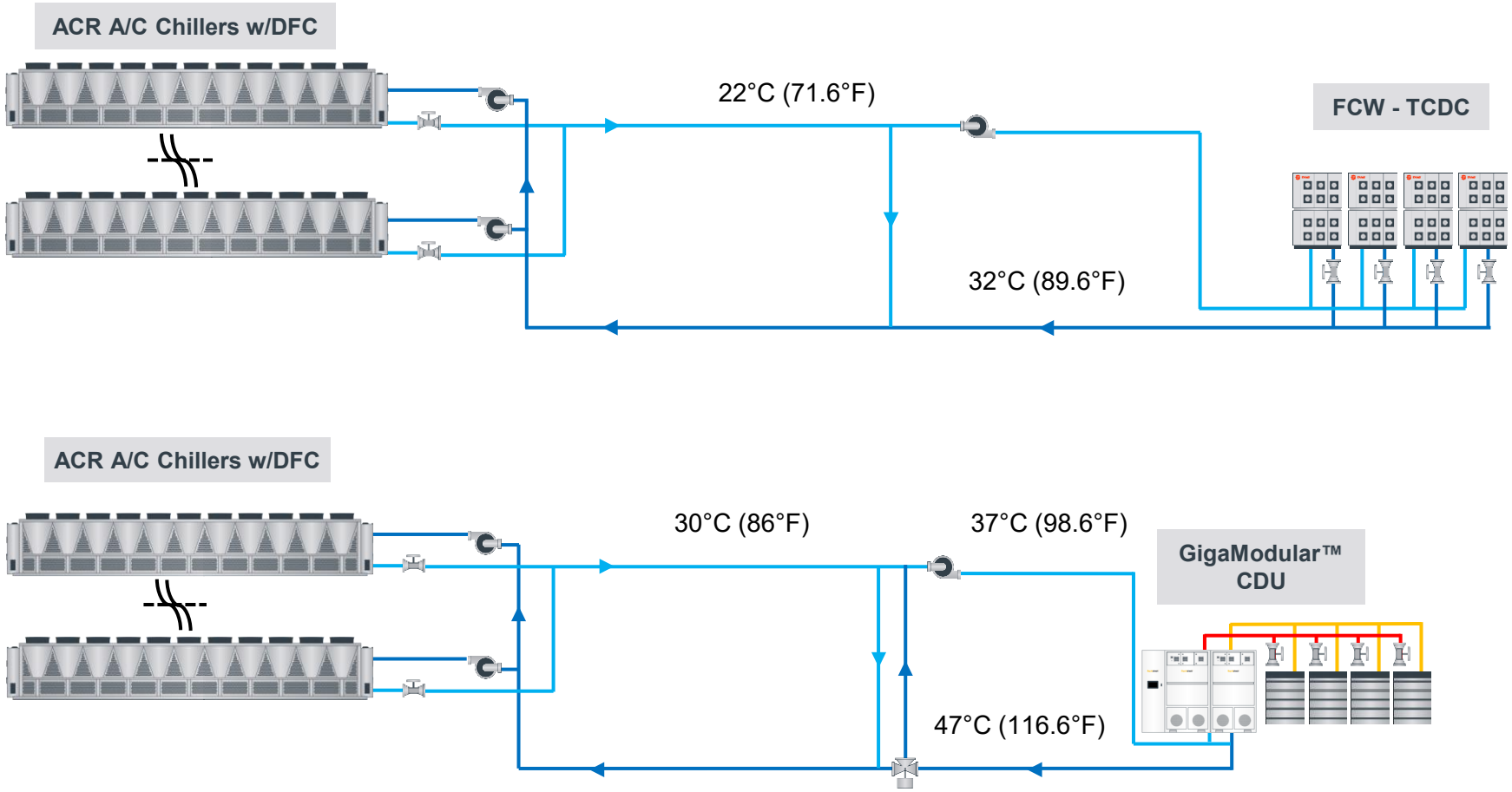
Qualified as NVIDIA DSX Ready CDU for this reference design, LiquidStack's GigaModular CDU supports liquid-cooled AI factory infrastructure aligned to applicable NVIDIA DSX reference design requirements.

SYSTEM BENEFITS

Scalable and Simplified for Greater Efficiency

Dual-temperature chiller plant, dedicated medium and high temperature chillers

- Best used when load ratios and temperature requirements are well defined and stable.
- Separate loops eliminate unnecessary lift, allowing chillers to be selected and optimized specifically for each temperature band.
- Avoids the energy waste of single-temperature mixing strategies.



ENHANCED APPROACH

Design for Footprint or Efficiency

Design for Footprint Reduction – Peak Capacity

- Designing for the peak capacity for a given air-cooled unit allows for a reduced chiller plant footprint

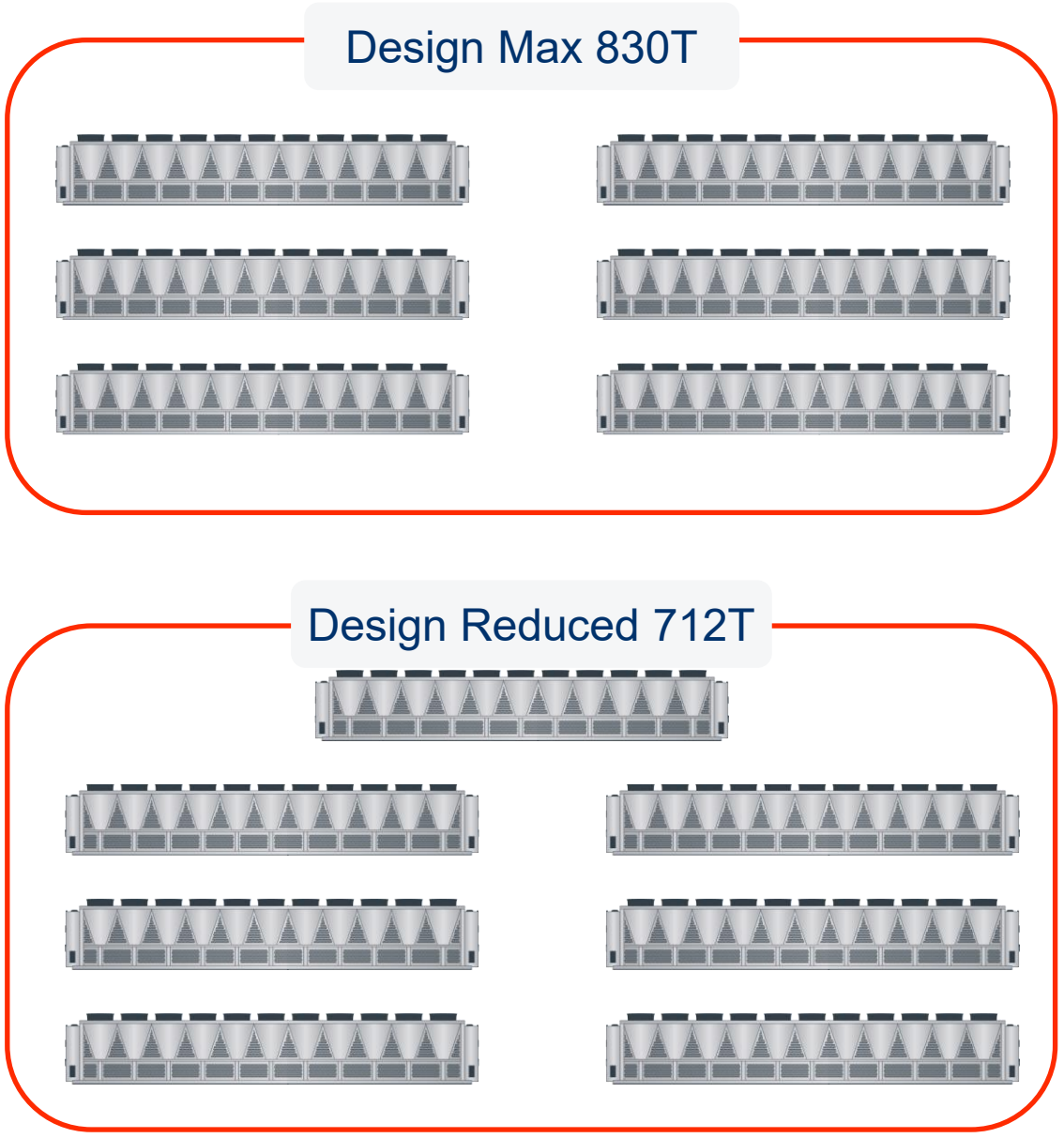
Design for Efficiency – Below Peak Capacity

- For a given ambient temperature, limiting the capacity of an air-cooled unit reduces the condenser approach temperature, improving overall unit efficiency.
- Optimize according to your genset power allocation.

