



CDU Requirements

Application Note

Document History

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Introduction

This application note is intended to be used as a template to capture and finalize requirements for L2L in-row and L2A in-row cooling distribution units (CDUs) before deployment in a data center. This includes mechanical, hydraulic, thermal, power, fluids, telemetry, wetted materials, safety, and so on. Once finalized, these requirements must be met in the selected CDU for a facility, lab, or data center. No changes may be made to the requirements without the review and approval of the owner's representatives.

General Expectations

Vendor responses to this RFP/ RFQ are expected to be well-written, communicative, and accurate. Acronyms, when used, shall be defined before first use. Sensor and other naming in the response shall be consistent. For example, a sensor referred to in Table 14 “Telemetry Requirements” shall have the same name if used in the “MIB List” section, Table 15 “Alarms Requirements,” and so on.

Requirements and Description

The tables in this section describe the requirements for L2L and L2A CDUs.

Table 1. General Mechanical Requirements

Requirement ID	Item	CDU Type	Description
GEN-REQ-01	Backflow in case of failure	L2L In-Row L2A In-Row	The unit shall prevent water backflow in the event of pump failure.
GEN-REQ-02	Erosion	L2L In-Row L2A In-Row	No erosion is allowed at max CDU performance - Velocity shall not exceed 3 m/s for yellow materials and 6 m/s for stainless-steel anywhere inside the unit.
GEN-REQ-03	Silks and labels	L2L In-Row L2A In-Row	All ports and connectors shall be properly marked and labeled.
GEN-REQ-04	Anti-seismic rack support	L2L In-Row	The rack shall have provisions to be bolted down so as not to move or tip over during seismic events.
		L2A In-Row	The rack shall have provisions to be bolted down so as not to move or tip over during seismic events.
GEN-REQ-05	Pre-crimped hoses	L2L In-Row L2A In-Row	All hoses shall have an end connector with thread or flange that was pre-crimped.
GEN-REQ-06	Insulation	L2L In-Row	All primary loop piping and heat exchanger shall be insulated to prevent condensation on the piping.
		L2A In-Row	Not applicable
GEN-REQ-07	Certification	L2L In-Row L2L In-Rack L2A In-Row	The unit shall be regionally CE or UL-certified.
GEN-REQ-08	Choice of fluid	L2L In-Row L2A In-Row	PG25 (24.5 - 29.5%) with inhibitors and water making up ~75% of the formulation. The following characteristics and ranges shall be inherent: Freeze Point 9 to 15°F (-13 to -9 °C), fluid pH 8.0 - 10.5, Unadjusted Reserve Alkalinity >4 mL, Copper <2 ppm, Iron <2 ppm, Total Hardness <20 ppm, Chloride <5 ppm,

Requirement ID	Item	CDU Type	Description
			Sulfate <10 ppm. PG25 heat transfer fluids for liquid cooled computer racks contain corrosion inhibitors, antifoam agents, bio growth inhibitors, and dye that are designed for this application. For other coolant types, the supplier shall seek approval from NVIDIA. Otherwise, they will be liable for the consequences.
GEN-REQ-9	Fill pump	L2L In-Row L2A In-Row	The unit shall be equipped with a fill pump
GEN-REQ-10	Primary flow control valve	L2L In-Row	A 2-way or 3-way valve is required to regulate the primary flow rate, maintaining the TCS temperature at its setpoint.
		L2A In-Row	Not applicable

Table 2. Thermal Requirements

Requirement ID	Item	CDU Type	Description
THERM-REQ-01	Cooling capacity	L2L In-Row	<ul style="list-style-type: none"> > Minimum recommended cooling capacity is 1 MW at a 4 °C approach temperature at the minimum required coolant flow rate and pressure differential defined at PUMP-REQ-01 and PUMP-REQ-02 > Vendor shall provide the curve showing the unit's cooling capacity for the whole primary flow rate range at three secondary flow rates of 100%, 75%, and 50% of pumping capacity at two secondary temperatures (32 °C and 45 °C) for ATDs of 4 °C, 8 °C, and 12 °C. <p>↑ S class (Secondary temperature): 32C, 45C Secondary flow rate: 100%, 75%, and 50% of pumping capacity at N+1</p> <p>Cooling capacity (kW)</p> <p>Primary flow rate (LPM)</p> <p>ATD (12°C) ATD (8°C) ATD (4°C)</p>
		L2A In-Row	<ul style="list-style-type: none"> > Minimum recommended cooling capacity is 135 kW at a 10 °C approach temperature. > Vendor shall provide the curve showing the unit's cooling capacity vs air flow rate (CFM) at two secondary flow rates (100%, 75%, and 50% of pumping capacity) at two secondary temperatures (32 °C and 45 °C) for ATDs of 10 °C, 15 °C, and 20 °C.

