



Guidelines for Deployment of Single Phase Technology Cooling System

Installer/User

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The objective of this document is to guide mechanical installers responsible for flushing, filling, testing and other tasks related to the deployment of technology cooling system (TCS) networks.

Information contained in this document is sourced from publicly available material and experienced professionals. This document assumes the installer possesses all knowledge and capability to follow relevant installation and quality control procedures required to install a Coolant Distribution Unit (CDU) and TCS; such as pipe fitting, leak checking and electrical wiring installation.

This document is a general guidance document for liquid cooling fluid distribution systems. Individual product installation and user manuals should be reviewed for any product specific requirements; which take precedence over this document in the case of any discrepancy.

Review product user manual for product specific requirements before equipment installation or operation.

Technical Support Site

If you encounter any installation or operational issues with your product, check the pertinent section of this manual to see if the issue can be resolved by following outlined procedures.

Visit <https://www.vertiv.com/en-us/support/> for additional assistance.

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1 Important Safety Instructions

SAVE THESE INSTRUCTIONS



WARNING! Risk of electric shock. Can cause serious injury or death. Building and equipment damage may also result. Open all local and remote electric power supply disconnect switches and verify that power is off with a voltmeter before working within any electric connection enclosures. The controller does not isolate power from the unit, even in the Unit Off mode. Some internal components require and receive power even during the unit off mode of the controller.

Installation, service, and maintenance work must be performed only by properly trained and qualified personnel and in accordance with applicable regulations and manufacturer specifications. Opening or removing the covers to any equipment may expose personnel to lethal voltages within the unit even when it is apparently not operating and the input wiring is disconnected from the electrical source.



WARNING! Risk of short circuits and electric shock. Can cause serious injury or death. Building and equipment damage can result from cut insulation or damaged wires. Can cause overheated wiring, smoke, fire, activation of fire suppression systems and EMS personnel, and loss of power to fans. Verify that all wiring connections are tight and that all wiring is contained within the junction box prior to closing and securing the cover.

Insert CSA-certified or UL-listed bushings into holes and/or knockouts used to route wiring through metal panels to protect the wire insulation from contact with sheet metal edges.



WARNING! Risk of improper wire sizing/rating and loose electrical connections causing overheated wire and electrical connection terminals resulting in smoke or fire. Can cause serious injury or death. Building and equipment damage may also result. Use correctly sized copper wire only and verify that all electrical connections are tight before turning power On. Check all electrical connections periodically and tighten as necessary.



WARNING! Risk of improper wiring, piping, moving, lifting and handling. Can cause serious injury or death. Building and equipment damage may also result. Installation and service of this equipment should be done only by qualified personnel who have been specially-trained in the installation of air-conditioning equipment and who are wearing appropriate, OSHA-approved PPE.



CAUTION: Risk of contact with extremely hot or cold surfaces. Can cause injury. Verify that all components have reached a temperature that is safe for human contact or wear appropriate, OSHA-approved PPE before working with the electric connection enclosures or unit cabinet. Perform maintenance only when the system is de-energized and component temperatures have become safe for human contact.



CAUTION: Risk of contact with sharp edges, splinters and exposed fasteners. Can cause injury. Only properly trained and qualified personnel wearing appropriate, OSHA-approved PPE should attempt to move, lift, remove packaging from or prepare the unit for installation.

NOTICE

Risk of improper power supply connection. Can cause equipment damage and loss of warranty coverage.

Prior to connecting any equipment to a main or alternate power source (for example back-up generator systems) for start-up, commissioning, testing, or normal operation, ensure that these sources are correctly adjusted to the nameplate voltage and frequency of all equipment to be connected. In general, power-source voltages should be stabilized and regulated to within +/- 10% of the load nameplate nominal voltage. Also, ensure that no three-phase sources are single-phased at any time.

See transformer label for primary tap connections. Installer will need to change transformer primary taps if applied unit voltage is other than pre-wired tap voltage.

NOTICE

Risk of improper power supply connection. Can cause equipment damage and loss of warranty coverage.

Prior to connecting any equipment to a main or alternate power source (for example back-up generator systems) for start-up, commissioning, testing, or normal operation, ensure that these sources are correctly adjusted to the nameplate voltage and frequency of all equipment to be connected. In general, power-source voltages should be stabilized and regulated to within +/- 10% of the load nameplate nominal voltage. Also, ensure that no three-phase sources are single-phased at any time.

See transformer label for primary tap connections. Installer will need to change transformer primary taps if applied unit voltage is other than pre-wired tap voltage.

NOTICE

Risk of piping system corrosion and freezing fluids. Can cause leaks resulting in equipment and very expensive building damage. Heat exchangers and piping systems are at high risk of freezing and premature corrosion. Fluids in these systems must contain the proper antifreeze and inhibitors to prevent freezing and premature coil and piping corrosion. When the cooling unit or piping may be exposed to freezing temperatures, charge the system with coolant fluid based on the coldest ambient design temperature. Automotive antifreeze is unacceptable and must NOT be used in any fluid system. Use only coolant fluid solution that meets the requirements of recommended industry practices. Do not use galvanized pipe.

The system coolant fluid must be analyzed by a competent fluid treatment specialist before start up to establish the inhibitor and antifreeze solution requirement and evaluated at regularly scheduled intervals throughout the life of the system to determine the pattern of inhibitor depletion.

The fluid complexity and variants of required treatment programs make it extremely important to obtain the advice of a competent and experienced fluid treatment specialist and follow a regularly scheduled coolant-fluid system-maintenance program.

Fluid chemistry varies greatly as do the required additives, called inhibitors, that reduce the corrosive effect of the fluids on the piping systems and components.

The chemistry of the coolant fluid used must be considered, because some sources may contain corrosive elements that reduce the effectiveness of the inhibited formulation. Sediment deposits prevent the formation of a protective oxide layer on the inside of the coolant system components and piping. The coolant fluid must be treated and circulating through the system continuously to prevent the buildup of deposits and/or growth of sulfate reducing bacteria. Proper inhibitor maintenance must be performed to prevent corrosion of the system.

