CDU Self Qualification Guidelines

Application Note

Document History

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Introduction

This application note serves as a guideline for the qualification process of coolant distribution units (CDUs) conducted at the vendor's site. The goal is to verify the availability and functionality of key requirements for in-row L2L and L2A CDUs, including hydraulic performance, thermal capacity, telemetry, wetted materials, safety, redundancy, and failure response strategy. Once the process is complete, all test data must be submitted using the provided template for NVIDIA review and approval. Any changes to the requirements must be reviewed and approved by the owner's representatives.

General Expectations

Vendors are advised to thoroughly review the instructions outlined in this application note to ensure a comprehensive understanding of the steps involved in the process. Submissions are expected to be clear, well-written, and accurate. Acronyms must be defined upon first use. The provided data template must be followed, and the required raw data for each test must be included. Any additional considerations may be added directly to the relevant section for each test.

CDU Qualification Overview

This section provides an overview of the process, from product requirements document (PRD) review to RVL listing.

Step 1: Product Requirements Document Review

The vendor must respond to each item outlined in the "CDU Requirements" document, clearly indicating whether their design complies with each requirement. For any deviations, the vendor should specify whether there are plans to meet the stated requirement at a later time, or propose available alternative solutions.

Reference document: “CDU Requirements Document”

Table 1. CDU Qualification Example

Required ID	Item	Description	Response from Vendor
CONT-REQ-01	Constant differential pressure mode	The unit shall support operation using differential pressure on the secondary flow loop. The differential pressure set point shall be remotely settable.	Compliant/non-compliant (For non-compliant items, provide current design details and note any planned updates or alignment)

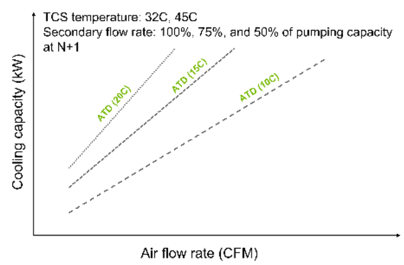
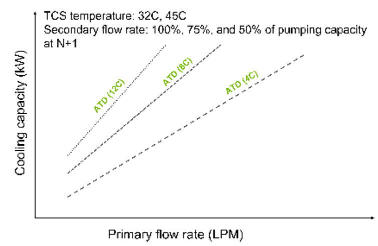
Step 2: Wetted Materials Compatibility

Vendors must complete the wetted materials table in the provided template (Report_Template.xlsx), specifying all materials used in their CDU. A comprehensive list of approved materials for metals, rubbers, plastics, sealants, lubricants, and brazing materials is provided as a guideline.

Step 3: Core Requirements Availability

A subset of the requirements has been designated as “Core Requirements,” representing the minimum essential features needed to successfully pass the qualification process. The test guidelines have been developed in accordance with the specified requirements. These requirements are outlined in the following table. Vendors must complete the “Core Requirements Checklist” in the provided template at the end of this application note.

Table 2. Core Requirements

No.	Core Requirement	Requirement ID	L2A CDU	L2L CDU
1	Cooling capacity	THERM-REQ-01	Minimum requirement is 70 kW (for single-wide, 600mm) and 135 kW (for double-wide,1200mm) at a 10 °C approach temperature at the minimum required coolant flow rate and pressure differential defined at PUMP-REQ-01 and PUMP-REQ-01 Cooling curve: 	Minimum requirement 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 Cooling curve: 
2	Secondary temperature stability	THERM-REQ-02	The unit shall support a stable secondary set-point temperature of ≤ 45 °C ± 1 °C for a baseline load of 10% of the maximum load (at 10°C ATD) to 100% of the maximum load (at 10°C ATD).	The unit shall support a stable secondary set-point temperature range of ≤ 45 °C ± 1 °C for a baseline load of 10% of the maximum load (at 4°C ATD) to 100% of the maximum load (at 4°C ATD).
3	Pumping capacity at required cooling capacity	PUMP-REQ-01 PUMP-REQ-02	The unit should provide a minimum flow rate of 1.5 LPM/kW at the minimum recommended cooling capacity (THERM-REQ-01).	The unit should provide a minimum flow rate of 1.5 LPM/kW at the minimum recommended cooling capacity (THERM-REQ-01).
4	Pump redundancy	PUMP-REQ-04	CDU Should have N+1 redundancy for pumps.	CDU should have N+1 redundancy for pumps.
5	Fan redundancy	FAN-REQ-04	CDU shall have N+1 redundancy for fans.	Not applicable