Requirement ID	Item	CDU Type	Description
			<p>S class (Secondary temperature): 32C, 45C Secondary flow rate: 100%, 75%, and 50% of pumping capacity at N+1</p> <p>The graph plots Cooling capacity (kW) on the vertical axis against Air flow rate (CFM) on the horizontal axis. Three dashed lines originate from different points on the vertical axis and slope upwards. The top line is labeled 'ATD (45C)', the middle line is 'ATD (20C)', and the bottom line is 'ATD (10C)'. All three lines have positive slopes, indicating that cooling capacity increases with air flow rate.</p>
THERM-REQ-02	Secondary temperature	L2L In-Row	<ul style="list-style-type: none"> ➢ The unit shall support a stable secondary set-point temperature range of $\leq 45^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for a baseline load of 10% of the max load to 100% of the maximum load. ➢ The secondary temperature shall be adjustable.
		L2A In-Row	<ul style="list-style-type: none"> ➢ The unit shall support a stable secondary set-point temperature of $\leq 45^{\circ}\text{C}$ for a baseline load of 10% of the max load to 100% of the maximum load. ➢ The secondary temperature shall be adjustable.
THERM-REQ-03	Approach temperature difference (ATD)	L2L In-Row	The CDU shall be rated for 4 °C ATD.
		L2A In-Row	The CDU shall be rated for 10°C ATD.
THERM-REQ-04	Heat exchanger effectiveness	L2L In-Row	HX effectiveness should be at least 90% at 4 °C ATD at nominal capacity
		L2A In-Row	HX effectiveness should be at least 80% at 10 °C ATD at nominal capacity

Table 3. Pump Requirements

Requirement ID	Item	CDU Type	Description
PUMP-REQ-01	Liquid flow rate	L2L In-Row	The unit should provide a minimum flow rate of 1.5 LPM/kW at the minimum recommended cooling capacity (THERM-REQ-01).

Requirement ID	Item	CDU Type	Description
		L2A In-Row	The unit should provide a minimum flow rate of 1.5 LMP/kW at the minimum recommended cooling capacity (THERM-REQ-01).
PUMP-REQ-02	Pressure head	L2L In-Row	<ul style="list-style-type: none"> > Minimum of external 35 PSID at minimum required flow rate specified in PUMP-REQ-01 > The 35 PSID is the available pressure head to outside of the heat exchanger.
		L2A In-Row	<ul style="list-style-type: none"> > Minimum of external 35 PSID at minimum required flow rate specified in PUMP-REQ-01 > The 35 PSID is the available pressure head to outside of the heat exchanger.
PUMP-REQ-03	PQ characteristics	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> > Vendor shall provide experimental Pressure vs Flow (PQ) curve measured at the supply and return of the CDU using 25% PGW. > Additional information like the fluid temperature and pump speed (0-100%) used to generate the curve shall be provided. Sensor measurement accuracy details are nice to have.
PUMP-REQ-04	Pump redundancy	L2L In-Row L2A In-Row	CDU should have N+1 redundancy for pumps.

Table 4. Heat Exchanger Requirements

Requirement ID	Item	CDU Type	Description
HX-REQ-01	Primary fluid	L2L In-Row	The CDU should comply with ASHRAE primary side guidelines - (following ASHRAE Liquid Cooling Guidelines for Datacom Equipment Centers-Edition 4).
		L2A In-Row	Not applicable
HX-REQ-02	Primary side pressure drop	L2L In-Row	It is preferred not to exceed a pressure drop of 20 PSID across the HX at the primary max flow rate.
		L2A In-Row	Not applicable

Table 5. Fan Requirements

Requirement ID	Item	CDU Type	Description
FAN-REQ-01	Air flow rate	L2A In-Row	<ul style="list-style-type: none"> > The air flow requirements at rated load and approach temperature shall be provided. > Additional information such as the fluid temperature and pump speed (0-100%) used to generate the curve, shall be provided. The details of the sensor measurement accuracy are nice to have.
		L2L In-Row	Not applicable
FAN-REQ-02	Fan speed	L2A In-Row	Fan speed shall be automatically adjustable to meet the coolant temperature set point.
		L2L In-Row	Not applicable
FAN-REQ-03	Type of fan	L2A In-Row	<ul style="list-style-type: none"> > Fans shall be selected to satisfy the required cooling capacity and supply TCS temperature > The fan's air outlet stream shall not require lateral free space to accommodate a clustered configuration of these units positioned side by side.
		L2L In-Row	Not applicable
FAN-REQ-04	Redundancy	L2A In-Row	Unit shall have N+1 fan redundancy.
		L2L In-Row	Not applicable
FAN-REQ-05	Noise	L2A In-Row	The unit's noise shall not exceed 85 dB.
		L2L In-Row	Not applicable
FAN-REQ-06	Fan location	L2A In-Row	It is preferred for fans to be positioned on the rear of the unit to draw air into the heat exchanger from the cold aisle towards the hot aisle.
		L2L In-Row	Not applicable
FAN-REQ-07	Fan control type	L2A In-Row	An adjustable PI and PID system to dynamically adapt to thermal load variations, ensuring stable fluid inlet temperature across different ATDs with a reasonable response time.
		L2L In-Row	Not applicable