Consult fluid manufacturer for testing and maintenance of inhibitors.

Commercial-grade coolant fluid is generally less corrosive to the common metals of construction than water itself. It will, however, assume the corrosivity of the coolant fluid from which it is prepared and may become increasingly corrosive with use if not properly inhibited.

Vertiv recommends installing a monitored fluid-detection system that is wired to activate the automatic closure of field-installed coolant fluid supply and return shut-off valves to reduce the amount of coolant fluid leakage and consequential equipment and building damage. The shut-off valves must be sized to close-off against the maximum coolant-fluid system pressure in case of a catastrophic fluid leak.

NOTICE

Risk of no flow condition. Can cause equipment damage. Do not leave the water/coolant fluid supply circuit in a no flow condition. Idle fluid allows the collection of sediment that prevents the formation of a protective oxide layer on the inside of the tubes. Keep unit switched On and water/ coolant fluid supply circuit system operating continuously. In multiple unit teams, allow standby units to enter the rotation automatically or schedule regular manual rotations.

NOTICE

Risk of leaking coolant fluid lines. Can cause equipment and building damage. Lines and joints must be inspected regularly. Improper installation, application and service practices can result in water leakage from the unit. Water leakage can result in severe property damage and loss of critical data center equipment. Do not locate unit directly above any equipment that could sustain water damage.

Vertiv recommends installing monitored leak detection equipment for the unit and supply and return lines.

NOTICE

Risk of a catastrophic water circuit rupture. Can cause expensive building and equipment damage.

The overflow drain pan should have a drain line connected to it that flows to a floor drain or maintenance sink in case of a shutoff valve or leak detection system malfunction.

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2 Purpose

The objective of this document is to guide mechanical installers responsible for flushing, filling, testing, and other tasks related to the deployment of technology cooling system (TCS) networks.

Information contained in this document is sourced from publicly available material and experienced professionals. This document assumes the installer possesses all knowledge and capability to follow relevant installation and quality control procedures required to install a coolant distribution unit (CDU) and TCS, such as pipe fitting, leak checking, and electrical wiring installation.

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3 Essential Components

Table 3.1 Essential Components

Component	Provider	Description
CDU	Vertiv or third-party	Direct to chip liquid cooled CDU <ul style="list-style-type: none"> • Vertiv CoolChip CDU • Vertiv CoolPhase CDU
Isolation valves and air vents	Vertiv or third-party	
Row manifolds	Vertiv or third-party	<ul style="list-style-type: none"> • Prefabricated supply and return manifolds supplied by Vertiv or others • Field fabricated manifolds by third-parties at the direction of the engineer of record/customer
TCS fill station	Third-party	
TCS flushing kit	Third-party	
Thermal water load banks	Third-party	
Thermal expansion tanks	Third-party	
Server rack cabinet	Vertiv or third-party	
In-rack manifolds	Vertiv or third-party	
Liquid cooled hose kits	Vertiv or third-party	<ul style="list-style-type: none"> • Connect between TCS and in-rack manifolds • Connect between in-rack manifolds and liquid cooled server
Liquid cooled servers	Vertiv or third-party	
Perimeter of in-row thermal unit	Vertiv or third-party	Maintain room humidity and dewpoint control
Heat rejection	Vertiv or third-party	Outdoor chiller or outdoor condenser

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4 General Cooling Configurations

Figure 4.1 Ring Piping Arrangement

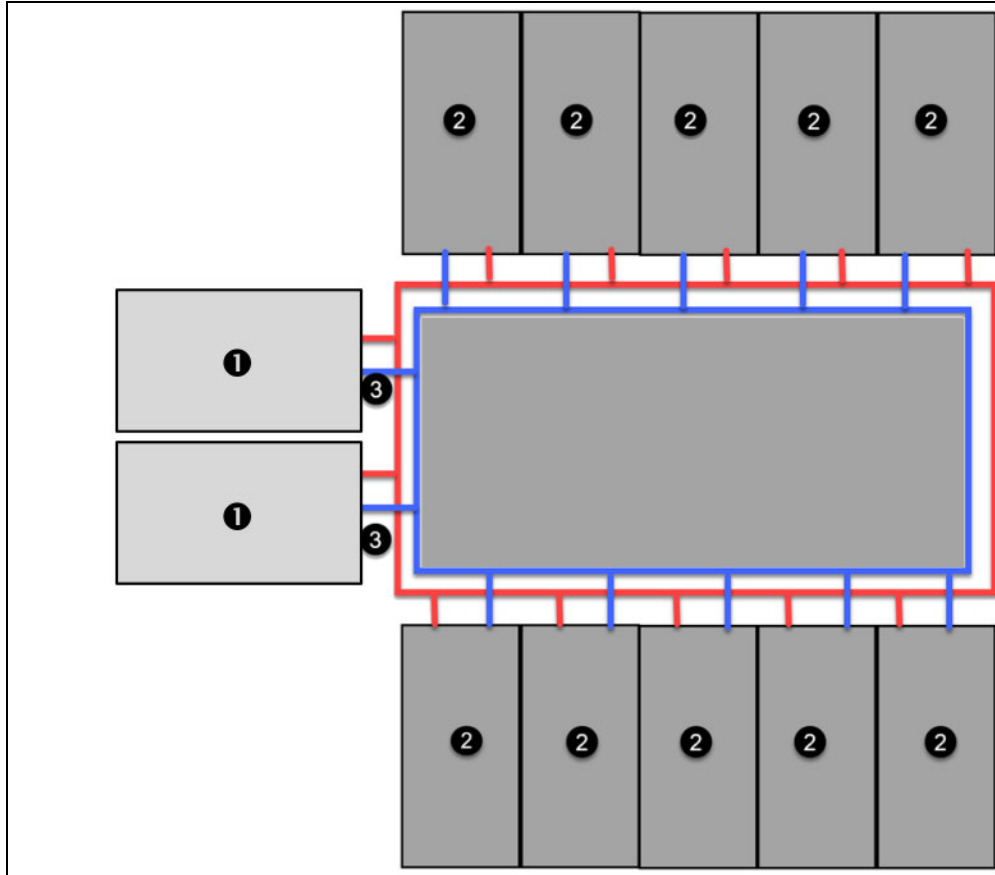
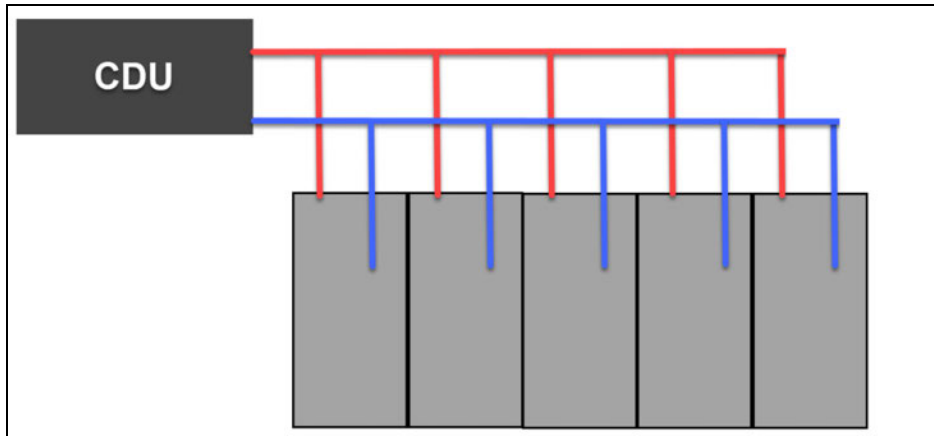