No.	Core Requirement	Requirement ID	L2A CDU	L2L CDU
6	Secondary filter	FILT-REQ-02	The CDU shall support 25 µm filter with no filter housing changes required. Secondary filters shall have N+1 redundancy.	The CDU shall support 25 µm filter with no filter housing changes required. Secondary filters shall have N+1 redundancy.
7	Pump field replacement	SERV-REQ-01	The pump shall be hot swappable with no system downtime.	The pump shall be hot swappable with no system downtime.
8	Fan field replacement	SERV-REQ-02	The fan shall be hot swappable with no system downtime.	Not applicable
9	Pressure Relief Valve (PRV) setpoint	SAFE-REQ-03	The unit shall have a PRV to prevent any damage in the presence of high working pressure. Set point pressure is 6 bar.	The unit shall have a PRV to prevent any damage in the presence of high working pressure. Set point pressure is 6 bar.
10	Constant differential pressure mode	CONT-REQ-01	The unit shall support operation using differential pressure on the secondary flow loop. The differential pressure set point shall be remotely settable.	The unit shall support operation using differential pressure on the secondary flow loop. The differential pressure set point shall be remotely settable.
11	Constant flow rate mode	CONT-REQ-02	The unit shall support operation using constant flow rate mode on the secondary flow loop. The flow rate set point shall be remotely settable.	The unit shall support operation using constant flow rate mode on the secondary flow loop. The flow rate set point shall be remotely settable.
12	Telemetry (sensor connection verification)	TELE-REQ-01	The unit shall support real-time monitoring for all the main parameters (flow rate, temperature, pressure, and level sensor)	The unit shall support real-time monitoring for all the main parameters (flow rate, temperature, pressure, and level sensor)
13	Flow sensor accuracy - TCS loop	SENS-REQ-01	Flow sensor shall be calibrated for Recochem's PG25 (25% propylene glycol/water) to ± 5% of the full-scale It is recommended to use an electromagnetic flow sensor due to its superior accuracy.	Flow sensor shall be calibrated for Recochem's PG25 (25% propylene glycol/water) to ± 3% of the full-scale It is recommended to use an electromagnetic flow sensor due to its superior accuracy.
14	Flow sensor accuracy - Primary loop	SENS-REQ-02	They shall be calibrated for water to ± 5% of the full-scale for each specific CDU type	They shall be calibrated for water to ± 5% of the full-scale for each specific CDU type
15	Pump failover	PUMPFAIL-REQ-01 to 04	If one pump fails, the transition time to another pump shall occur within 5 seconds or less.	If one pump fails, the transition time to another pump shall occur within 5 seconds or less.

No.	Core Requirement	Requirement ID	L2A CDU	L2L CDU
16	Fan failover	FANFAIL-REQ-01 to 02	If one fan fails, the transition time to another fan shall occur within 5 seconds or less.	Not applicable
17	Group control	GCONT-REQ-01 to 04	If one CDU fails, the transition time to another CDU shall occur within 5 seconds or less.	If one CDU fails, the transition time to another CDU shall occur within 5 seconds or less.

Step 4: Qualification Tests

This section outlines the details of each test, including its scope and the steps involved. All parameter setpoints are defined, with references to the corresponding tab in the template where test data must be provided.

This section starts with an overall review of setup instrumentation requirements, operating tolerance limits, stability criteria, and flushing procedure.

Instrumentation of the setup and external sensors requirements:

- Flow Sensor with accuracy of ±0.5% of reading
- Temperature Sensor – Type T (±1.0°C or ±0.75%)
- Pressure Sensors- ±0.25% to ±1.0% of full scale

Operating conditions tolerance limits:

- Temperature: $T - T_{target} \leq 0.56\ \Delta℃$
- Flow rate: $V - V_{target} \leq 5\%$

Stability criteria:

- Temperature: $s_T \leq 0.42\ \Delta℃$
- Flow rate: $s_V \leq 0.75\%$

Flushing Procedure:

- Flush the CDU before starting the test.
- A flushing procedure is provided in Appendix A as a guideline.
- Share the flushing procedure followed for your test with Nvidia.

Test 1: Hydraulic Test - Constant Differential Pressure

This section outlines the procedures and performance expectations for operating the CDU in constant differential pressure (DP) mode. In this control mode, the CDU maintains a fixed pressure difference across the secondary loop to ensure stable and consistent flow, regardless of downstream fluctuations. The following tests aim to verify the CDU's ability to deliver stable flow across a range of operating conditions.