Operational Efficiency

- Utilize redundant chiller(s) and operate chiller array with each chiller at a lower capacity

Unit Capacity	System Efficiency	Per Chiller Capacity
Reduced	0.757 kW/Ton	712 Tons
Max	0.837 kW/Ton	830 Tons



The capacity of the unit in this design is 550 nominal tons.

SYSTEM BENEFITS

Enhances Token per Watt

up to **25%** Cooling system improvement

up to **22MW** Available to reallocate

Results of Dedicated Loops Using a Higher Facility Water Temperature for Liquid Cooling at the Efficient Design Point in an AI Factory with 278 MW of Liquid Cooling and 31 MW of Air Cooling:

- Baseline: A single-loop design delivers a uniform water temperature of 22°C (71.6°F) to both the liquid-cooled Coolant Distribution Units (CDUs) and the air-cooled Fan Coil Walls (FCWs).
- Dedicated Loops: Splitting the load allows 90% of the cooling system to operate at a higher temperature of 30°C (86°F), significantly boosting heat-rejection efficiency. The remaining 7% of the load continues to operate at the 22°C (71.6°F) baseline temperature for the FCWs.
- Single-Loop to Dedicated-Loop Transition: Shifting to dedicated loops yields a 16% efficiency improvement, reclaiming 14 MW of cooling capacity.
- Peak to Off-Peak Optimization: Shifting roughly 15% of the peak load to off-peak hours yields an additional 9% efficiency gain. This brings the total cumulative improvement to approximately 25%, reclaiming an additional 8 MW and bringing the total returned capacity to 22 MW.

SYSTEM BENEFITS

Help Increase Facility Loop Temperature Differential to Help Reduce Pump Power and Reduce Ride-Through Storage Needs

Increasing chiller loop temperature differential (dT) to the lower of the following constraints provides increased operational benefits:

1. Minimum chiller flow rate
2. Distribution loop return fluid temperature minus chiller supply fluid temperature

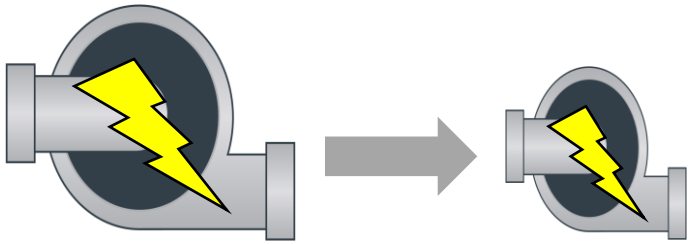
Impact on the High-Temperature Facility Loop (247 MW): *Comparison of 10°C (18°F) to 17°C (30.6°F) dT*

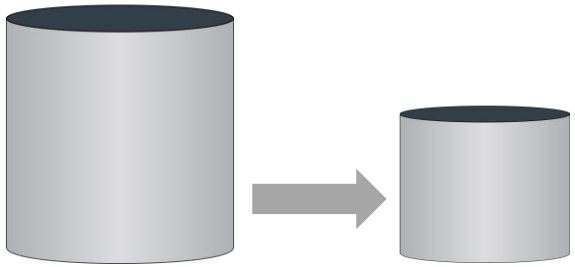
Increased dT (reduced flow rate) results in lower pumping power.

- Reduced flow lowers piping infrastructure costs.
- Maintaining the original pump pressure while reducing flow results in approximately 41.2% lower pump power consumption, freeing up about 1.2 MW for the IT load.

Ride-through storage tank size can be reduced by approximately 41.2%.

- For 3 minutes of ride-through, storage tank size would decrease from 1,063,398 L (280,920 gallons) to 625,527 L (165,247 gallons).
- For 10 minutes of ride-through, storage tank size would decrease from 3,544,660 L (936,400 gallons) to 2,085,096 L (550,824 gallons)





Integrated Free Cooling – Free Cooling Basics

How Does It Work?

- Cooling loads are typically sized at the worst case “design point” condition. Not only can the cooling load vary from the design point, but the conditions of the heat sink (outdoor ambient in the case of an air-cooled chiller) can vary as well. When the outdoor ambient is favorable, some of the load can be satisfied for “free” using integrated water side economizers (WSE).
- Free cooling capacity is dependent on the delta between the fluid temperature and the outdoor ambient temperature. Free cooling operation can be categorized into 3 operating modes:

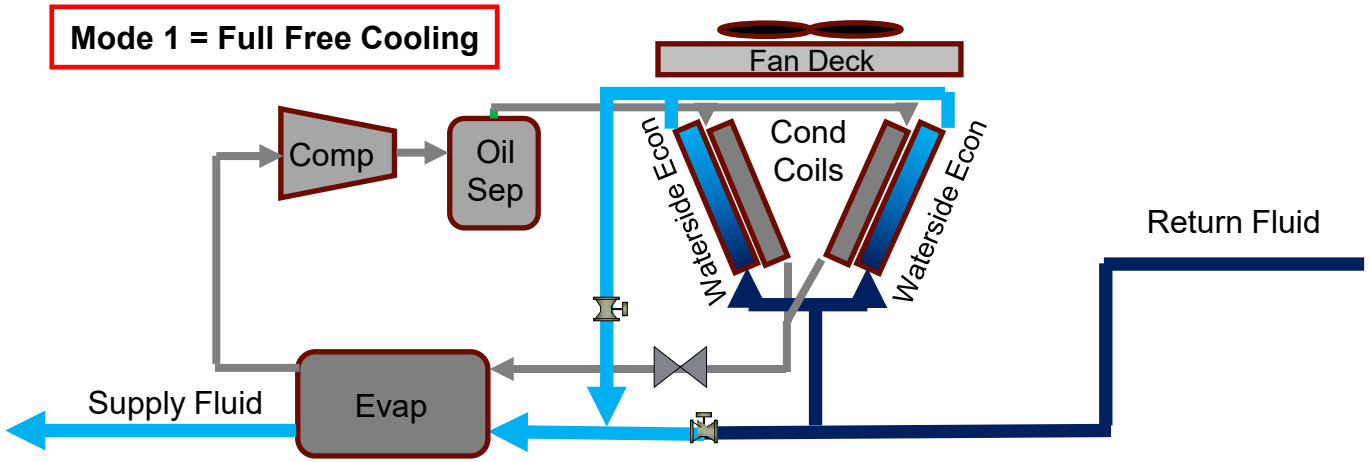
Mode 1 = **Outdoor Ambient < Supply Fluid Temperature – WSE Approach**. Full cooling capacity w/o mechanical cooling.
Mode 2 = **Return Fluid Temperature > Outdoor Ambient < Supply Fluid Temperature - WSE Approach**. Not sufficient for full cooling capacity. May be used as precooling to reduce mechanical cooling required.
Mode 3 = **Outdoor Ambient > Return Fluid Temperature**. No free cooling available. Fluid would be heated by outdoor air. Free cooling is bypassed.

Note: Controls to switch between mechanical and free cooling are integrated into the unit controller. No external customer points required.

Outdoor Ambient = Low

Outdoor Ambient < Supply Fluid Temperature – WSE Approach

- Full capacity via free cooling
- Compressor idle – no refrigerant flow
- Total capacity via waterside economizers
- No heat transfer in evaporator
- Only fan power consumed



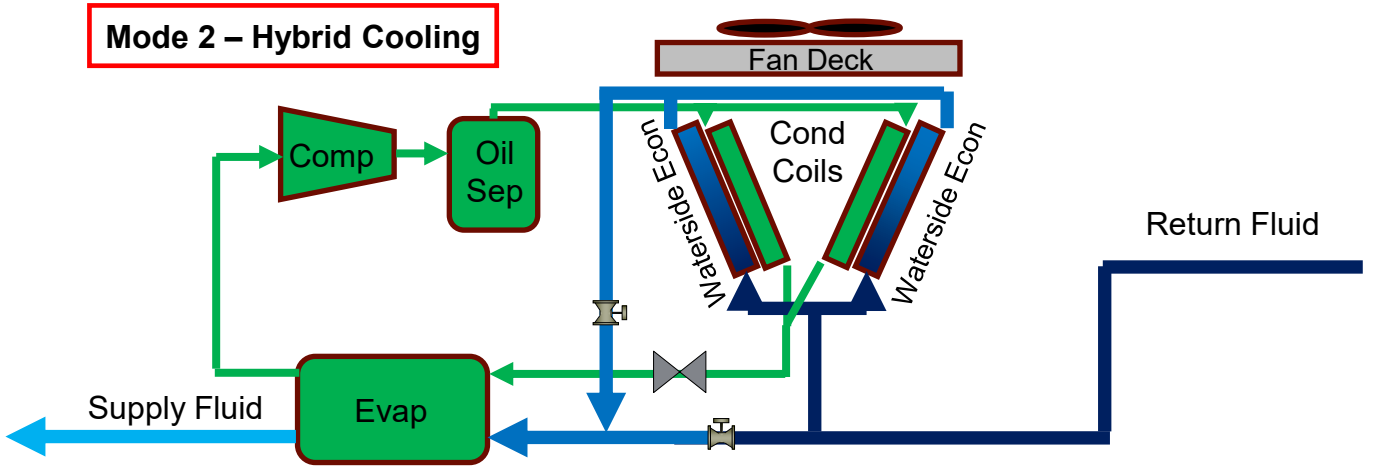
Integrated Free Cooling – Free Cooling Basics

How Does It Work?