Table 4.1 Ring Piping Arrangement

Item	Description
1.	Cooling Distribution Unit
2.	IT Load (liquid cooled server cabinet)
3.	TCS Piping (may include thermal expansion tank and other field provided equipment)

Figure 4.2 Single Closed Loop



5 TCS Piping Requirements—Stainless Steel Construction

5.1 Application

The piping described in this specification is to be used for single-phase, direct-to-chip, liquid cooling fluid (treated water or a glycol solution) in the Data Center industry. The piping will see nominal operating fluid pressures up to 6.9 bar (100 psig) and fluid temperatures up to 60°C (140°F). Due to the very small openings inside of server cooling cold plates in this application, the surface finish and cleanliness of the pipes, valves, and fittings is critical.

5.2 Cleanliness Requirements

All parts must be free from dirt and moisture. Fittings to be free of burrs and paint, and the internal surface must be free of oil and debris. To avoid excessive internal polishing of the piping, starting with electro-polished piping is recommended.

If particulates must be measured, a standard to us is ISO 16232:2018 size class E-N. It is recommended to use the criteria of size class C&D shown below as reference points.

Table 5.1 ISO 16232:2018 Cleanliness Requirements

Cleanliness Requirements:		
Test liquid kinematic viscosity ≤ 5 mm ² /s		
Blank test according to ISO 16232 Section 6.3		
Size Class		
C	D	E-N
Particle count per 1000 cm ² (x= particle size in micrometers)		
15 ≤ x < 25	25 ≤ x < 50	50 ≤ x
5000	350	0
Clean Cleanliness Level		
13	9	00
CCC=C(C13/D9/E - N00)		
<ul style="list-style-type: none"> No particles bigger or equal to 50µm permitted Extraction method according to ISO 16232 Section 7.4.5, internal rinsing Analysis filtration method based on ISO 16232:2018 Section 8.2, <ul style="list-style-type: none"> 2µm mesh filter required Filter pore size - 1/2 Light optical analysis according to ISO 16232:2018 Section 9.2.3: <ul style="list-style-type: none"> Zoom microscope required with a low depth of field 10 µm to 50 µm Particle size requirements according to ISO16232-2018 		
Size Class		
C	D	E-N
Particle count per 1000 cm ² (x= particle size in micrometers)		

Table 5.1 ISO 16232:2018 Cleanliness Requirements (continued)

Cleanliness Requirements:		
Test liquid kinematic viscosity $\leq 5 \text{ mm}^2/\text{s}$		
Blank test according to ISO 16232 Section 6.3		
Size Class		
$15 \leq x$	$25 \leq x < 50$	$50 \leq x$
50,000	3500	0
Cleanliness Level		
16	12	00
CCC = A(C16/D12 - N00)		

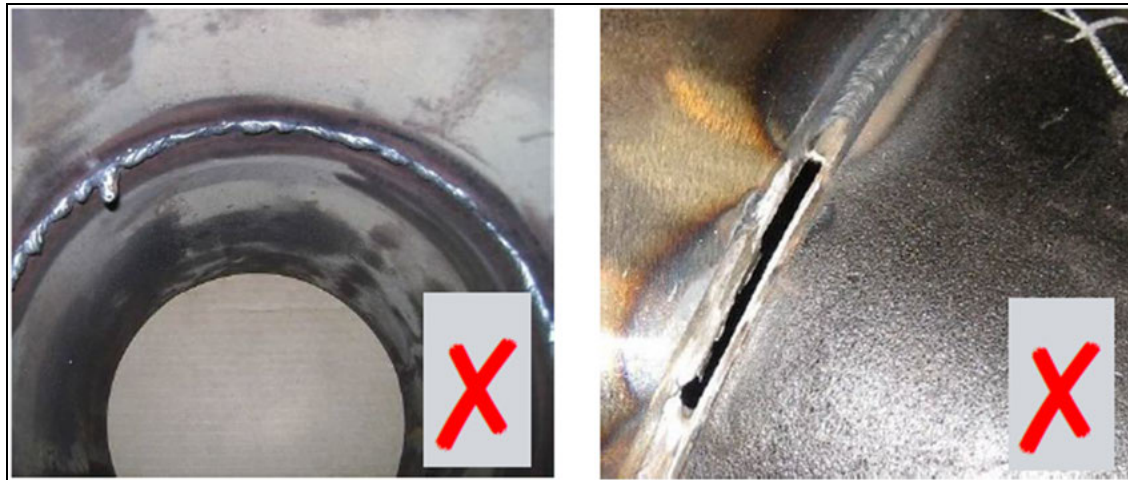
5.3 Weld Requirements

The internal corrosion resistance of the stainless-steel pipes, valves and fittings must be maintained. To accomplish this, it is recommended to flow argon with 5% hydrogen gas through the assembly during welding to assist with protection against oxidation of the weld areas. Orbital welding is preferred; however, no specific weld method is required so long as the final product meets the requirements.