Test Steps:

1. Configure the CDU to operate under constant differential pressure (DP) mode as defined in the system settings.
2. Set the CDU to operate at multiple DP setpoints: 20 psi, 25 psi, 30 psi, and 35 psi. At each setpoint, allow the system to respond and stabilize, and monitor its performance (for example, DP, flow rate, and any system alarms or faults).
3. If any of the specified DP setpoints are unsupported by the CDU or do not fall within the operational range, this should be documented in the report along with an explanation of the limitation.
4. Record the stabilization time for each DP setpoint. Start timing from the moment the new DP setpoint is applied and capture the time when the system reaches steady state condition.
5. Maintain operation at each setpoint after reaching a steady state:
    a. For L2L CDUs, continue the test for at least 5 minutes after stabilization.
    b. For L2A CDUs, continue for at least 15 minutes.

    i. During this period, observe for fluctuations, alarm triggers, and consistent sensor readings.

6. Ensure effective stabilization, meaning the CDU maintains its target setpoint and key performance parameters (DP and flow rate) remain stable across all test conditions without oscillation or drift.
7. Record data from all available pressure, temperature, and flow sensors within the CDU during each test to verify sensor functionality and data integrity.
8. Record data from all available external pressure, temperature, and flow sensors during each test to verify CDU's sensors functionality and accuracy.
9. The data sampling rate should be at least once per two seconds throughout the test to ensure accurate trend analysis and post-test validation.
10. Provide the test data in the specified tab, "Test 1," in the template.

Test 2: Hydraulic Test - Constant Flow Rate Mode

This section describes the procedures and performance criteria for operating the CDU in constant flow rate mode. In this mode, CDU maintains a fixed secondary loop flow rate, regardless of pressure changes in the system. The following tests aim to verify the CDU's ability to deliver stable flow across a range of operating conditions.

Test Steps:

1. Configure the CDU to operate under constant flow rate mode as defined in the system settings.
2. Set the CDU to operate at multiple flow rate setpoints: 25%, 50%, 75%, and 100% of the nominal flow rate. At each setpoint, allow the system to respond and stabilize, and monitor its performance (for example, DP, flow rate, and any system alarms or faults).
3. Record the stabilization time for each flow rate setpoint. Start timing from the moment the new setpoint is applied and capture the time when the system reaches steady state condition.
4. Maintain operation at each setpoint after reaching a steady state:
    a. For L2L CDUs, continue the test for at least 5 minutes after stabilization.
    b. For L2A CDUs, continue for at least 15 minutes.
        i. During this period, observe for fluctuations, alarm triggers, and consistent sensor readings.
5. Ensure effective stabilization, meaning the CDU maintains its target setpoint and key performance parameters (DP and flow rate) remain stable across all test conditions without oscillation or drift.
6. Record data from all available pressure, temperature, and flow sensors within the CDU during each test to verify sensor functionality and data integrity.
7. Record data from all available external pressure, temperature, and flow sensors during each test to verify CDU's sensors functionality and accuracy.

8. The data sampling rate should be at least once per two seconds throughout the test to ensure accurate trend analysis and post-test validation.
9. Provide the test data in the specified tab, “Test 2,” in the template.

Test 3: Telemetry Verification Test – Flow Sensor Accuracy

This test is conducted to verify the accuracy of the flow sensor under controlled conditions. The measured flow rates will be compared against reference values obtained from a calibrated flow meter. The goal is to ensure the sensor meets the required accuracy specifications across the expected operating range.

Test Steps:

1. Select a calibrated and accurate external flow sensor to serve as the reference for this test. The selected sensor must have a minimum accuracy of ±0.5% of reading and be calibrated for PG25 fluid conditions. Recommended sensor types include Coriolis or Electromagnetic flow meters. Specify the sensor type, model, and calibration certificate and reference in the report.
2. Document the type of internal flow sensor used in the CDU on the secondary side, including manufacturer, model, and stated accuracy.
3. Configure the CDU to operate in constant flow rate mode and test it at 4 flow rate setpoints including 10%, 50%, 75%, and 100% of the nominal (rated) secondary flow rate.
4. At each flow rate setpoint, run the CDU at three TCS supply temperatures to observe any temperature-dependent variation
   a. 25°C
   b. 35°C
   c. 45°C
5. Record and compare flow readings from both the internal CDU sensor and the external reference sensor at each combination of flow rate and temperature. Maintain steady-state conditions before taking the readings to ensure data consistency.
6. Repeatability Check: Optionally, repeat each test point at least twice to verify consistency and repeatability of internal sensor readings under the same conditions.
7. Provide the test data in the specified tab, “Test 3,” in the template.

Test 4: Cold Start Thermal Test

The objective of this test is to verify that the temperature control PID loop does not experience loop windup (accumulated error) that could hinder timely valve response during a cold start.