Table 6. Environmental Requirements

Requirement ID	Item	CDU Type	Description
ENV-REQ-01	Ambient temperature range	L2L In-Row L2A In-Row	Following ASHRAE recommendations – 18 to 45 °C
ENV-REQ-02	Ambient humidity	L2L In-Row L2A In-Row	Following ASHRAE recommendations – 8 to 80%
ENV-REQ-03	Maximum dew point	L2L In-Row L2A In-Row	17 °C following ASHRAE H1 specification

Table 7. Serviceability Requirements

Requirement ID	Item	CDU Type	Description
SERV-REQ-01	Pump field replacement	L2L In-Row	The pump shall be hot swappable with no system downtime.
		L2A In-Row	The pump shall be hot swappable with no system downtime.
SERV-REQ-02	Fan field replacement	L2L In-Row	Not applicable
		L2A In-Row	The fan shall be hot swappable with no system downtime.
SERV-REQ-03	Filter cleaning	L2L In-Row	Filters shall be hot swappable with no system downtime.
		L2A In-Row	Filter shall be hot-swappable with no system downtime.
SERV-REQ-04	Service access	L2L In-Row	Shall be accessible from the front and back.
		L2A In-Row	Shall be accessible from the front side (cold aisle)
SERV-REQ-05	Primary side feeds	L2L In-Row	The unit shall have both top and bottom feeds. This can be available in two SKUs not necessarily in one SKU.
		L2L In-Rack	The CDU shall have rear feeds.
		L2A In-Row	Not applicable
SERV-REQ-06	Secondary side feeds	L2L In-Row	The unit shall have both top and bottom feeds. This can be available in two SKUs not necessarily in one SKU.
		L2A In-Row	The unit shall have both top and bottom feed option. This can be available in two SKUs not necessarily in one SKU.
SERV-REQ-07	Draining	L2L In-Row L2A In-Row	The unit shall have a draining port. The drain valve shall be positioned to allow complete drainage.
SERV-REQ-08	Air bleeder	L2L In-Row	The unit shall be able to automatically bleed any air captured inside it without any service.
		L2A In-Row	The unit shall be able to automatically bleed any air captured inside it without any service.

Requirement ID	Item	CDU Type	Description
SERV-REQ-09	Cable arrangement inside the unit	L2L In-Row L2A In-Row	All cables routed inside the unit shall be secured and not dangling. Consider sufficient workspace for power connections.
SERV-REQ-10	Filling port	L2L In-Row	It shall be easily accessible from the front or rear and be equipped with a fill pump.
		L2A In-Row	It shall be easily accessible from the front or rear and equipped with a fill pump.
SERV-REQ-11	Fluid sampling port	L2L In-Row L2A In-Row	The drain port should be used as a sampling port. When properly filled, system should be able to tolerate a 150 ml fluid sample without causing any alarms.
SERV-REQ-12	Low voltage control	L2L In-Row L2A In-Row	The low voltage components shall be accessible while the unit is running. Note that the controller board is part of the low voltage components. 50 Volts or less is ideal, but if 120 Volts is included in the cabinet, make sure it is finger safe.
SERV-REQ-13	High voltage control	L2L In-Row L2A In-Row	The high voltage components (greater than 50 V) shall not be accessible while the unit runs.

Table 8. Electrical Requirements

Requirement ID	Item	CDU Type	Description
ELEC-REQ-01	Regional available input power options	L2L In-Row	<p>CDU power supply should support:</p> <ul style="list-style-type: none"> > 190V/3P/50 Hz and 60 Hz > 200V/3P/50 Hz > 208V/3P/50 Hz and 60 Hz > 220V/3P/50 Hz and 60 Hz > 380V/3P/50 Hz > 400V/3P/50 Hz > 415V/3P/50 Hz and 60 Hz > 480V/3P/60 Hz <p>There can be different SKUs to support different voltage ranges</p>
		L2A In-Row	<p>CDU power supply should support:</p> <ul style="list-style-type: none"> > 190V/3P/50 Hz and 60 Hz > 200V/3P/50 Hz > 208V/3P/50 Hz and 60 Hz > 220V/3P/50 Hz and 60 Hz > 380V/3P/50 Hz > 400V/3P/50 Hz > 415V/3P/50 Hz and 60 Hz > 480V/3P/60 Hz