Vacuum brazing is acceptable if care is taken to ensure no oxides form on the surface to keep it ultra-clean, and the brazing temperature is controlled to avoid any negative impact on the stainless pipe material. Any welding or brazing material used must meet the requirements outlined in [Material Compatibility Requirements](#) on the facing page .

Grinding the inside weld joints to a maximum Ra of 0.5 microinches helps reduce the opportunity for bacteria to adhere to the walls and particulates to build up to ensure there are no sharp edges or voids (reference **Figure 5.1** below). Any polishing should be done as each section is welded together to allow for all joints to be polished.

Figure 5.1 Unacceptable Welded Joints



The outside of the weld does not need to be completely polished out. See **Figure 5.2** on the facing page for finish references. Pickling is an acceptable alternative to eliminate burns or other dark marks.

Figure 5.2 Treatment Levels of Welded Joints

After welded assemblies are completed, they should be passivated according to ASTM A-380 or 2 hours at 60° C per ASTM A-967. A dip tank works best to reach all surfaces. The part must be rinsed and dried after passivation to avoid leftover residue or surface imperfections. Assemblies that have been vacuum brazed are exempt from passivation if the material has not been affected by any external contamination, polishing or grinding on the surface finish.

5.4 Material Compatibility Requirements

Parts must not be contaminated by brass, PTFE, silicone, or free iron (plain carbon steel). All wetted materials must also be listed in the acceptable materials listed in tables below. (Source:= OCP “Guidelines For Using Propylene Glycol-Based Heat Transfer Fluids In Single-Phase Cold Plate-Based Liquid Cooled Racks” guidance document as of 11/06/2024). All wetted materials must also be listed with an “X” under the TCS column of table 2 in the White Paper Developed by ASHRAE Technical Committee 9.9, “Water-Cooled Servers Common Designs, Components, and Processes. The link to this paper is in [Reference Documents](#) on page 31 .

Table 5.2 Acceptable Metals and Metal Alloys

Materials	Details	Comments
Copper	CDA110, CDA1020, CDA1220, CDA1100	
Brass of <15% zinc		Brass used for quick connectors can lead to zinc coming into solution over time, particularly in brass with >15% zinc which has a more corrosion prone beta phase. There may be potential for dezincification of brass connectors and valves. Zinc levels can be monitored in the fluid to assess the need to inspect these components for replacement. If brass is used as a wetted material, it is recommended that annual zinc analysis be completed via ICP analysis. Brass with <15% zinc is preferred, however, if using >15% zinc it should be verified that the material is dezincification resistant by performing ISO 6509. Results should indicate a maximum of 100 micron dezincification depth.
Stainless Steel	304L, 316L or higher grades preferred	*See note below
Nickel, high nickel alloys	Avoid Hastelloy B and other alloys designed for reducing environments	Most SS alloys should be acceptable, including 410.

Table 5.2 Acceptable Metals and Metal Alloys (continued)

Materials	Details	Comments
Chromium	Plated corrosion resistant materials	*See note below
Titanium	Grade 2 (UNS R50400)	
B-Ni-6	88.9% Ni + 11% P	Brazing material in copper cold plate
BCuP-1	95% Cu + 5% P	
BCuP-2	93% Cu + 7% P	
BCuP-3	Cu 89%, Ag 5%, P 6%, others 0.15%	
BCuP-4	Cu 87%, Ag 6%, P 7%	Brazing material in copper cold plate
BCuP-5	Cu 80%, Ag 15%, P 5%	Brazing material in copper cold plate
TF-H600F	Cu 74.9%, Sn 15.6%, P 5.3%, Ni 4.2%	Brazing material in copper cold plate
<p>NOTE: Quick connects made of stainless steel are preferred. Exercise caution when using nickel plated and chromium plated quick connects. Life cycle testing may be performed to assess the risk level of plated quick connects. This is because after many uses, the plating can be worn away and the underlying metal exposed to the heat transfer fluid. Although corrosion inhibitors may protect underlying metal, the galvanic couple created by the exposed metal with the plating material may increase the corrosion tendency. For example, brass corrosion will introduce zinc, and potentially copper, into the heat transfer fluid. The consequences of dissolved zinc on the long-term performance of the copper cold plates have not been determined at this time and identification of acceptable thickness of plating metals is outside the scope of this document. Plated quick connects should be inspected regularly or as needed based on fluid analysis.</p>		

Table 5.3 Acceptable Elastomers, Plastics, and Other Materials

Materials	Details	Comments
EPDM	Ethylene propylene diene monomer	Peroxide cured EPDM is recommended. Sulfur-cured EPDM can introduce sulfate into the heat transfer fluid over time, leading to issues with corrosion, and should be used with caution.
Viton A		
Viton GF	Fluorinated ethylene propylene polymer	
Viton ETP		
FEP		
PTFE	Polytetrafluoroethylene polymer	Teflon™
HDPE	High density polyethylene	
PEEK	Poly ether ether ketone	
Loctite 564	Thread sealant	Other thread sealants might be acceptable but should be verified; avoid anything that can introduce particles into the fluid
Permabond MH02		

Table 5.3 Acceptable Elastomers, Plastics, and Other Materials (continued)

Materials	Details	Comments
Permabond A131		
PP-RCT		
PP-R		

5.5 Material Handling Requirements for TCS

All components shall be packaged/stored so that their cleanliness is maintained at the level described in the cleanliness requirement. All openings are to be capped to exclude dirt and moisture during assembly, leak check, packaging, storage and transportation processes.