Test Steps:

1. Start the CDU with no heat load applied, only the pumps operating. Ensure the CDU secondary supply temperature is at least 2°C below the setpoint (with the primary valve fully closed) and maintain this condition for 30 minutes before starting the test.
2. Apply a 50% heat load to the CDU. Monitor the secondary supply temperature and observe it gradually increasing and approaching the setpoint.
3. Confirm that the primary valve begins to modulate open either:
    a. Just before the secondary supply temperature reaches the setpoint, or
    b. Within 10 seconds after the secondary supply temperature exceeds the setpoint.
4. Once the system stabilizes, ensure that the secondary supply temperature remains within ±1°C of the setpoint.
5. Step 3 serves as the pass or fail criterion. If the primary valve fails to open within the required time window, the CDU does not meet the control response requirements.
6. Provide the test data in the specified tab, “Test 4,” in the template.

Test 5: Thermal Test – Low Load

The objective of this test is to evaluate the CDU’s ability to maintain a stable and uniform TCS temperature setpoint under low-load conditions.

Test Steps:

1. Set the CDU to operate in constant differential pressure (DP) mode as defined in system settings.
2. Fine-tune the DP setpoint so the secondary flow rate reaches 50% of the nominal flow.
3. Configure the CDU to maintain a TCS supply coolant temperature of 30°C.
4. Gradually introduce heat load until it reaches 10% of the rated capacity.
5. Record the stabilization time, starting from heat load application until the system reaches steady state condition.
6. At steady state, monitor the CDU secondary supply coolant temperature and confirm that temperature fluctuations remain within ±1°C of the 30°C setpoint.
7. If temperature fluctuations exceed ±1°C, fine-tune the PID control parameters to improve stability and response.
8. Once stabilized, continue the test as required:
    a. For L2L CDUs, continue the test for at least 5 minutes after stabilization.
    b. For L2A CDUs, continue for at least 15 minutes.
        i. During this period, observe for fluctuations, alarm triggers, and consistent sensor readings.
9. Provide the test data in the specified tab, “Test 5,” in the template.

Test 6: Thermal Test – Nominal Capacity

Section 1: This section looks for validation of the nominal cooling capacity of the CDU at 4°C ATD for L2L CDUs and 10°C ATD for L2A CDUs. The test covers two pump and fan configuration modes:

- N+1 mode (one pump/fan in standby)
- All pumps/fans running (no standby)

Test Steps:

1. Set the CDU to operate with N pumps and fans running and 1 pump or fan on standby.
2. Set the CDU to operate in constant differential pressure (DP) mode as defined in system settings.
3. Fine-tune the DP setpoint so the secondary flow rate reaches 100% of the nominal flow.
4. Adjust the primary flow rate to its maximum, which corresponds to the maximum recommended differential pressure (DP) of 20 psi on the primary side (HX-REQ-02). If achieving the requested maximum flow rate is not possible, use the highest available primary flow rate and clearly indicate this in the result section.
5. Configure the CDU to maintain a TCS supply coolant temperature of 30°C (TCS temperature can be higher at 40°C for L2A CDUs if lower is not possible).
6. Gradually introduce heat load until it reaches 100% of the rated capacity at 4°C ATD. Define the rated capacity as the point at which the TCS supply temperature rises by 2°C above the setpoint.
7. Record the stabilization time, starting from heat load application until the system reaches steady state.
8. At steady state, monitor the CDU secondary supply coolant temperature and confirm that temperature fluctuations remain within ±1°C of the 30°C setpoint.
9. If temperature fluctuations exceed ±1°C, fine-tune the PID control parameters to improve stability and response.
10. Once stabilized, continue the test as required:
    a. For L2L CDUs, continue the test for at least 5 minutes after stabilization.
    b. For L2A CDUs, continue for at least 15 minutes.
        i. During this period, observe for fluctuations, alarm triggers, and consistent sensor readings.
11. If the heat load cannot meet the nominal capacity, clearly document this in the report and explain the limitation.
12. Repeat Step 2 through Step 10 with all pumps and fans running and no pump or fan in standby.
13. Provide the test data in the specified tab, “Test 6-1”, in the template.

Section 2: Provide cooling performance curves at the specified Approach Temperature Differences (ATDs) for each CDU type and validate them with test data. If some setpoints cannot be achieved due to insufficient available heat load, the remaining data points may be generated using heat exchanger modeling software. In such cases, the available test data must be used to verify the accuracy of the software-generated values.