Requirement ID	Item	CDU Type	Description
			There can be different SKUs to support different voltage ranges
ELEC-REQ-02	Electrical main feeds orientation	L2L In-Row	CDU shall support both top and bottom feeds being able to utilize either way
		L2A In-Row	CDU shall support both top and bottom feeds being able to utilize either way
ELEC-REQ-03	Electrical main feeds connection type	L2L In-Row	It shall be hard-wired
		L2A In-Row	It shall be hard-wired
ELEC-REQ-04	EMI	L2L In-Row L2A In-Row	The unit shall include EMI filters to prevent inductive spikes during motor start up.
ELEC-REQ-05	Leakage current	L2L In-Row L2L In-Rack L2A In-Row	Shall have isolated grounding that would help to stop issues if installed on the same distribution as IT infrastructure.
ELEC-REQ-06	Upstream circuit breakers needed for the different applications	L2L In-Row L2A In-Row	Identify KAIC needed rating, time to trip, type, and so on for the feeder breakers.
ELEC-REQ-07	Power feeds	L2L In-Row	The CDU shall have redundant power feeds.
		L2A In-Row	The CDU shall have redundant power feeds.
ELEC-REQ-08	Grounding and bonding point	L2L In-Row L2A In-Row	EARTH GROUND: The CDU will include an Earth Grounding terminal and Lug that can be connected to the facility earth grounding system.
ELEC-REQ-09	Master emergency power off switch	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ It shall be available with an electrical lockout feature calling out a lockout once power has been shut down. ➢ The EPO requested would be a red mushroom button that can be pressed to shut down all power and functionality of the CDU the moment it is pushed.
ELEC-REQ-10	Power draw	L2L In-Row	Power consumption shall be less than 2% of the unit's nominal capacity.
		L2A In-Row	Power consumption shall be less than 5% of the unit's nominal capacity.
ELEC-REQ-11	Power supply placement	L2L In-Row L2A In-Row	The power supplies shall be placed on top of the unit to prevent burnout in case of a leakage accident

Table 9. Wetted Materials Requirements

Requirement ID	Item	CDU Type	Description
WETTEDMAT-REQ-01	Metals	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> > Brass w/ <15% Zinc > Copper (CDA110, CDA1020, CDA1220, CDA1100) > High Nickel Alloys > Stainless Steel (Most SS alloys should be acceptable, including 410, 304L, 316L or higher grades preferred) > Titanium Grade 2 (UNS R50400)
WETTEDMAT-REQ-02	plastics and rubbers	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> > EPDM (Peroxide Cured required for hoses) > FEP > HDPE – High density Polyethylene > PEEK > PP-Polypropylene > PTFE > Viton A > Viton ETP > Viton GF
WETTEDMAT-REQ-03	sealants and lubricants	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> > Parker Super O Lube > Staubli G11 > Loctite 567
WETTEDMAT-REQ-04	Brazing materials	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> > BCuP-2: Cu93/P7 > BCuP-3: Cu89/Ag5/P6/Other 0.15 > BCuP-4: Cu87/Ag6/P7 > BCuP-5: Cu80/Ag15/P6 > B-Ni-6: Ni88.9/P11 > TF-H600F: Cu74.9/Sn15.6/P5.3/N4.2
WETTEDMAT-REQ-05	Materials to avoid	L2L In-Row L2A In-Row	Aluminum ABS CR CPVC Hastelloy B Lead Non-Stainless Steel PVC Zin

Table 10. Safety Requirements

Requirement ID	Item	CDU Type	Description
SAFE-REQ-01	Maximum operating pressure - Secondary side	L2L In-Row	72 psig
	Maximum operating pressure - Fluid side	L2A In-Row	72 psig
SAFE-REQ-02	Maximum operating pressure - Primary side	L2L In-Row	The CDU primary side shall tolerate flow pressure up to 100 psi (following ASHRAE Liquid Cooling Guidelines for Datacom Equipment Centers-Edition 4.
		L2A In-Row	Not applicable
SAFE-REQ-03	Secondary pressure relief valve (PRV)	L2L In-Row L2A In-Row	The unit shall have a PRV to prevent any damage in the presence of high working pressure. Set point pressure is 6 bar.
SAFE-REQ-04	Burst pressure - safety	L2L In-Row L2A In-Row	The unit shall stand the following burst pressure of 3X of the working pressure according to TC 9.9 per IEC code. Maximum operating pressure is 72 psig, so burst pressure would be 216 psig.
SAFE-REQ-05	Electrically energized components	L2L In-Row L2A In-Row	High-voltage and low-voltage components shall be separated. The high-voltage components shall only be accessible when the CDU is powered off, while the low-voltage components shall be accessible while the CDU is running.
SAFE-REQ-06	Expansion tank	L2L In-Row	The CDU shall have an expansion tank.
		L2A In-Row	The CDU shall have an expansion tank.