Outdoor Ambient = Mid

Return Fluid Temperature > Outdoor Ambient < Supply Fluid Temperature - WSE Approach

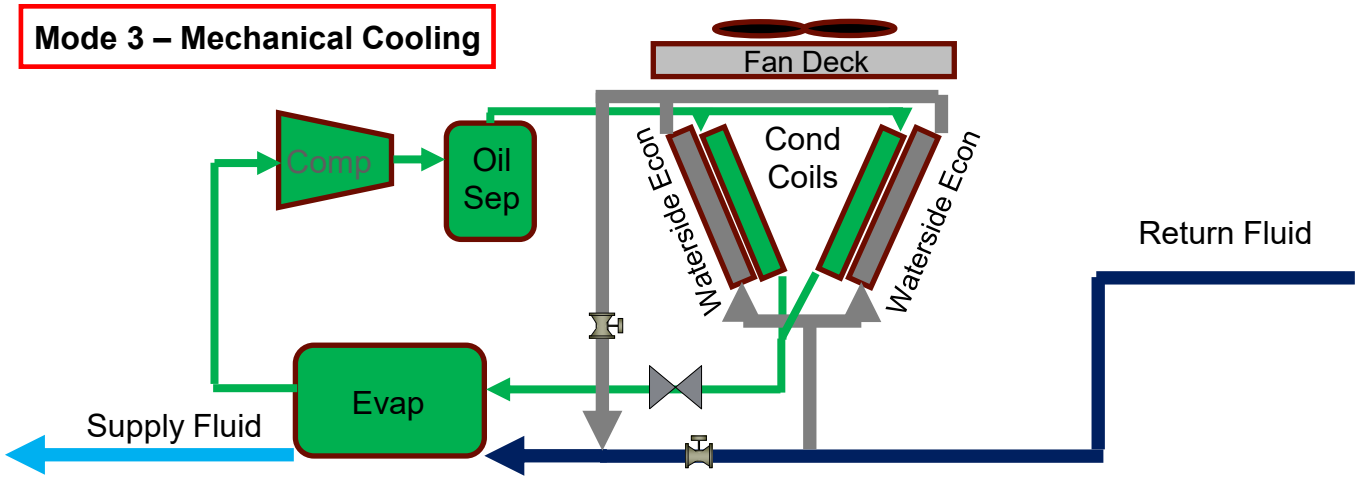
- Full capacity not achievable via free cooling
- Compressor running normal cycle
- Waterside economizers pre-cool water to reduce mechanical cooling capacity requirement
- Evaporator provides remaining cooling capacity
- Fan speed controlled per mechanical cooling demand



Outdoor Ambient = High

Outdoor Ambient > Return Fluid Temperature

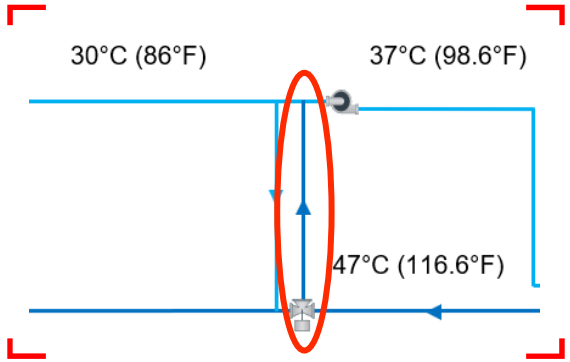
- Compressor running normal cycle
- Waterside economizers circuit bypassed
- Evaporator provides total cooling capacity
- Fan speed controlled per mechanical cooling demand

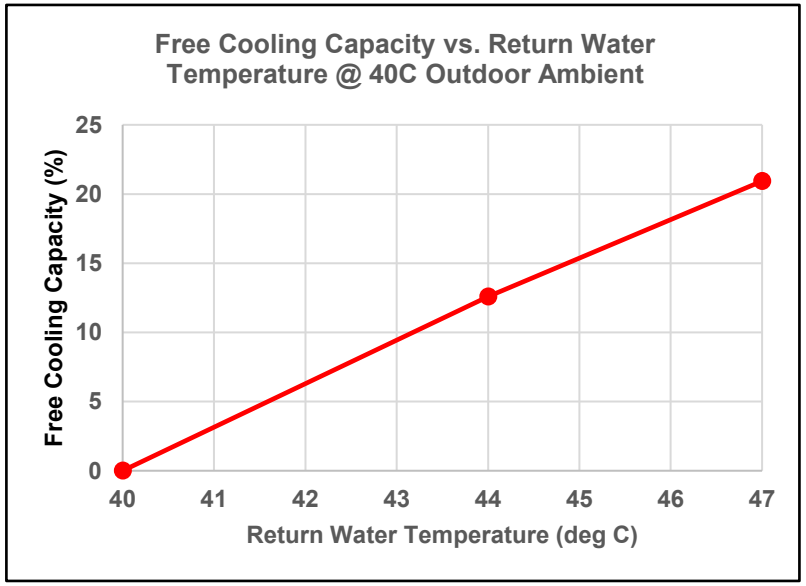


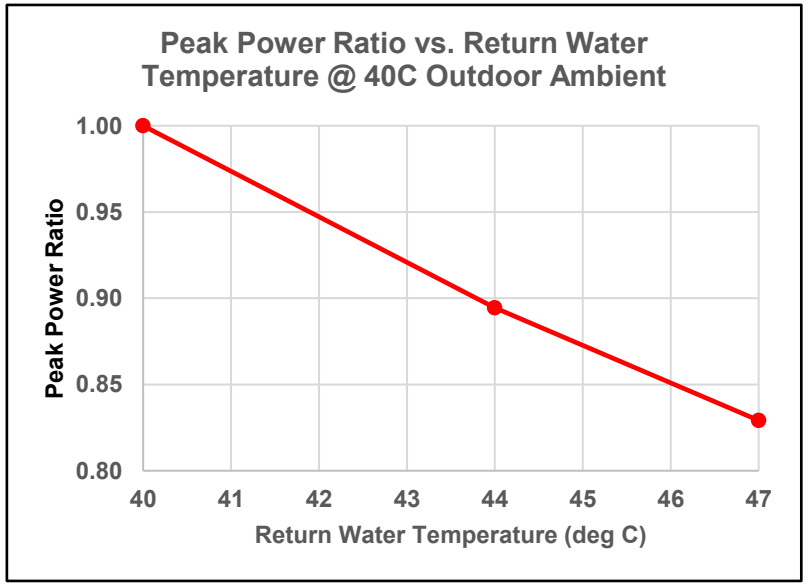
Advantages of Blending

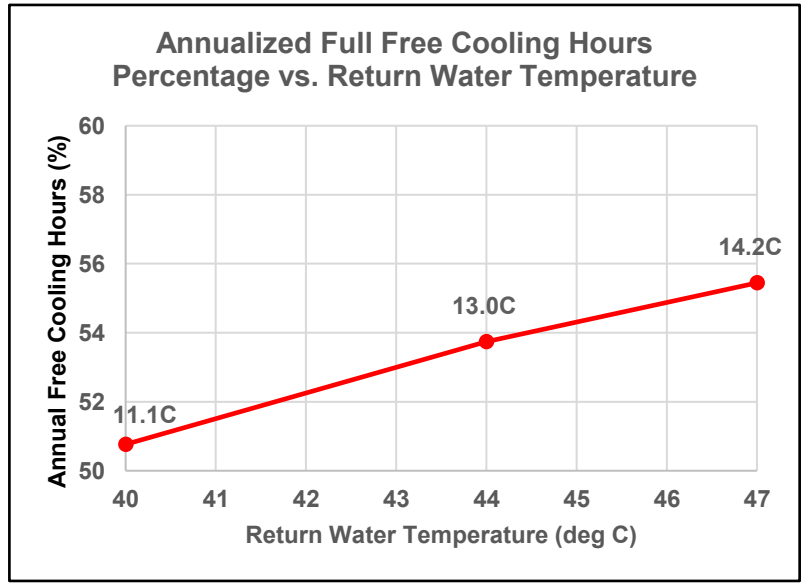
Blending return water 47C (116.6F) with the chiller leaving water 30C (86F) to achieve desired supply 37C (98.6) allows free cooling benefits at 40C (104F) ambient design condition

- Blending up to 47C (116.6F) allows ~21% of capacity via free cooling at design conditions due to higher return water temperature vs ambient air temperature.
- The free cooling capacity gained reduces the demand of the mechanical cooling capacity resulting in ~17% reduction in peak power. This reduces power infrastructure as well as improves peak PUE.
- Raising return water temperature increases the temperature differential across the chiller resulting in lower flow rates. Lower flow rates reduce pump power draw and provide more annual hours at full free cooling (where compressors are not required). This will improve annualized PUE values.