Table 3. ATDs for CDU Type

CDU Type	ATD Setpoints	TCS Flow Rate (% of Rated Flow Rate at 100% Pump Speed)
L2A	10°C, 15°C, 20°C	50%, 75%, 100%
L2L	4°C, 8°C, 12°C	50%, 75%, 100%

Test Steps:

1. Configure the CDU to operate in constant flow rate mode as defined in the system settings.
2. Run this test with an N+1 pump or fan redundancy configuration, meaning one pump or fan being in standby mode.
3. Set the CDU to operate at multiple flow rate setpoints: 50%, 75%, and 100% of the nominal TCS flow rate. At each setpoint, allow the system to respond and stabilize, and monitor its performance (for example, DP, flow rate, and any system alarms or faults).
4. Adjust the TCS supply temperature setpoint to achieve the ATD for each test condition. The recommended TCS temperatures are 30°C and 40°C for L2L CDUs, and 40°C and 45°C for L2A CDUs.
5. Gradually introduce heat load until it reaches 100% of the rated capacity at each ATD. Define the rated capacity as the point at which the TCS supply temperature rises by 2°C above the setpoint.
6. Once steady-state conditions are reached, monitor the secondary supply temperature and ensure fluctuations remain within ±1°C.
7. Record the maximum stable heat load achieved at each flow rate and ATD condition as the nominal cooling capacity for that test.
8. Specify the temperature and flow rate of the primary medium:
   a. Water (or other fluid) for L2L CDUs
   b. Air for L2A CDUs
9. If the heat load is insufficient to reach nominal capacity at a given ATD, clearly document this in the test report and explain the limitation (for example, available load, system constraints).
10. Provide the test data in the specified tab, “Test 6-2,” in the template.

Test 7: Pump Failover

Section 1: This section examines the time required for the pumps to start up and reach their nominal flow rate capacity.

Test Steps:

1. Set the CDU to operate with N pumps running.
2. Configure the CDU to operate in constant differential pressure (DP) mode as defined in system settings.
3. Fine-tune the DP setpoint to achieve 100% of the nominal TCS flow rate.
4. Record the time required for the pumps to reach the nominal flow rate capacity.
5. Ensure the CDU reaches a steady state condition at the nominal flow rate.

Section 2: The objective of this test is to validate the CDU's ability to respond appropriately in a pump failover scenario. The test covers two pump configuration modes:

- N+1 mode (one pump in standby)
- All pumps running at lower speed (no standby)

Test Steps:

1. Set the CDU to operate with N pumps running and 1 pump on standby.
2. Configure the CDU to operate in constant differential pressure (DP) mode as defined in system settings.
3. Fine-tune the DP setpoint so the TCS flow rate reaches 100% of the nominal flow.
4. Configure the CDU to maintain a secondary supply coolant temperature of 30°C.
5. Gradually introduce heat load until it reaches 100% of the rated capacity at 4°C ATD.
6. If the heat load is insufficient, use the maximum available heat load, and document this in the test report along with the reason (for example, load bank limits, system constraints).
7. Wait until the system reaches steady-state conditions before simulating a failure. Key indicators should include stable DP, flow rate, and supply temperature.
8. Simulate a failure of the active pump and observe the system's behavior.
9. Monitor failover response by
   a. Record the time it takes for the backup pump to start and ramp up.
   b. Record the time required for the CDU to recover to its target DP, flow rate, and supply temperature.
   c. Monitor and document any transient fluctuations in flow rate and supply temperature during the transition.
10. Repeat Step 2 through Step 9 with all pumps running at a reduced speed and no pump in standby.
11. Provide the test data in the specified tab, "Test 7," in the template.

Test 8: Fan Failover

The objective of this test is to validate the CDU's ability to respond appropriately in a fan failover scenario. The test covers two pump configuration modes:

- N+1 mode (one fan in standby)
- All fans running at lower speed (no standby)

Test Steps:

1. Set the CDU to operate with N fans running and 1 fan on standby.
2. Configure the CDU to operate in constant differential pressure (DP) mode as defined in system settings.
3. Fine-tune the DP setpoint so the TCS flow rate reaches 100% of the nominal flow.
4. Configure the CDU to maintain a secondary supply coolant temperature of 30°C.

5. If 30°C is not achievable due to air supply temperature constraints, target the minimum possible temperature and clearly state the new setpoint.
6. Gradually introduce heat load until it reaches 100% of the rated capacity at 10°C ATD.
7. If the heat load is insufficient, use the maximum available heat load, and document this in the test report along with the reason (for example, load bank limits, system constraints).
8. Wait until the system reaches steady-state conditions before simulating a failure. Key indicators should include stable DP, flow rate, and supply temperature.
9. Simulate a failure of one of the active fans and observe the system's behavior.
10. Monitor failover response by
    a. Record the time it takes for the standby fan to start and ramp up.
    b. Record the time required for the CDU to recover to its target DP, flow rate, and supply temperature.
    c. Monitor and document any transient fluctuations in supply temperature or cooling performance during recovery.
11. Repeat Step 2 through Step 10 with all fans running at reduced speed and no fan in standby.
12. Provide the test data in the specified tab, "Test 8," in the template.