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6 General Requirements

6.1 General Requirements—Equipment

All third-party equipment must be cleaned and flushed using an external pump and filter station and must be free of any oil or material contamination before installation into the TCS. Flushing fluid velocity must meet or exceed the maximum fluid velocity during system operation. One method to achieve the required level of cleanliness is to flush in steps beginning at 100 μm and slowly decrease filter particle size until the target size is achieved. See ASHRAE TC9.9 White Paper on Water Cooled Servers. The link is in [Reference Documents](#) on page 31.

Avoid chemical cleaners and detergents due to their corrosive nature and potential for remnants in the heat transfer fluid unless following the guidance of the supplier of the new heat transfer fluid.

Table 6.1 Equipment General Requirements

Equipment Type	Special Requirements (Additional to Cleanliness)
Thermal Tanks	May require pressure relief
Thermal Fill Stations	Must have serviceable inline filter in supply line
Fluid Load Banks	
Intermediate Pumping Station (CDU)	
In-Rack Manifolds	Must be leak checked (often by vendor)
Hoses	Must be leak checked (often by vendor)
Liquid Cooled Servers (ITE)	Pre-filled ITE must have proper specified fluid

6.2 General Requirements—Cleaning Filters and Strainers

To avoid reintroduction of contamination into the TCS or CDU, exercise caution when attempting to clean filters and strainers. Municipal water supplies often contain contaminants and particles larger than what is allowed in liquid cooling systems. Wet filters can attract and retain contaminants. When used for drying purposes, compressed air sources can also dispel oils and other contaminants onto filter surfaces. When contamination is likely, such as in a construction environment, replacement of filters may be preferable to cleaning.

6.3 General Requirements—Room

- Sufficient dehumidification capability and an adequate vapor barrier must be provided to maintain the room dew point.
 - For proper humidity control, keep outside or fresh air to an absolute minimum (less than 5% of total air circulated in the room).
 - Confirm that the room is properly insulated and has a sealed vapor barrier.
- Review CDU dimensions, piping connection locations, and piping schematics as described in the user manual and mechanical drawings and provide to the engineer of record.
- Review required pressure, temperature, and flow rate requirements for facility piping.
- Verify that the floor is level, solid, and sufficient to support both static and dynamic loading requirements, considering all equipment.

- Ensure that power and water resources are available and ready.
- Allow at least the minimum recommended clearances for maintenance and service. See the appropriate user manuals and mechanical drawings for dimensions.
- Ensure that facilities personnel has completed electrical and mechanical connections to the unit(s) and has pressure tested all fluid connections.
- Ensure that proper grounding and bonding has been identified and followed.

6.4 General Requirements—CDU

- TCS must have a strainer in the cooling loop to protect the IT equipment. The strainer should be located on the supply side of the CDU and should have a filtration rating between 10% and 50% the size of the narrowest channel width in the liquid cooling system; which is typically defined by the cold plate passage sizes. In full-flow filtration (not side stream), the filtration rating is typically between 25% and 40% of the narrowest channel.
- Ensure appropriate placement and installation of air vents in the TCS to remove air from the cooling loop.
- Isolation valves should be installed at CDU (internal or external to the CDU) and at the supply and return connections to the heat load(s).
- External fluid leak sensor detection devices should be placed along (or below) the secondary fluid row manifold.
- TCS fluid must contain biocide and corrosion inhibitors.
- TCS must be flushed and filtered to the target level of cleanliness before installing/connecting IT equipment into the cooling loop.

7 TCS Design Best Practices

- Ensure pressure relief valve ratings are appropriately selected and labeled.
 - Ensure any desired hosing is connected to PRVs and directed toward containment area
- Threaded joints must not be sealed with polytetrafluoroethylene tape (PTFE) as particles from the tape may enter the fluid stream and cause clogging. Instead, an approved thread sealant must be used to seal thread fittings (Common sealants for TCS include Loctite 567 and Permabond A131). Follow manufacturer instructions for proper application and curing duration.
- Side stream filtration permanently designed/installed into the TCS; filtering 10% of the flow rate at a particle filtration level typically between 10% and 40% the smallest passage in the cooling system. Side stream filtration rating is typically greater than full-flow filtration; with intent to mitigate corrosion, fouling, scale formation, and microbial growth.

See **Figure 7.1** below for the top view of the ring piping layout.