Table 11. Filtration Requirements

Requirement ID	Item	CDU Type	Description
FILT-REQ-01	Primary side	L2L In-Row	500 micron or less
		L2A In-Row	Not applicable
FILT-REQ-02	Secondary side	L2L In-Row	<ul style="list-style-type: none"> ➢ The CDU shall support 25 µm filter with a beta ratio of 75, following ASHRAE recommendation ➢ Secondary filters shall have N+1 redundancy. ➢ It is recommended to place filters after the pumps at the supply to the finest channels.

Requirement ID	Item	CDU Type	Description
		L2A In-Row	<ul style="list-style-type: none"> ➢ The CDU shall support 25 µm filter with a beta ratio of 75, following ASHRAE recommendation. ➢ Secondary filters shall have N+1 redundancy. ➢ It is recommended to place filters after the pumps at the supply to the finest channels.

Table 12. System Control Requirements

Requirement ID	Item	CDU Type	Description
CONT-REQ-01	Constant differential pressure mode	L2L In-Row L2A In-Row	The unit shall support operation using differential pressure on the secondary flow loop. The differential pressure set point shall be remotely settable.
CONT-REQ-02	Constant flow rate mode	L2L In-Row L2A In-Row	The unit should support operation using constant flow rate mode on the secondary flow loop. The flow rate set point shall be remotely settable.
CONT-REQ-03	Constant pump speed mode	L2L In-Row L2A In-Row	Constant secondary pump speed mode is desirable but not a requirement. The pump speed set point shall be remotely settable.

Table 13. HMI Requirements

Requirement ID	Item	CDU Type	Description
HMI-REQ-01	Front panel HMI	L2L In-Row L2A In-Row	The unit shall have an HMI to demonstrate key parameters status and setup configuration
HMI-REQ-02	Primary side	L2L In-Row	Front panel HMI shall display data points on the primary side showing essential temperatures, pressures, and flow rate.
	Air side	L2A In-Row	Front panel HMI shall display data points on the air side showing essential temperatures, pressures, flow rates, and fan speeds.
HMI-REQ-03	Secondary side	L2L In-Row	Front panel HMI shall display a schematic of the secondary loop showing essential temperatures, pressures, flow rates, and pump speed.
	Liquid side	L2A In-Row	Front panel HMI shall display a schematic of the secondary loop showing essential temperatures, pressures, flow rates, and pump speed.
HMI-REQ-04	Product code identification, IP address, installed	L2L In-Row L2A In-Row	All items shall be accessible by navigating from the home screen

Requirement ID	Item	CDU Type	Description
	software version, date, and time		
HMI-REQ-05	Main menu screen	L2L In-Row L2A In-Row	The main screen on the front panel LCD shall display log in, status, alarms, setup configuration, service, and diagnostics.
HMI-REQ-06	Status screen	L2L In-Row L2A In-Row	The status screen on the front panel LCD shall display the operating condition
HMI-REQ-07	Alarm screen	L2L In-Row L2A In-Row	The alarm screen on the front panel LCD shall display new or active alarms to acknowledge these events
HMI-REQ-08	Log in screen	L2L In-Row L2A In-Row	The log in screen on the front panel HMI shall allow user to access further information and adjust various parameters
HMI-REQ-09	Configuration screen	L2L In-Row L2A In-Row	The configuration screen on the front panel HMI shall allow user to set specific parameters and control functions
HMI-REQ-10	Diagnostic screen	L2L In-Row L2A In-Row	To give raw information and analog to digital conversion factors for the status for all inputs and outputs

Table 14. Telemetry Requirements

Requirement ID	Item	CDU Type	Description
TELE-REQ-01	Real-time monitoring	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ The CDU shall support real-time monitoring. ➢ The unit shall support data polling rate of once per second for all data points. ➢ The data polling rates shall be adjustable. ➢ External management system real-time monitoring is a requirement.
TELE-REQ-02	Remote monitoring and control	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ The CDU shall support remote monitoring of all sensors, actuators, pumps, fans, and other physical inputs or outputs over Modbus TCP. ➢ The CDU shall support remote monitoring and adjustment of all setpoints and control parameters over Modbus TCP. ➢ The unit shall support remote monitoring through SNMP over a second NIC to allow for monitoring by an independent network. (optional)
TELE-REQ-03	Firmware	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ Firmware shall be upgradable both locally and over the local network. ➢ The capability of firmware upgrade without interruption of operations (it is preferred but not a requirement).