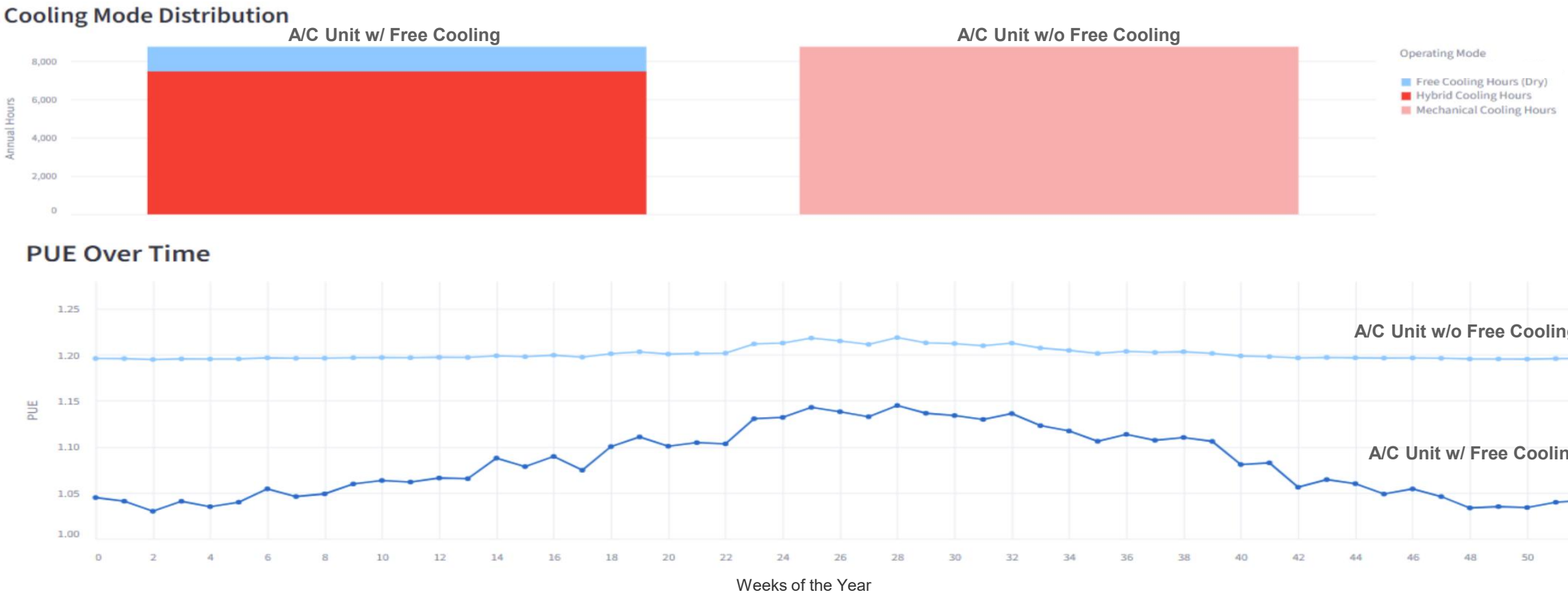


Additional pump power for free cooling is approximately 5kW.
Free cooling engaged when return water temperature is 1C greater than ambient temperature.

Temperatures listed at points are transition ambient temps for full free cooling (mode1).

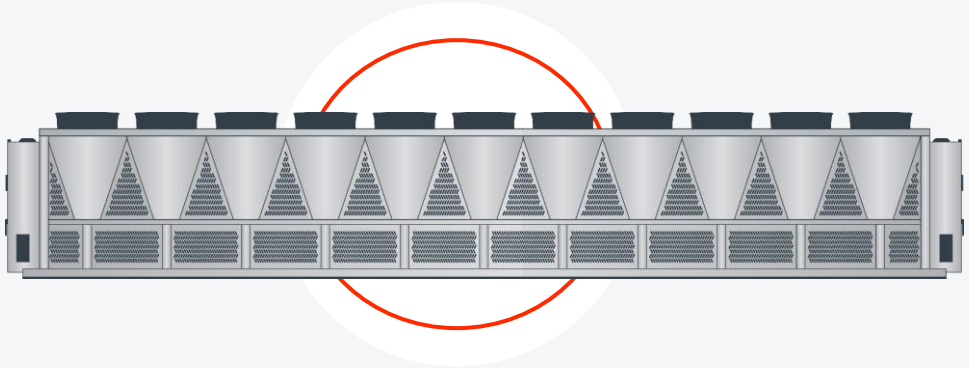
Annualized PUE Impact with Free Cooling

- Free cooling results in ~49% reduction in annual cumulative cooling energy compared to same unit w/o free cooling.
  - Assuming continuous full load at prescribed conditions
- PUE improves from 1.201 -> 1.083



This represents partial PUE including: Chiller (condenser fan/compressor power); CDU & FCW (based on fixed kW/ton); and Facility Primary & Secondary Loop Pump power
Results based on these exact conditions

KEY SYSTEM COMPONENTS



Ascend® ACR Air-Cooled Data Center Chiller

The Ascend® ACR Air-Cooled Data Center Chiller delivers efficient, reliable cooling with integrated free cooling and exceptional high-ambient performance.

Fan Coil Walls, Model TCDC

Trane Fan Coil Walls provide higher capacity, efficient air cooling in the data hall, using medium chilled-water temperatures to deliver added capacity where air cooling is needed most.

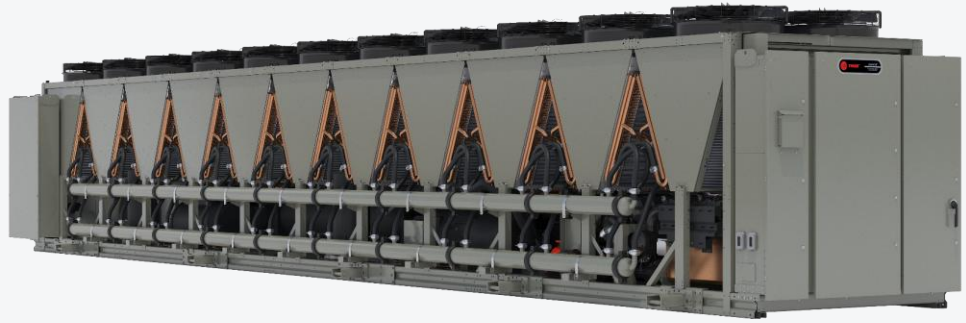
GigaModular™ Coolant Distribution Units (CDUs)

LiquidStack® CDUs support the liquid-cooled portion of the data hall, separating facility and technical loops with a liquid-to-liquid heat exchanger for efficient, high-temperature cooling compatible with AI servers.