Figure 7.1 External Field Piping Arrangement

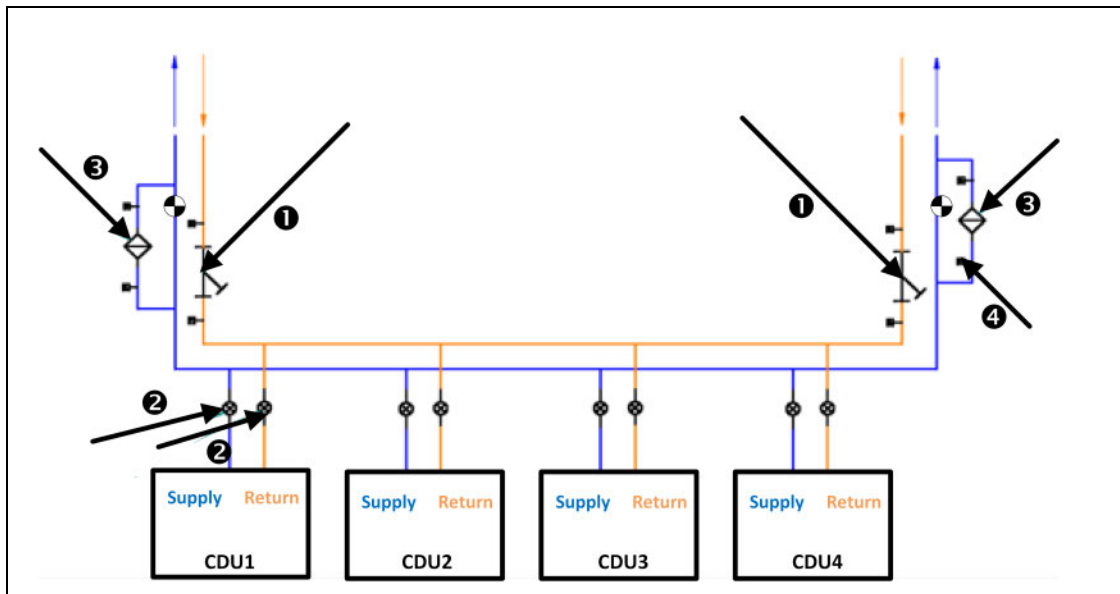


Table 7.1 External Field Piping Arrangement

Item	Part	Purpose	Notes
1	Strainer/Filter	Inline filter sized to prevent CDU heat exchangers from blockages / damage.	Vertiv flushing procedures are stringent. This provides further protection for the CDU against large scale contamination within the TCS from reusable heat loads or other external commissioning equipment. Cleans the fluid loop prior to any contamination reaching the CDU heat exchanger.
2	Isolation Valves	Isolate each CDU from TCS Loop	Typically included at every CDU connection.
3	Side stream Filter	Continuously filters ~10% of circuit fluid flow rate	A side stream filter will continuously remove very small particles, without the effect of a large pressure drop on the system. This is most effective after the system has been flushed and commissioned.
4	Pressure Gauge	Mechanical gauge for checking circuit pressures, filter DPs	These are critical for being able to check when filters in the system, external to the CDUs, are dirty.

- FWS fluid must be filtered prior to entering the CDU. Filters/Strainers must be less than or equal to 500 μm filtration rating. The purpose of this filter is to prevent blockages in the primary side of the CDU heat exchanger.
- Mechanical pressure gauges or electronic sensors can be installed on both sides of each filter/strainer in the TCS system (external to CDUs) to determine when filter/strainer need changing/cleaning.

Figure 7.2 below illustrates TCS installed above the CDU and below the CDU.

Figure 7.2 CDU External Piping Arrangement

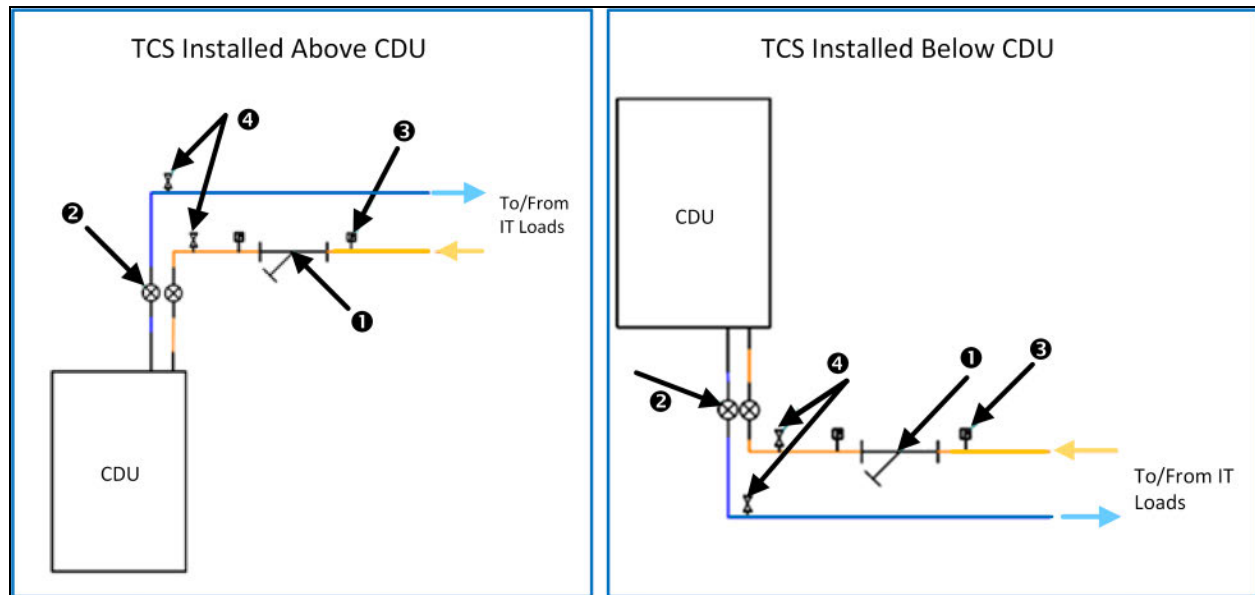


Table 7.2 CDU External Piping Arrangement

Item	Part	Purpose	Notes
1	Strainer / Filter	Inline filter sized to prevent CDU heat exchangers from blockages / damage (<500 microns).	This is critical during initial startup. The TCS may be very contaminated after construction is complete. The CDU's heat exchanger must be protected, and more filters in the system will help clean the TCS faster.
2	Isolation Valves	Isolate each CDU from TCS Loop	
3	Pressure Gauge	Mechanical gauge for checking circuit pressures, filter DPs	These are critical for being able to check when filters in the system, external to the CDUs, are dirty.
4	Auto Air Vent	Automatically bleed air from TCS loop	These should not be positioned above any IT equipment, as they can leak during operation.

- External filtration must be installed at the discharge of all major equipment such as fill stations and ports should be included (design dependent) for external flushing/fill pumps.
- Enough air vents must be installed across long piping runs and at local high points if elevation changes exist.
- Sufficient bypass between supply and return when no racks are installed in the TCS. This bypass is commonly used during TCS flushing.
- Fill ports and drains must be installed at low points of the TCS and should be strategically placed between all system isolation points to comply with system maintenance and uptime requirements.
- Fluid fill and sampling stations available for large fluid loops.
- Provision for external pumps and filtration.
- Provision made for connecting external load banks for load testing of the CDUs and TCS.
- Previously used load banks should be isolated from TCS with a heat exchanger to prevent potential TCS contamination.