Test 9: CDU Group Control

To validate the group control functionality of CDUs operating in coordination. This test ensures the system can detect the failure of one CDU and automatically redistribute the load across the remaining units without compromising cooling performance.

The test is performed under the following two configurations:

> N+1 configuration – One CDU is in standby mode
> All CDUs are running at reduced capacity (no standby)

Test Setup:

> Minimum of two or more CDUs configured in a group control scheme
> Shared connection to the same TCS secondary loop
> Each CDU is equipped with independent power and control, but operates with shared group logic

Test Steps:

1. Set multiple CDUs to operate in group control mode with active communication between units.
2. Define one CDU as the group leader, if applicable.
3. Confirm all CDUs are assigned roles and sharing load as designed.
4. Set the system to operate with N CDUs running and 1 CDU on standby.
5. Set all CDUs to operate in constant differential pressure mode.

6. Adjust setpoints so the running CDU provides 100% of the nominal secondary flow rate.
7. Set the TCS supply temperature setpoint to 30°C.
8. Gradually introduce heat load until it reaches 100% of the rated capacity at 10°C ATD.
9. If the heat load is insufficient, use the maximum available heat load, and document this in the test report along with the reason (for example, load bank limits, system constraints).
10. Wait until the system reaches steady-state conditions before simulating a failure. Key indicators should include stable DP, flow rate, and supply temperature.
11. Power off or simulate a fault in one of the active CDUs.
12. Observe system behavior and confirm the standby CDU activates and compensates for the failed unit.
13. Record system response for the following:
    a. Time to activate standby CDU
    b. Time to return to target flow, DP, and temperature
    c. Any fluctuations in flow, DP, or temperature
    d. Any alarms or faults triggered
14. Repeat Step 5 through Step 13 with all CDUs running at reduced speed and no CDU in standby.
15. Provide the test data in the specified tab, “Test 9,” in the template.

Test 10: Pumping Capacity

The objective of this test is to verify the pump PQ (pressure vs. flow) curve and determine the available external pressure head. This test should be conducted using PG25 fluid conditions.

The test is performed under the following two configurations:

> N+1 configuration – One pump is in standby mode
> N configuration – All pumps running

Test Steps:

1. Set the CDU to operate with N pumps running and 1 pump on standby.
2. Use 25 micron secondary filter size.
3. Configure the CDU to operate at 100% pump speed (fixed speed) to generate a consistent PQ curve.
4. Adjust the DP setpoint or use external flow restriction to achieve multiple flow rates, covering the full operational range of the pump.
5. Specify what the CDU-reported DP represents:
    a. Does it include internal impedance or is it limited to external loop DP?
    b. What are the secondary filter sizes if different from 25 microns?

6. Use calibrated pressure sensors placed at the inlet and outlet of the CDU to measure the true external DP (that is, pressure head available to the loop).
7. Compare the CDU-reported DP with the externally measured DP at each flow rate.
8. Document any discrepancies and verify consistency with the expected PQ curve behavior.
9. Repeat Step 2 through Step 7 with all pumps running at 100% speed and no pump in standby.
10. Provide the test data in the specified tab, "Test 10," in the template.

Business and Supply Chain Readiness

This section provides the business and supply chain requirements.

Purpose: Ensure the supply chain and material readiness to support Ecosystem needs.

Criteria:

> Healthy cooperate financial status
> Global manufacturing locations:
  - China+1 COO manufacturing capability & capacity.
> Sufficient capacity of CDU assembly in global location footprint to support regional demands
> Strategic sub-tier component buffer
> Drive multi-source and diversified global footprint of sub-tier component to achieve supply chain resiliency

Requirements:

> Provide financial status and report for risk assessment.
> Provide global manufacturing location, capability, and capacity
> Provide supply chain risk assessment and heatmap.
> Provide supply chain mapping and capacity information of critical components
> Share sub-component buffer status and risk mitigation plan for long lead time parts
> Provide multi-source qualification plan and status update reports.
> Provide the material readiness report including:
  - Critical material readiness
  - On-hand inventory
  - Components
  - Semi-finished goods
  - Finished goods
  - Buffer

Quality and Reliability

This section outlines the expectations for overall product reliability and quality assurance. It covers the necessary measures to ensure long-term performance under operational conditions, as well as compliance with established quality and environmental standards. The goal is to ensure both functional reliability and adherence to industry best practices throughout the product lifecycle.