KEY SYSTEM COMPONENTS

Ascend® Air-Cooled Data Center Chiller Model ACR

Design Characteristic	Requirements
Capacity Range	*Up to 830 tons (~3 MW)
Ambient Operation Range	−40 °C (−40 °F) to 63 °C (145 °F)
Facility Supply Water Temperature	Up to 30°C (86°F)
Compressor	Variable Speed/Variable Volume Ratio
Free Cooling Options	Direct or Indirect Free Cooling
Refrigerant	Low GWP: R-513A, R-1234ze
Restart After Power Loss	160 Sec @ 80% Load
Power Feed Requirement	380-480, 3 PH 50/60 Hz; 575 3 PH 60 Hz



** Capacity is based on the nominal unit at 550 tons at these conditions: 30°C (86°F) supply water at a 40°C (104°F) ambient condition.*

KEY SYSTEM COMPONENTS

Fan Coil Wall, Model TCDC

Design Characteristic	Requirements
Capacity Range	Up to 800 KW
Airflow Range	110K CFM+
Entering Air Temp	Up to 40°C (104°F)
Fan Type	ECM Direct Drive Fans
Additional Feature Options	Automatic Transfer Switch Controller Capacitor Backup Controls Teaming Application Backdraft Dampers
Filtration	2” or 4” Filters (MERV 8 or 11)
Harmonic Filtration	5% or Less of Total Demand Distortion
Power Draw	< 6% of Capacity Being Cooled in KW
Power Feed Requirement	415-480, 3 ph, 50/60 Hz

KEY SYSTEM COMPONENTS

GigaModular™ Coolant Distribution Unit (CDU)

Design Characteristic	Requirements
Capacity Range	Up to 14 MW at 4°C (7.2°F) Approach, up to 2.5 MW per Pump Module
Flow Rate	3750 LPM (991 GPM) per Module
Available Head Pressure	50 PSID
Maximum Secondary (PG25) Return Temperature	Up to 60°C (140°F)
Design Facility Water Temperature	Up to 45°C (113°F)
Connectivity	Modbus TCP, Restful API, Redfish, SNMPv3 or BACnet
Features	Scalable Solution Centralized two-way ring network control 316 Stainless Steel Plate Heat Exchanger EM Flow Meters
Secondary Side Filtration	Dual 25-Micron Filtration
Valve Options	CCV, PICV or ePICV valves
Power Draw	< 2% of Capacity Being Cooled in KW
Power Feed Requirement	380-480, 3 ph, 50/60 Hz

KEY SYSTEM COMPONENTS

Computer Room Air Handler (CRAH), Model VCDC

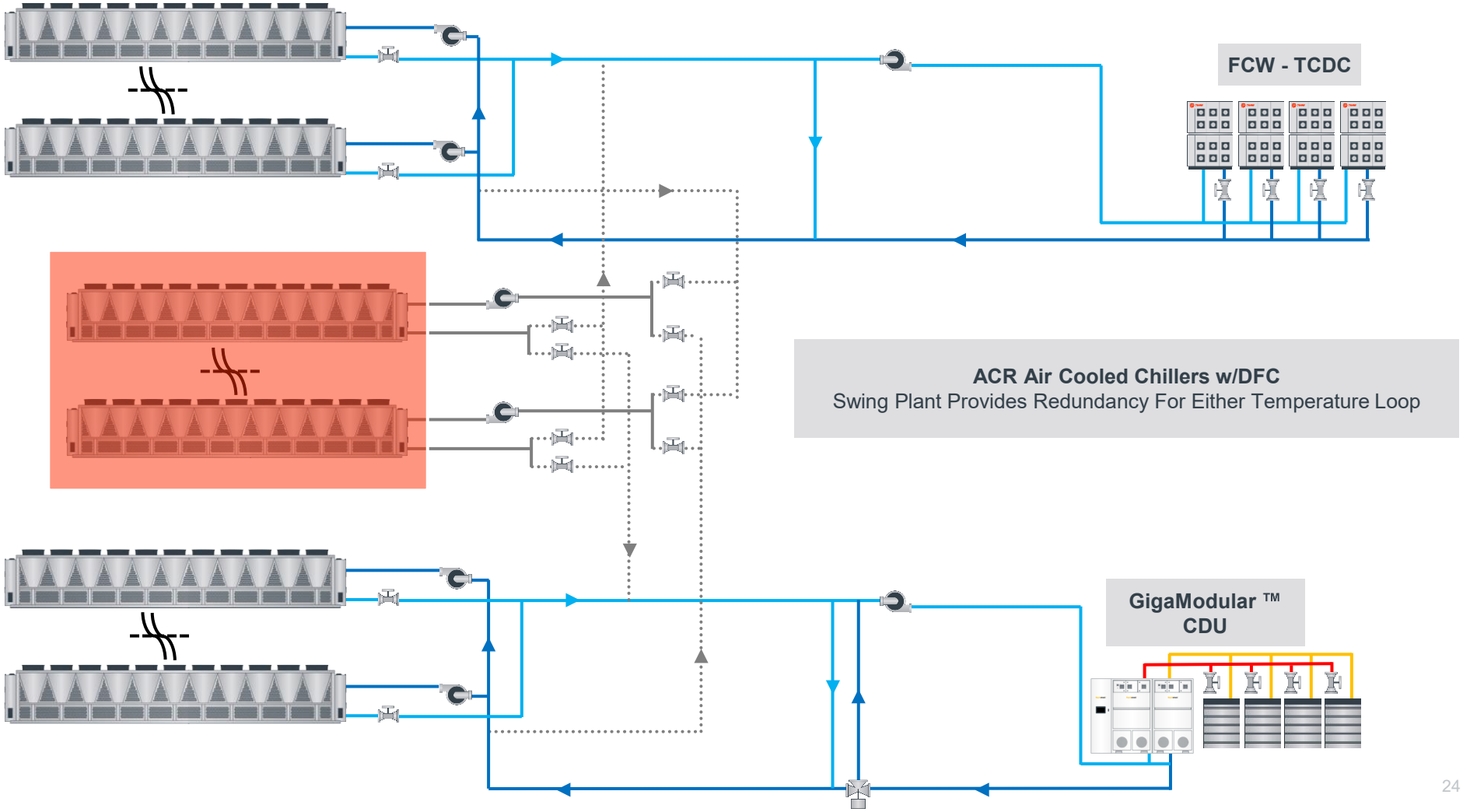
Design Characteristic	Requirements
Capacity Range	50kW to 360kW to support varied density zones
Airflow Range	5,000 - 50,000k CFM
Fan Type	ECM Direct Drive Fans
Entering Air Temp	Up to 43°C (110°F)
Additional Feature Options	Automatic Transfer Switch (ATS) Controller Capacitor Backup Condensate Pump Motorized return air damper
Filtration	2" (Merv 8 or 11) or 4" (Merv 8) Filters
Harmonic Filtration	5% or Less of Total Demand Distortion
Deployment Configuration	Downflow horizontal discharge for electrical room cooling Flexible for downflow white space use Optional upflow configuration
Power Feed Requirement	415-480, 3-phase, 60 Hz

BEST PRACTICES

Redundancy

Dual-temperature plant with swing chillers

A dual-temperature chiller plant with swing chillers allows redundant units to be flexibly assigned to either the high- or low-temperature loop, reducing the total number of chillers needed when full dual-loop redundancy isn't required.



BEST PRACTICES

Adiabatic Pre-Cooling

How It Works

- Air-cooled condenser performance depends on the temperature difference between refrigerant temperature and incoming dry-bulb air.
- Adiabatic cooling evaporates water into the inlet airstream, lowering effective dry-bulb temperature.
- Air temperature approaches wet-bulb, increasing heat-transfer capacity.
- Biggest gains occur in hot, dry climates with large DB–WB spreads.

Mechanical Cooling Benefits – Peak Shaving

- Helps boost heat-rejection capacity during peak ambient temperatures.
- Helps reduce chiller lift and compressor power use.
- Allows for fewer quantity of units or reduced loading on existing units.
- Helps cut compressor and fan energy during high-temperature periods.

- **Scenario 1:** Reduced Number of A/C Chillers
  - Lower first cost
  - Smaller footprint
- **Scenario 2:** Same Number of A/C Chillers
  - Reduced cooling power requirement
  - Lower sound with fan speed reduction
  - Resilience to micro-climate effect

BEST PRACTICES

Freeze Protection

Outdoor equipment such as air-cooled chillers and exposed piping is at risk of freezing when ambient temperatures drop below the fluid's freeze point. Protection can be achieved by selecting a suitable fluid or by adding heat to maintain temperature above freezing.