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8 Mechanical Installer Checklist

- Confirm all the equipment has been delivered and is stored correctly.
- Validate all design considerations were made appropriately.
- Confirm external fill pumping stations used to fill the TCS are clean and free of contamination.
- Understand the defined cleanliness requirements for whole system before assembling it.
- Do not install piping while there is dust/debris suspended in the air. Cap any open pipes/fittings until they are needed for install to prevent contamination. Excess dirt/debris in the piping system will cause significant time increases in the flushing process.
- Avoid chemical cleaners and detergents to clean system or equipment.
- Validate system coolant fluid containers are properly labeled and match design intent.
- Ensure system coolant fluid containers are sealed appropriately and stored in correctly.



WARNING! If the Vertiv™ CDU is used during the installation and commissioning process for flushing and/or cleaning the secondary fluid network, Vertiv assumes no liability for any resulting damages or issues. Flushing is defined as the process of removing debris, contaminants, or foreign particles that may be present in the fluid circuits connected to the CDU. All liability in such cases shall be transferred to the contractor of party performing the flushing. Furthermore, any use of the Vertiv™ CDU for flushing purposes resulting in damage to the product will void the Vertiv Limited Warranty for Thermal Management Products. Flushing a fluid circuit that does not meet the same cleanliness standards as our unit and/or uses unapproved detergents or chemical agents may cause damage to the internal components of the CDU, including but not limited to, pumps, filters, heat exchanger, and pipework and may also result in debris, contamination, or foreign particles within the CDU.

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9 Filling and Flushing

9.1 Filling and Flushing the CDU

- CDUs are typically cleaned and flushed at the factory. If additional flushing beyond the factory flushing is required, contact Vertiv.. Vertiv CDUs are factory flushed and shipped with dry nitrogen charge
- CDUs should be flushed prior to connection with the TCS (via factory and/or field process).
- CDUs should only be connected to the TCS after the TCS initial flushing processes have been completed.



WARNING! Using the CDU as part of the initial flushing processes significantly increases the risk of contaminants migrating to the heat exchanger of the CDU and may void warranty.

- Service technicians should be present and performing CDU startups.
- CDU primary water inlet should have an inline strainer at least $500\mu\text{m}$ (35 Mesh) to prevent contaminants from building up in the heat exchanger from the primary facility side.
- For additional protection (particularly during load testing or when equipment may be added or removed from the TCS over time), CDU secondary fluid inlet may have inline strainer within 10 feet of the CDU entering fluid connection to prevent contaminants from building up in the heat exchanger from the TCS side. (Refer to CDU user manual for inline strainer size).
- CDU flush and fill should be carried out as described in the user manuals.
- Clean or replace filters and strainers as needed to achieve the required filtration level. During initial flushing this may require careful attention and repeated cleaning/replacement cycles.