Requirement ID	Item	CDU Type	Description
TELE-REQ-04	System data	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ The unit shall allow remote downloading of system data, alarms, and logs. ➢ All system data, alarms, and logs shall be retained for a duration of 72 hours. ➢ All unit configuration parameters and setpoints should be exportable to external devices for backup, recovery, and configuration management.
TELE-REQ-05	Cybersecurity	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ SNMP communication must support TSL and SSL authentication and encryption. ➢ Local HMI will require user login for any configuration or setpoint changes performed locally.

NVIDIA requires the ability to set alarm thresholds and disable alarms remotely. NVIDIA understands that this may not be possible with all alarms, so the vendor should be prepared to work with NVIDIA to create a more specific list of alarms that NVIDIA needs to be able to set or disable remotely.

Table 15. Alarms Requirements

Requirement ID	Item	CDU Type	Description
ALARM-REQ-01	General alarming functionality	L2L In-Row L2A In-Row	<ul style="list-style-type: none"> ➢ All alarms and associated adjustable parameters will be available to read over Modbus communications and local HMI. ➢ All alarms and adjustable parameters (thresholds, return to normal deadbands, and delays) will be available to be read and written to (adjusted) over Modbus communications and local HMI. ➢ Alarms associated with analog points (temperature, pressure, flow, and so on) will have an adjustable alert threshold value, return to normal deadband, and alert delay.
ALARM-REQ-02	Primary supply/return temperature	L2L In-Row	CDU shall issue an alarm when the primary supply/return temperature readings are out of the specified range. Following ASHRAE recommendations (ASHRAE TC 9.9 Reference Card), supply temperature should not exceed beyond the specified limit for each class including W17 ($2 < T < 17$ C), W27 ($2 < T < 27$ C), W32 ($2 < T < 32$), and W45 ($2 < T < 45$). Maximum return temperature shall be determined based on the facility capacity limitations.

Requirement ID	Item	CDU Type	Description
	Air temperature	L2A In-Row	The unit shall issue an alarm when the supply air temperature reading is above the defined alarm limit.
ALARM-REQ-03	Secondary supply temperature	L2L In-Row L2A In-Row	The unit shall issue an alarm when the secondary supply temperature reading exceeds the defined alarm limit.
ALARM-REQ-04	Secondary return temperature	L2L In-Row L2A In-Row	The unit shall issue an alarm when the secondary return temperature reading is above 65 °C.
ALARM-REQ-05	Primary supply pressure	L2L In-Row	CDU shall issue an alarm when primary supply pressure readings are out of the specified range. Maximum allowable working pressure is (following ASHRAE Liquid Cooling Guidelines for Datacom Equipment Centers-04) 100 psig.
		L2A In-Row	Not applicable
ALARM-REQ-06	Secondary supply pressure	L2L In-Row L2A In-Row	The unit shall issue an alarm when the secondary supply pressure readings are out of the specified range in SAFE-REQ-01.
ALARM-REQ-07	Room dry bulb temperature	L2L In-Row	CDU shall issue an alarm when the temperature probe reads out of the specified range.
		L2A In-Row	CDU shall issue an alarm when the temperature probe reads out of the specified range.
ALARM-REQ-08	Room relative humidity	L2L In-Row L2A In-Row	The unit shall issue an alarm if the RH is out of the specified range based.
ALARM-REQ-09	Dew point temperature	L2L In-Row L2A In-Row	The unit shall issue an alarm when room dew point has increased within 3 F of the current secondary supply temperature.
ALARM-REQ-10	Filter differential pressure	L2L In-Row L2A In-Row	The unit shall issue an alarm when pressure drop across the filter or strainer exceeds its specified alarm limit. The alarm limit should be specified based on the filter mesh size and maximum flow rate passing through.
ALARM-REQ-11	Secondary differential pressure	L2L In-Row L2A In-Row	The unit shall issue an alarm when in DP control mode and the secondary DP is out of range within ± 5 % of the specified set-point.
ALARM-REQ-12	Secondary flow rate	L2L In-Row L2A In-Row	The unit shall issue an alarm when in flow control mode and the secondary flow rate is out of range within ± 5% of the specified set-point.
ALARM-REQ-13	Leak detection	L2L In-Row L2A In-Row	The unit shall issue an alarm if any water leakage has been detected.
ALARM-REQ-14	Level sensor-no fluid detected	L2L In-Row L2A In-Row	The unit shall issue an alarm if the coolant level sensor measures the low point - Fluid