Heaters

- Factory Installed
- Down to -20F
- Will not prevent refrigerant migration

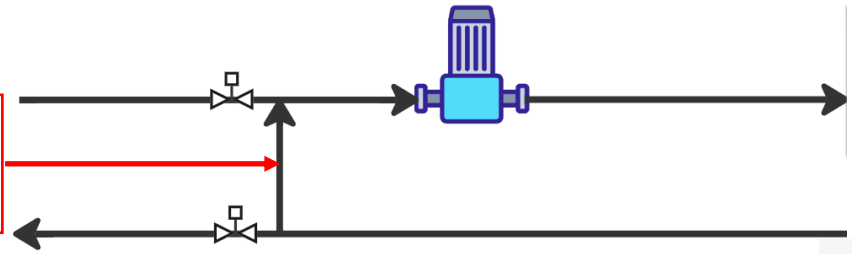
Heat Trace

- Field installed on all piping, pumps, and other water components exposed to ambient

Flow Control

- Provided freeze avoidance for refrigerant migration (see p. 5 in Engineering Bulletin)
- Must be provided without delay
- Meet minimum evap flow

*If chiller is to be isolated during flow control, included loop volume must be sufficient to prevent fluid from reaching its freeze point.



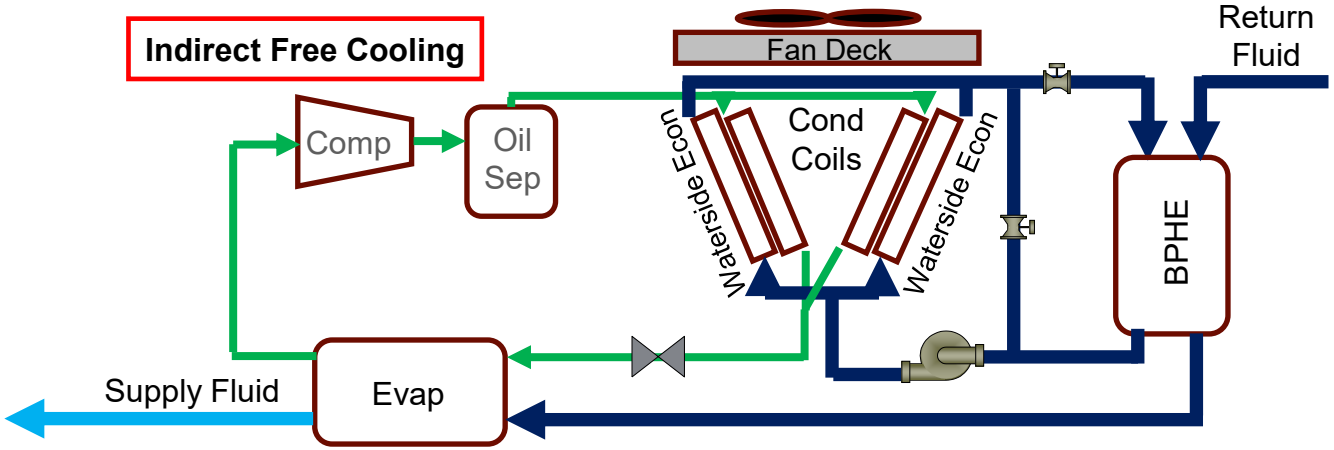
BEST PRACTICES

Freeze Protection – Indirect Free Cooling

In applications where outdoor ambient can fall below freezing, indirect free cooling can be used for freeze protection.

Indirect Free Cooling - IDFC

- Customer fluid isolated from waterside economizers via brazed plate heat exchanger
  - Glycol is contained in a smaller closed loop
- Waterside economizers in series with evaporator
- Fluid can bypass water side economizers
- Unit can run free cooling only, mechanical cooling only, hybrid free-mechanical cooling



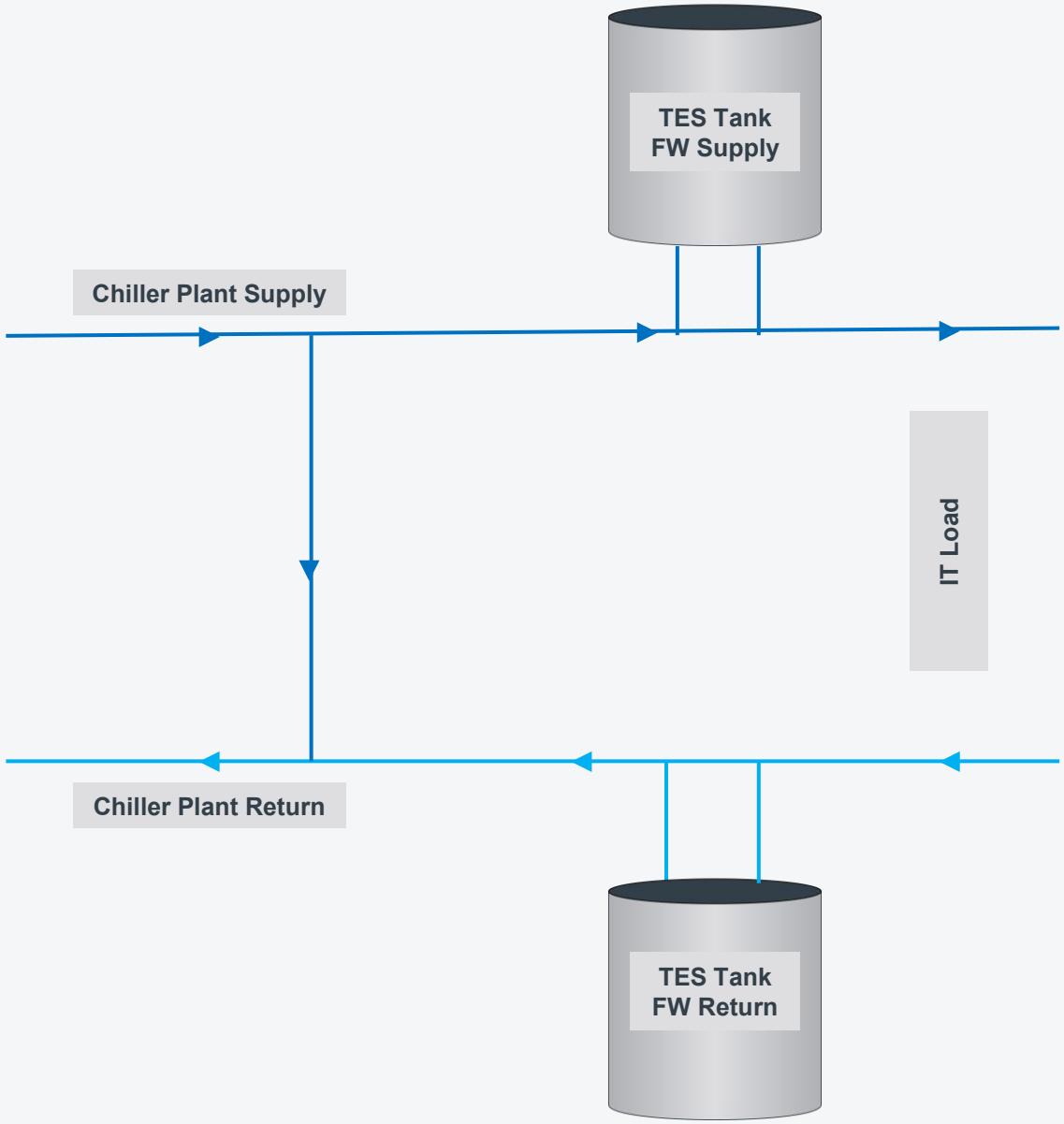
BEST PRACTICES

Thermal Energy Storage (TES)

Storage Location Matters

Thermal storage can be integrated into the chiller plant in several ways, with tank location determined by system needs.

- ✓ TES on Facility Water Supply (FWS)
  - Provides capacity if the chiller plant is down
- ✓ TES on Facility Water Return (FWR)
  - Smooths out chiller plant operation when compute loads fluctuate.
    - When installed on the return side, the tank helps buffer large temperature swings in return water during rapid load changes.
    - Stabilizing the return temperature enables chillers to maintain a consistent leaving-water temperature.



KEY SYSTEM COMPONENTS

Thermal Management Skid

Design Characteristic	Requirements
Capacity Range	1-3 MW (300-850 Tons) Custom sizes available Storage and flowrates adaptable to site specific requirements
Operating Modes	Freeze Avoidance Normal Operation Thermal Energy Discharge Thermal Energy Recharge
Pump	Variable Speed VFD
Other Accessories	Air Separator Bypass Piping Isolation Valves Control Panel
Commissioning	Full Function Testing with Tank and Chiller Possible.