9.1.1 Load Bank Arrangement

Figure 9.1 Load Bank

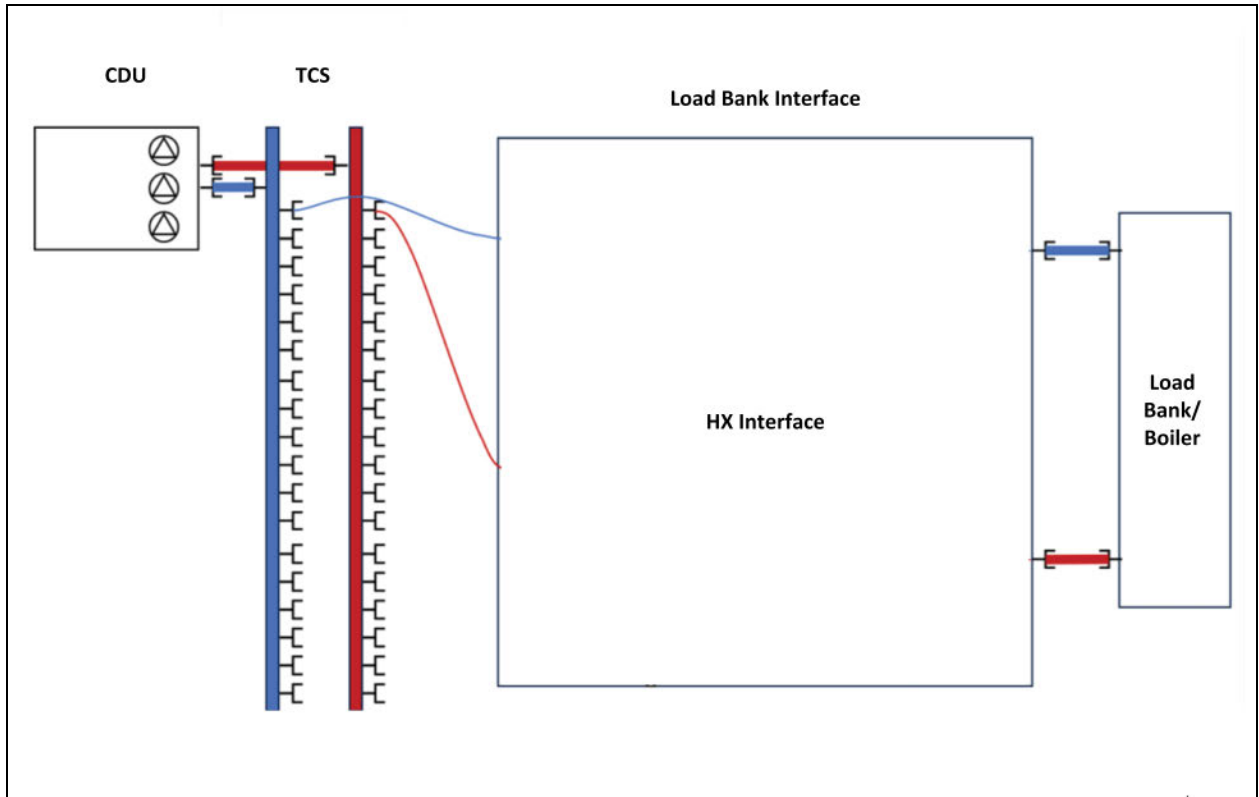


Table 9.1 CDU and Load Bank External Piping Arrangement

Item	Part	Purpose	Notes
1	Auto Air Vent	Automatically bleed air from TCS loop	These should not be positioned above any IT equipment, as they can leak during operation.
2	Fill/Drain Port	Ports added to fill/drain TCS piping efficiently	Fil /drain ports should be located at the lowest points in the system. The CDU is filled internally, these ports are for filling the TCS piping loop.
3	Filter/Strainer (optional)	Sized to protect cold plates	Filters at the inlet to each IT rack are an optional last line of protection for clogging a cold plate. Even with the other filters in the system, if a rack is kept offline for some time, particles and scale could stagnate in that area. Once the rack is turned on, those particles could then be pulled straight into the cold plates if no inline filter is present. Must consider impact to system flow rate and pressure drop. (Not typically used due to complexity and cost)
4	Filter/Strainer	Temporary install during flushing and load bank testing.	If heat loads are used, an inline filter at the outlet is critical to stop all internal debris from contaminating the system and clogging the CDU's heat exchanger. Furthermore, additional filters throughout the system like this will help speed up the flushing process prior to startup and commissioning.

9.2 Filling and Flushing the TCS

- Initial flushing fluid should be agreed upon with the end user to confirm if acceptable.
- Using the design intended fluid is the safest option to prevent chemical incompatibility.
- Using treated DI water may be acceptable, but it must be removed from the TCS before final fill of any glycol mix fluid (remaining fluid will reduce/ impact system performance).
- Cease any construction operations that may generate debris in system during fill (such as: drywall work).
- Isolate the CDU(s) from the TCS and ensure fluid circulation pathway does not leave dead legs for contaminant settling. Depending upon the design of the pipework, this may require a fluid bypass between the supply and return piping. Additionally, this may require installation of bypasses or flushing loops at each rack position to ensure proper flushing of rack supply and return piping assemblies.
- All equipment, pipes, fittings and devices that used to commission the TCS should be flushed individually prior to installation to avoid introducing contamination into the TCS. Items with extreme contamination may foul the entire TCS and complicate the commissioning process.

IMPORTANT! Flushing the system should be done before installing IT equipment to prevent clogging tight channels in cold plates.

- If water cooled load banks are to be used, they should be flushed and then installed into the system.



WARNING! Rental load banks may have extreme contamination from previous uses. Filters must be installed on the discharge of the load banks. Best practice includes isolating previously used load banks from TCS with a heat exchanger to prevent potential TCS contamination.

- An external fill pump should be used to fill the TCS. An appropriately sized filter should be used on the discharge of the fill pump.
- Ensure all air vents are open in the TCS.
- Fill pumps should be run at speeds to prevent over pressuring the system or introducing air bubbles.
- Fill from the lowest point in the system to mitigate air entrapment. Fill until all air bleeders are no longer expelling air.
- Once sufficient fluid is in the system, use circulation pump(s) running at maximum TCS design flow or higher (without over pressuring system limits) to flush the TCS and remove debris.
- It is recommended to clean in sections to ensure proper removal of miscellaneous materials that can be introduced into the system during manufacturing and installation such as dirt, debris, solder flux, joint compound, scale, or grease. Cleaning in sections ensures proper flows can be achieved with external pumps.
- Additional flushing fluid may need to be added to system during flushing as air is expelled from the system.



WARNING! An external fill pump should be used to fill the TCS. An appropriately sized filter should be used on the discharge of the fill pump. Consider starting with a larger filter requirement (100 um instead of 50 or 25 um), and slowly decrease filter particle size until the target size is achieved. See ASHRAE TC9.9 White Paper on Water Cooled Servers. The link is in [Reference Documents](#) on page 31

- If a fluid other than the final fluid was used for flushing, drain the TCS using the appropriate processes to remove residual fluids. If TCS final fluid filling is not to occur within 24 hours of draining, consider drying the entire TCS to minimize the potential for biological growth.

If the fluid used for flushing will be the same as the final fluid, send a sample for testing and record the chemical make-up. Ensure that fluid chemistry is within acceptable limits and maintain records of fluid chemistry over time to inform fluid treatment schedules.

NOTE: For additional similar arrangements, repeat the above instructions.

Appendices

Appendix A: Technical Support and Contacts

A.1 Technical Support/Service in the United States

Vertiv Group Corporation

24x7 dispatch of technicians for all products.

1-800-543-2378

Liebert® Thermal Management Products

1-800-543-2778

Liebert® Channel Products

1-800-222-5877

Liebert® AC and DC Power Products

1-800-543-2378

A.2 Locations

United States

Vertiv Headquarters

505 N Cleveland Ave

Westerville, OH, 43082, USA

Europe

Via Leonardo Da Vinci 8 Zona Industriale Tognana

35028 Piove Di Sacco (PD) Italy

Asia

7/F, Dah Sing Financial Centre

3108 Gloucester Road, Wanchai

Hong Kong

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Appendix B: Reference Documents

1. 2022 Guidelines For Using Propylene Glycol-Based Heat Transfer Fluids in Single-Phase Cold Plate-Based Liquid Cooled Rack: <https://www.opencompute.org/documents/guidelines-for-using-water-based-transfer-fluids-in-single-phase-cold-plate-based-liquid-cooled-racks-final-pdf>
2. ASHRAE TC9.9 White Paper on Water Cooled Servers – pages 25 through 30 discuss filtration recommendations: https://www.ashrae.org/File%20Library/Technical%20Resources/Bookstore/WhitePaper_TC099-WaterCooledServers.pdf

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