Hydrostatic Pressure

The CDU must pass hydrostatic pressure tests in accordance with applicable industry standards such as IEC 62368-1, ASME B31.1/31.3, or equivalent. Upon successful completion of the tests, there should be no evidence of leaks or deformation throughout the pressurized system.

Leak Verification

All leak testing must follow applicable standards such as EN 1779, ASTM E1003-13, or similar. Upon completion of thermal and mechanical testing, CDUs are to be inspected for leaks in accordance with applicable standards.

Fluid Compatibility

Vendors must provide a list of materials for all wetted materials used in the flow network and demonstrate these are compatible with the coolant fluid. For further guidance on wetted materials compatibility, see ”Step 2: Wetted Materials Compatibility” in the “CDU Qualification Overview” section.

Dynamics

CDU assemblies must pass industry standard testing which simulates dynamic loads anticipated during shipping and handling to customer premises per ISTA or equivalent standards. Applicable dynamic testing standards include 60068-2-27 for vibration and IEC 60068-2-64 for shock or equivalent.

> **Note:** Tests must be performed on final assemblies as shipped to the customer (for example, inclusive of packaging such as pallets, crates, and so on). A post-test inspection should be completed, and there should be no evidence of physical damage or defects to the final assembly, including packaging (for example, crate, pallet, and so on).

Life Expectancy

Testing must be performed demonstrating CDUs meet or exceed vendor provided specifications for life expectancy. Failure rates should be characterized through industry standard reliability demonstration testing (RDT) (ASTM E3291-2 or equivalent) and provided (for example, MTTF, MTBF, AFR, and so on).

Quality Management

All vendors should adhere to industry best practices for quality management. As such, all CDU manufacturing and assembly locations should be ISO 9000 certified and provide evidence of compliance with ISO 9001 requirements before approval.

Environmental Management

All vendors should adhere to industry best practices for environmental management. As such, CDU manufacturing and assembly locations should provide evidence of ISO 4001 certification prior to approval.

Regulatory Requirements

CDU suppliers must provide evidence of certification and compliance with all required regulatory bodies and industry best practices for the geographies where the CDUs are being manufactured and delivered. Some examples include, but are not limited to, UL, CE, OSHA, IEC 62368-1/ IEC 60950-1, RoHS, REACH, EN 55032/EN 55035, and so on.

Flushing Procedure

Executive Summary

Liquid cooling systems can encounter contamination issues that compromise their efficiency and longevity. Biological growth, often stemming from insufficient biocide levels or water ingress, can lead to clogs and diminished heat transfer. Regular monitoring and biocide maintenance are vital to prevent this. Additionally, metal corrosion within the loop introduces metallic contaminants, necessitating the use of corrosion inhibitors and compatible components. Dust and particles can obstruct flow and reduce cooling efficiency, requiring regular filtration and cleaning of system components. Chemical contaminants, whether from manufacturing residues or impurities in the coolant, pose risks that can be mitigated by using high-quality coolant and thorough component flushing before assembly.

To maintain optimal performance, liquid cooling systems demand proactive upkeep, adherence to manufacturer guidelines, and vigilance in detecting and resolving issues promptly. By implementing these measures, users can minimize the risk of contamination and preserve the efficiency and longevity of their liquid cooling systems.

1. Flushing needs to be performed twice before sending it to the customer deployment site.
2. Connect the secondary supply and return the hose directly and then circulate the coolant within the heat exchanger.
3. For flushing, a filter of 5 microns needs to be used for the entire flushing procedure.
4. Secondary loop filters need to be installed, and the maximum filter size should not exceed 5 microns.
5. Fill the heat exchanger with PG-25.
    a. Must meet the following requirements:
        i. pH: 8 - 10.5 (ASTM D1287)
        ii. Reserve Alkalinity: > 4 ml based on the fluid as is (ASTM D1121)
        iii. Copper: < 2 ppm (ASTM D6310)
        iv. Iron: < 2 ppm (ASTM D6310)
        v. Total Hardness: < 100 ppm (ASTM D6310)
        vi. Chloride: < 25 ppm (ASTM D5827)
        vii. Sulfate: < 25 ppm (ASTM D5827)