INTEGRATED ELECTRICAL & POWER ARCHITECTURE

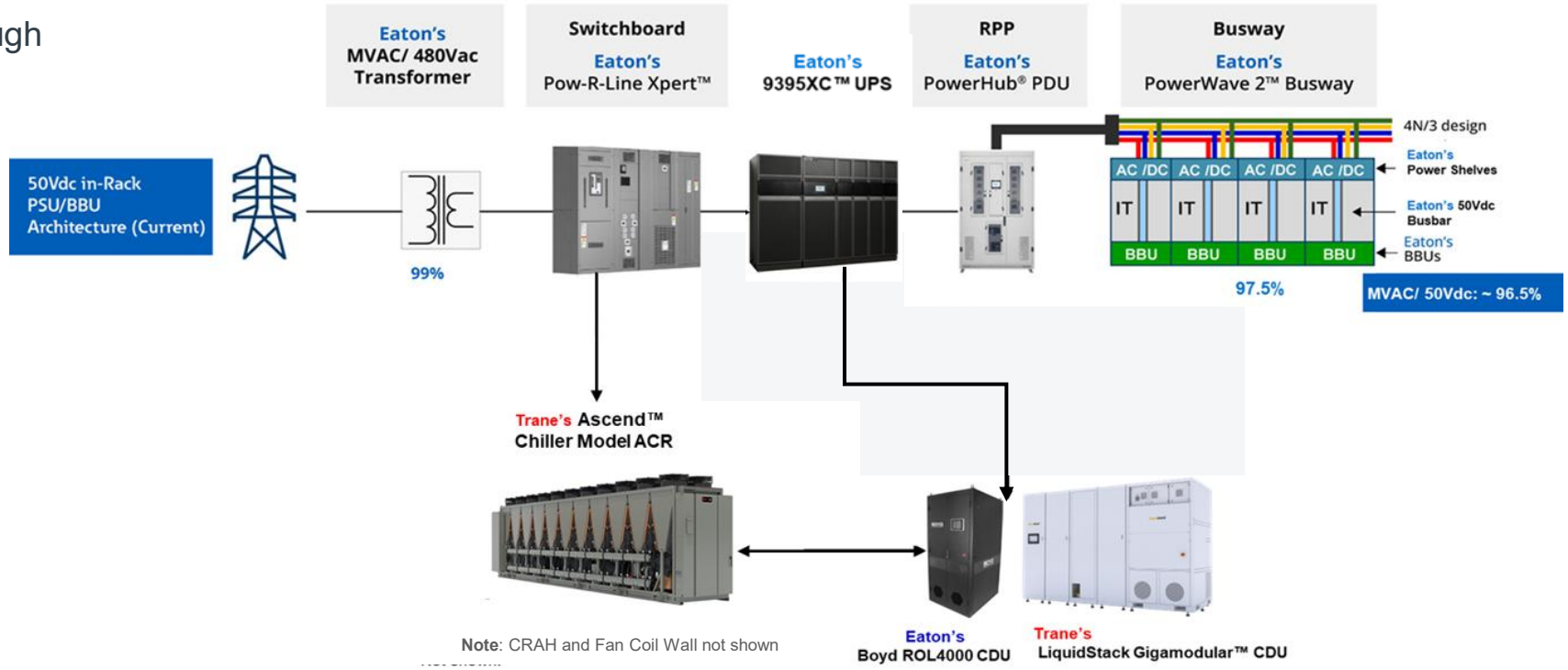
Trane + Eaton

Unified Power Distribution

- Trane mechanical and HVAC systems connect directly to Eaton switchgear, distribution panels, and circuit protection devices.
- Eaton's modular switchgear supports scalable expansions and high-density power architectures used in AI and high-load environments.
- Selective coordination ensures reliable power delivery to mission-critical cooling equipment.

Power Quality & Backup Integration

- Eaton UPS systems provide ride-through power to help prevent HVAC control system resets during disturbances.
- Power quality conditioning (harmonic filtering, surge suppression) protects Trane VFDs & control electronics.
- Integration with Eaton transfer switches and generator systems provides seamless transition to emergency power.



TRANE

EATON
Powering Business Worldwide

CONTROLS, MONITORING AND OPTIMIZATION

Trane + Eaton

Advanced Metering & System Visibility

- Eaton metering and Power Xpert platforms deliver real-time visibility into mechanical-system loads (kW, kWh, demand, harmonics).
- Data streams integrate into Trane BMS/EMS platforms for unified dashboards that combine power and thermal system performance.
- Enables energy benchmarking, capacity planning, and predictive maintenance.

Controls & Automation Synergy

- Trane controls interface with Eaton intelligent breakers, relays, and gateways using open protocols (BACnet, Modbus, Ethernet/IP).
- Supports coordinated load shedding, start-up sequencing, and protective logic tied to electrical system conditions.
- Enables remote monitoring, alarm forwarding, and secure updates across mechanical and electrical equipment.

Resiliency & Safety

- Eaton arc-flash mitigation and UL-listed electrical components help enhance service safety for Trane system maintenance.
- Redundant power paths and dual-feed configurations help ensure high availability for liquid-cooling and mechanical systems.
- Combined diagnostics from both systems accelerate troubleshooting and help reduce downtime.

SYSTEM CONTROLS

Reference Diagram

Effective controls are critical to chiller plant performance and reliability. Trane's data center–specific control platform helps promote efficiency, uptime and responsiveness by integrating all major components — chillers, dry coolers, pumps, valves, CDUs and fan coil walls — into one coordinated system.

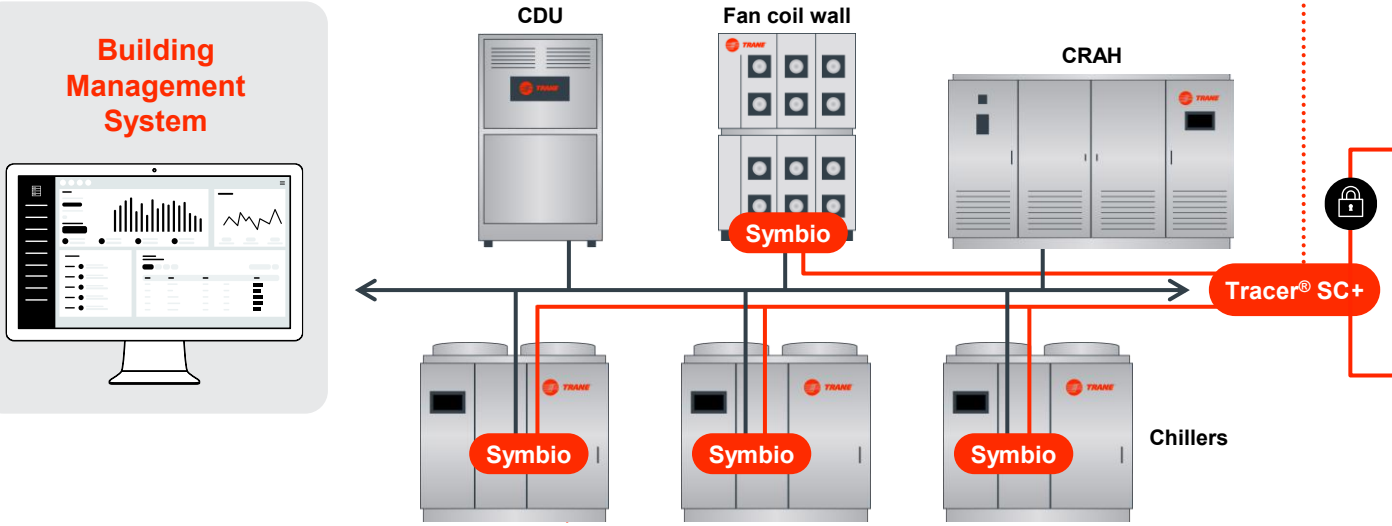
System Control

Tracer® is a unified thermal management system that simplifies operations by handling chiller rotation, staging, and sequencing with built-in tools that boost reliability and enable data-driven performance.

AI Enhancements

Take optimization further with our AI-driven efficiency engine. **Trane® AI Control** blends decades of expertise with real-time data to continuously improve your thermal management system and help capture every possible watt of savings.

Trane Thermal Management System



Digital Hub

Trane® Cloud
- Secure connectivity
- Remote service
- Analytics and diagnostics

Tracer® Synchrony®
- Chiller plant control
- Enhancement strategies
- Equipment monitoring

Insights + Optimization

When power is limited, your cooling system must run at peak efficiency—every kilowatt saved means more racks online. **Trane Intelligent Services** uses whole-system data to help deliver actionable energy-saving strategies.

Equipment Connectivity

Symbio® controls collect and translate key equipment data into the **Tracer SC+,** enabling data-driven service and optimization.

Predictive Maintenance

With your permission, we can securely connect to your equipment or Tracer SC+ to enable **Connected Mechanical Service**. By monitoring trends and performance data, we help identify issues early so your team or our technicians can act before failures occur. And when on-site support is needed, **Trane Service Agreements** and **local technicians** are ready to respond.

