Data Center PUE Optimization Liquid Cooling Retrofit Whitepaper - Official Technical Overview & Hardware Datasheet

EXECUTIVE SUMMARY

This whitepaper presents a comprehensive technical overview of a vendor-neutral, carrier-grade liquid cooling retrofit solution engineered to drive meaningful reductions in Power Usage Effectiveness (PUE) within existing and greenfield data center environments. As rack power densities continue to escalate with the adoption of high-performance computing and accelerated workloads, conventional air-cooling architectures are increasingly unable to meet thermal and efficiency targets. The retrofit platform described herein enables operators to transition from air-cooled to direct-to-chip liquid cooling without wholesale facility reconstruction, preserving existing infrastructure investment while unlocking PUE improvements typically in the range of 0.15 to 0.35 points. The solution comprises a modular coolant distribution unit (CDU), rear-door heat exchangers, dielectric-compatible cold plates, leak-detection and manifold assemblies, and a supervisory control layer that integrates with existing DCIM and BMS platforms. All content is presented for engineering evaluation and procurement planning purposes.



ARCHITECTURE & CHASSIS DESIGN

The retrofit architecture is built around a scalable, loop-isolated coolant distribution framework that decouples facility water from IT equipment loops, thereby minimizing contamination risk and enabling serviceability without downtime. The primary CDU is available in 1RU and 4RU form factors, with the 1RU variant delivering up to 120 kW of heat rejection and the 4RU variant supporting up to 500 kW for high-density pod deployments. Redundant pumps configured in N+1 or 2N topologies ensure continuous operation, while integrated plate-and-frame heat exchangers maintain a tight approach temperature to maximize chiller efficiency. The chassis design incorporates front-to-rear service access, hot-swappable pump modules, and quick-disconnect blind-mate fittings rated for 10,000 mating cycles. Rear-door heat exchangers are designed to retrofit standard 42U and 48U racks with no

modification to the rack frame, capturing 60 to 80 percent of rack heat load passively before air enters the room.

HARDWARE FEATURES

Key hardware elements include dielectric-compatible cold plates with copper or aluminum base materials and pressure-drop-optimized microchannel geometries; flexible EPDM and stainless-steel braided hoses with dripless quick disconnects; a leak-detection sensor array with addressable rope sensors and point sensors providing per-rack and per-manifold alerting; and a manifold assembly supporting up to 8 or 16 blind-mate ports per rack. The supervisory control unit provides Modbus TCP, SNMP v3, and RESTful API interfaces for integration with DCIM, BMS, and orchestration platforms. Automated flow balancing and differential pressure control maintain optimal coolant distribution across heterogeneous rack loads. Optional integrated filtration and coolant quality monitoring extend service intervals and protect cold plate internals.

COMPLIANCE & STANDARDS

The platform is designed to comply with IEC 60950-1 and IEC 62368-1 for safety, IEC 61010-2-201 where applicable, and is manufactured under ISO 9001 and

ISO 14001 quality and environmental management systems. Coolant chemistry conforms to ASHRAE recommended water quality guidelines for liquid cooling, and electromagnetic compatibility is engineered to EN 55032 Class A and FCC Part 15 Subpart B. RoHS and REACH compliance are maintained across all bill-of-materials components. Installation and commissioning procedures align with ASHRAE Datacom Series guidance and Open Compute Project liquid cooling specifications where interoperable.

TECHNICAL SPECIFICATIONS

The following table summarizes verified performance and physical parameters for the baseline CDU and retrofit kit configurations. Values are typical at nominal operating conditions and should be validated against site-specific design parameters during detailed engineering.

Parameter	**Specification**
Form Factor	1RU / 4RU Chassis (CDU); Retrofit Kit for 42U/48U Racks
Heat Rejection Capacity	120 kW (1RU) / 500 kW (4RU)
Power Supply	1+1 Redundant AC; 208-240 VAC or 380-415 VAC
Pump Redundancy	N+1 or 2N

Coolant Interface	Facility Water Loop, Isolated via Plate Heat Exchanger
Leak Detection	Addressable Rope and Point Sensors, Per-Rack Alerting
Management Interfaces	Modbus TCP, SNMP v3, RESTful API
PUE Improvement Potential	0.15 to 0.35 Points vs. Air-Cooled Baseline
Operating Temperature Range	5 ° C to 45 ° C Ambient (Facility Dependent)
Compliance	IEC 62368-1, EN 55032 Class A, RoHS, REACH

ORDERING OPTIONS

Ordering configurations are structured by heat rejection capacity, redundancy topology, and facility-water interface type. Standard SKUs include the 1RU CDU with N+1 pumps and 120 kW capacity, the 4RU CDU with 2N pumps and 500 kW capacity, and retrofit kits bundling rear-door heat exchangers, manifolds, cold plates, and leak detection for 8-rack and 16-rack pods. Optional line items include redundant supervisory controllers, extended filtration modules, and factory acceptance testing documentation packages. Regional power interface

variants are available for 208-240 VAC single-phase and 380-415 VAC three-phase input.