Requirement ID	Item	CDU Type	Description
			reservoir shall have at least 2 sensors indicating low point and maximum level.
ALARM-REQ-15	Restricted pump performance	L2L In-Row L2A In-Row	The unit shall issue an alarm if pump speed is reduced automatically in response to an overpressure condition in the secondary loop.
ALARM-REQ-16	Power monitoring	L2L In-Row L2A In-Row	CDU shall send out an alarm if one power source is lost.
ALARM-REQ-17	pH value	L2L In-Row L2A In-Row	CDU shall issue an alarm if pH value is below 7.8 (It is preferred but not a requirement).
ALARM-REQ-18	Conductivity value	L2L In-Row L2A In-Row	CDU shall issue an alarm if the conductivity value is below 4600 μs (It is preferred but not a requirement).
ALARM-REQ-19	Turbidity	L2L In-Row L2A In-Row	CDU shall issue an alarm if the turbidity value is above 2 NTU (It is preferred but not a requirement).

Table 16. Leak Detection Requirements

Requirement ID	Item	CDU Type	Description
LEAK-REQ-01	Drain pan	L2L In-Row L2A In-Row	The unit shall include an overflow drain pan under the unit to collect the fluid with a monitored leak detection system in the pan.
LEAK-REQ-02	Shutoff valve	L2L In-Row	Shutoff valves shall be available in the supply and return liquid lines that can be manually closed if a catastrophic leak detected by the leak detection system – The unit shall not automatically shut itself down.
		L2A In-Row	Shutoff valves shall be available in the supply and return liquid lines that can be manually closed if a catastrophic leak detected by the leak detection system – The unit shall not automatically shut itself down.

Table 17. Sensor Requirements

Requirement ID	Item	CDU Type	Description
SENS-REQ-01	Flow sensor – TCS loop	L2L In-Row	Flow sensors shall be installed on the secondary side. They shall be calibrated for Recochem's PG25 (25% propylene glycol/water) to $\pm 3\%$ of the full-scale. It is recommended to use an electromagnetic flow sensor due to its superior accuracy.
	Flow sensor – TCS loop	L2A In-Row	Flow sensors shall be installed on the secondary side. They shall be calibrated for

Requirement ID	Item	CDU Type	Description
			Recochem's PG25 (25% propylene glycol/water) to $\pm 5\%$ of the full-scale It is recommended to use an electromagnetic flow sensor due to its superior accuracy.
SENS-REQ-02	Flow sensor – Primary/facility side	L2L In-Row	They shall be calibrated for water to $\pm 5\%$ of the full-scale for each specific CDU type
SENS-REQ-03	Temperature sensor	L2L In-Row L2A In-Row	Temperature sensors are required on both air and liquid sides. All temperature sensors shall be calibrated to $\pm 0.2\text{ }^{\circ}\text{C}$ for a range of $17\text{ }^{\circ}\text{C}$ to $65\text{ }^{\circ}\text{C}$
SENS-REQ-04	Pressure sensor	L2L In-Row L2A In-Row	Pressure sensors are required on both air and liquid sides. Pressure sensors shall be calibrated to $\pm 1\%$ of the full-scale (14 to 45 psi)
SENS-REQ-05	Relative humidity (RH) sensor	L2L In-Row L2A In-Row	The unit shall include an RH sensor, and it shall be calibrated to $\pm 2\%$ RH of the full-scale (8% to 100%).
SENS-REQ-06	pH sensor	L2L In-Row L2A In-Row	pH sensors should be calibrated to $\pm 0.1\text{ pH}$ for a range of 6.8 to 10 (It is preferred but not a requirement).
SENS-REQ-07	Conductivity sensor	L2L In-Row L2A In-Row	The conductivity sensors should be calibrated to $\pm 3\%$ conductivity of the full-scale (0 to 5000 $\mu\text{s}/\text{cm}$) (It is preferred but not a requirement).
SENS-REQ-08	Turbidity sensor	L2L In-Row L2A In-Row	Turbidity sensors should be calibrated to $\pm 3\%$ of the full-scale (0 to 40 NTU) (It is preferred but not a requirement).

The requirements concerning pump failover are specified as having redundant pumps in the CDU. For two or more pumps in a CDU, the following scenarios should be accommodated:

- > One pump running at full capacity, the other pump/pumps at idle.
- > 50%-50%

Table 18. Individual CDU Pump Failover Requirements

Requirement ID	Item	CDU Type	Description
PUMPFAIL-REQ-01	Pump failover	L2L In-Row L2A In-Row	If one pump fails, the transition time to another pump shall occur within 5 seconds or less.