viii. **Two products that we recommend meets these requirements

(1) Recohem 18-929

(2) KostChill PG-XL

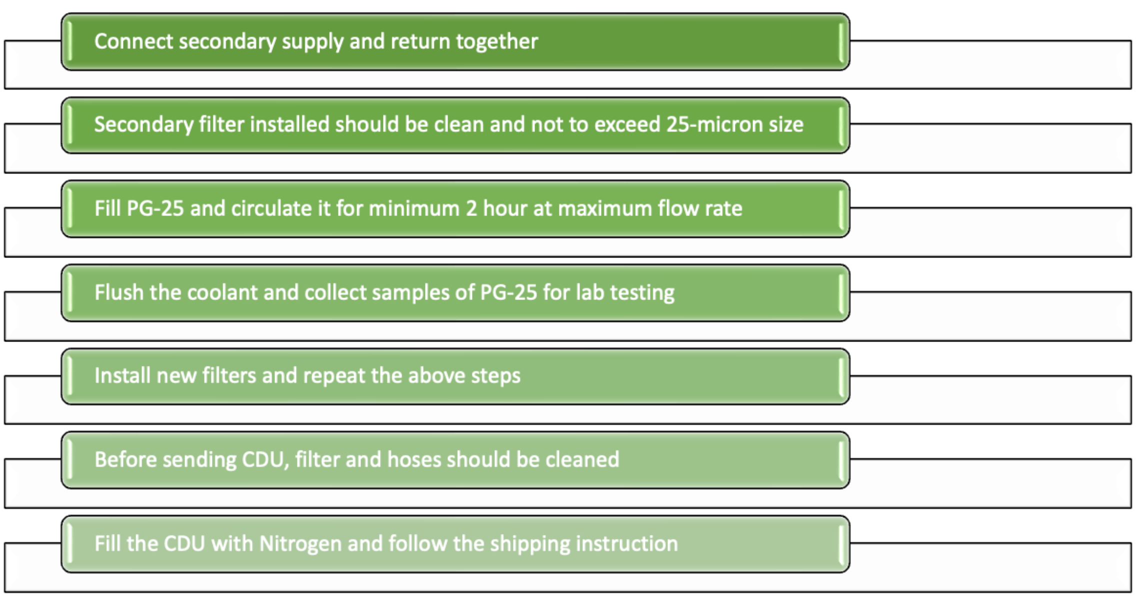
ix. If using any other PG-25 products, confirm with the NVIDIA DC Engineering team first.

6. Switch ON the heat exchanger and circulate the coolant for the 2 hours at maximum flow rate of the heat exchanger.
7. After the first circulation, flush the coolant and collect the coolant samples for lab testing and remove the filters.
8. Inspect the filters and if those are dirty clean it before reusing it for a second flush or use a new filter.
9. Repeat the these steps for the second flushing step.
10. Make sure before sending the heat exchanger to the customer, filters and internal hoses are clean.
11. Once the heat exchanger is flushed according to the mentioned steps, install the filter as requested by customer.
12. Follow the shipping instructions as mentioned in the following steps and include flushing reports with CDU SN and label information.

Detailed Flushing Steps

To ensure a contamination-free CDU, follow the flushing steps carefully and make sure to repeat the process twice before shipping the CDU for deployment.

Figure 1. Flushing Steps



Filter Initial Inspection

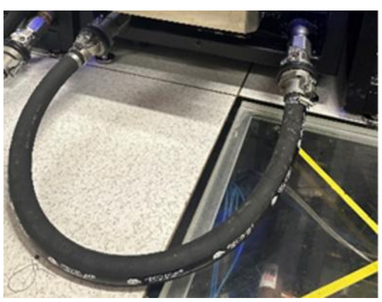
It is essential to examine and clean the filters before filling the unit with coolant since most of the contaminants are typically stuck in the filter. The required filter size is 25 microns (550 meshes). Make sure to inspect the inside of the filter for contaminants as well.

Figure 2. Filter Inspection

Looping and Charging

Once the filters have been securely reinstalled, the unit should be connected in a loop configuration using a dedicated hose. This involves connecting the unit coolant supply port to the return port in a loop fashion.

Figure 3. Connecting Unit Coolant Supply Port



Flushing with Coolant

- After the unit is fully charged while looped to itself, pumps can be turned on at low speed (less than 30% of full speed).
- Make sure that the charging system is still active, so that more coolant is pumped into the unit as air bubbles bleed out from the internal vents.
- Whenever there is no air left in the system, operate the CDU at maximum flow rate (for an hour at least, if possible) to flush it properly.

Draining and Inspecting

- The samples of the drained coolant should be taken for lab inspection.
- Monitor and measure the drained coolant volume. Comparing it with the initial fluid charge will indicate the residual fluid in the unit. This will indicate how much fluid is remaining in the CDU.

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