TRANE CLOUD

Digital Solutions

Trane Cloud connects your thermal management system to a secure, scalable digital environment where data becomes insight and insight becomes action. By bringing together equipment, controls and analytics in one place, it gives you and your operations team a shared view of system performance — so issues can be identified, prioritized and addressed with clarity.

- Centralized equipment, building and service data enable faster response and issue resolution
- Advanced analytics and expert guidance turns real-time data into prioritized insights, so you know what matters most
- System architecture supports future scalability
- Foundation for advanced services enables AI, predictive diagnostics and ongoing optimization

SECURE CONNECTIVITY

Digital Solutions

In data center environments, connectivity can’t come at the expense of security. Trane’s secure connectivity framework is designed to help protect your systems, data and operations while still delivering the full value of digital services. With layered protections, controlled access and industry-aligned practices, you get the insights you need — without taking on unnecessary risk.

- Built-in security helps protect your system at every level
- Secure remote access lets you monitor and service your system without exposing critical infrastructure
- Data protection and encryption help keep your information secure in transit and at rest
- Role-based access and governance make sure the right people have access to the right data
- OTA updates help you stay current with evolving cybersecurity standards and best practices
- Dedicated Trane cybersecurity teams help keep you ahead of emerging threats and your system secure over time

NUVOLO

Asset and Maintenance Management

Nuvolo® delivers a modern, ServiceNow-native CMMS platform designed to help data centers operate with greater reliability, efficiency, and control. By unifying facilities and IT operations, Nuvolo enables seamless management of critical infrastructure — from chillers and generators to UPS systems and other mission-critical assets.

With automated maintenance workflows, real-time asset tracking, and built-in space and capacity management, the platform helps reduce downtime, extend equipment life, and helps strengthen compliance with evolving regulatory standards. Nuvolo also transforms operational data into actionable insights, empowering smarter capital planning and supporting sustainability goals. The result is a connected, proactive approach to data center operations that helps keep facilities resilient and future-ready.

SUSTAINABILITY

Your Sustainability Goals Are Our Sustainability Goals

As the demand for data processing and storage grows, so does the need for sustainable practices.
Trane is committed to helping data centers achieve their sustainability goals while maintaining operational efficiency and strengthening community relations.

Trane offers solutions to help mitigate community relations concerns, including noise reduction and community engagement.

As a global climate innovator and energy services provider we translate sustainability priorities into actionable tactics and strategies to help lower carbon emissions, conserve resources and reallocate energy.

Trane provides scalable solutions that help customers grow as they go, helping to balance CapEx and OpEx.

Trane’s innovative and scalable solutions create sustainable outcomes helping to ensure energy efficiency, regulatory compliance and cost savings.

TRANE SERVICE

As data centers expand in size and complexity, the need for dependable, efficient cooling grows with them. Trane's thermal management services are designed to help meet these evolving demands — providing scalable, responsive support that adapts to changing loads, tighter schedules and zero-tolerance uptime requirements.

- Embedded expertise helps ensure reliable operation from design through expansion and refresh
- Proactive planning helps reduce risk and downtime
- Connected insights help enhance capacity and efficiency across the lifecycle

TRANE RENTAL SERVICES

Need unrivaled temporary thermal management and power solutions for your data center? Trust Trane Rental Services for:

- Level 2, 3, and 4 **commissioning services**, including line flushes and load bank testing
- **Expansion and retrofits** for new chip designs
- Planned **maintenance, emergency response, and redundancy** to help protect SLAs
- Overcoming **new equipment lead times** to help speed up new facility launches

As one of North America's largest OEM HVAC rental companies, Trane Rental Services leads the market. Our highly trained staff, rapid emergency response, and unmatched expertise are supported by 150 locations, 230 parts centers, and 2,600 technicians. Choose Trane Rental Services for reliable, expert solutions.

Trane.com/rentals

1-800-755-5115

DESIGN RESOURCES

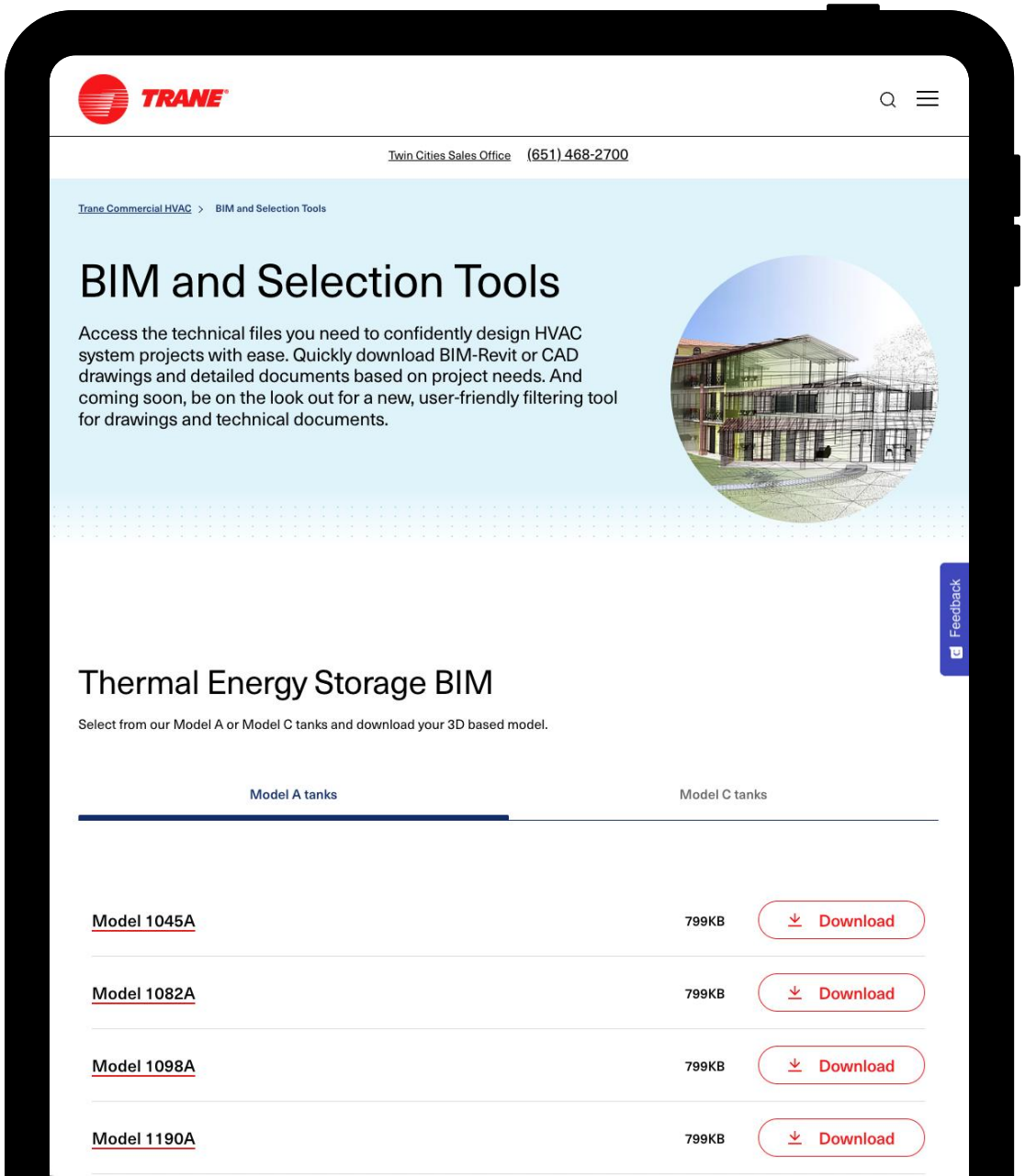
Trane provides a complete suite of resources to support the design of high-performance thermal management systems for data centers.

- All mechanical components are selected for site-specific conditions, with detailed submittal packages available
- System control sequences and operating modes can be customized for any chiller plant configuration
- TRACE® modeling tools evaluate annual energy performance and efficiency
- Application guides and Trane experts are available to assist with design, optimization and implementation

Reach out to Trane today for more information.

HELPFUL LINKS

Trane BIM and Selection Tools →



Trane.com/DataCenters

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Trane – by Trane Technologies (NYSE: TT), a global climate innovator – creates comfortable, energy efficient indoor environments through a broad portfolio of heating, ventilating and air conditioning systems and controls, services, parts and supply. For more information, please visit *trane.com or tranetechnologies.com.*

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