Requirement ID	Item	CDU Type	Description
PUMPFAIL-REQ-02	Pump failover - secondary flow rate	L2L In-Row L2A In-Row	In the event of a pump failover, the secondary flow rate shall be maintained within $\pm 5\%$ of the last specified flow rate value over the next 30 seconds after switching to the backup pump.
PUMPFAIL-REQ-03	Pump failover – secondary pressure	L2L In-Row L2A In-Row	In the event of a pump failover, the secondary pressure shall be maintained within $\pm 5\%$ of the last specified pressure over the next 30 seconds after switching to the backup pump.
PUMPFAIL-REQ-04	Pump failover – secondary temperature rise	L2L In-Row L2A In-Row	In the event of a pump failover, the secondary supply temperature shall be maintained within $\pm 2\text{ }^{\circ}\text{C}$ of the last specified temperature over the next 30 seconds after switching to the backup pump.

The group control and CDU failover requirements reflect two or more CDUs running on the same secondary cooling loop.

For two or more CDUs operating on the same loop, the following scenarios should be accommodated:

- One pump running at full load, the other pump at idle.
- All CDUs equally load-sharing, for example, 33% each for three CDUs
- Any combination of load-sharing between the CDUs.



Note: Group control and CDU failover requirements apply to L2L In-Row and L2A In-Row only.

Table 19. Group Control and CDU Failover Requirements

Requirement ID	Item	CDU Type	Description
GCONT-REQ-01	CDU failover	L2L In-Row L2A In-Row	If one CDU fails, the transition time to another CDU shall occur within 5 seconds or less.
GCONT-REQ-02	CDU failover - secondary flow rate	L2L In-Row L2A In-Row	In the event of a CDU failover, the secondary flow rate shall be maintained within $\pm 5\%$ of the last specified flow rate value over the next 30 seconds after switching to the backup CDU.
GCONT-REQ-03	CDU failover - secondary pressure	L2L In-Row L2A In-Row	In the event of a CDU failover, the secondary pressure shall be maintained within $\pm 5\%$ of the last specified pressure over the next 30 seconds after switching to the backup CDU.
GCONT-REQ-04	CDU failover - secondary temperature rise	L2L In-Row L2A In-Row	In the event of a CDU failover, the secondary supply temperature shall be maintained within $\pm 2\text{ }^{\circ}\text{C}$ of the last specified temperature over

Requirement ID	Item	CDU Type	Description
			the next 30 seconds after switching to the backup CDU.

Table 20. Fan Failover Requirements

Requirement ID	Item	CDU Type	Description
FANFAIL-REQ-01	Fan failover	L2L In-Row	Not applicable
		L2A In-Row	If one fan fails, the transition time to another fan shall occur within 5 seconds or less.
FANFAIL-REQ-02	Fan failover – secondary temperature rise	L2L In-Row	Not applicable
		L2A In-Row	In the event of a fan failover, the secondary supply temperature shall be maintained within $\pm 2^{\circ}\text{C}$ of the last specified temperature over the next 30 seconds after switching to the backup fan.

Table 21. Real Time Chemistry Health Reporting

Requirement ID	Item	CDU Type	Description
CHEM-REQ-01	Chemistry health check	L2L In-Row L2A In-Row	The CDU capability of reporting liquid quality by reporting on the coolant's pH, conductivity, and turbidity in real-time (It is preferred but not a requirement).

MIB List

The vendor is expected to provide a well-written, descriptive, accurate Modbus point map and MIB list as part of their response to this RFP/RFQ. NVIDIA will review the MIB list in detail and will engage the vendor with questions about the MIB list.

CDU Documentation

The following table lists the CDU documentation used for all requirements.

Table 22. CDU Documentation

Requirement ID	Item	Description
DOC-REQ-01	Technical manual	The technical manual shall include all the information regarding the cooling capacity, pumping power, alarm and control systems, filter info, wetted materials list, local component display and configuration instructions, safety certifications, basic component troubleshooting steps and all the other items specified in this PRD. It is strongly suggested to include all the performance test data if they are available.
DOC-REQ-02	Installation guideline	The installation guidelines shall include all the piping connection requirements, power hook-up and specifications (voltage rating), step-by-step powering up process, and safety features.
DOC-REQ-03	Modbus register map	Need to provide a complete Modbus register map
DOC-REQ-04	CAD files and drawings	2D and 3D (.STEP), and REVIT *.RVT files are required. USD format CAD for Digital Twin model (it is a requirement if planning to get involved in DT development)
DOC-REQ-05	Flushing report	The flushing report shall outline the step-by-step procedure taken by the vendor to flush and clean the CDU before shipping it to the customer.

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