Standalone
300KW LHP MDC
Specification

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Reviewer: Jens S.

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1.2 Acknowledgements

The Contributors of this Specification would like to acknowledge the following companies for their feedback:

List all companies or individuals who may have assisted you with the specification by providing feedback and suggestions but did not provide any IP.

Schneider Electric - For Creating the original 90 kW Standalone Specification
PCX Corp - For Supporting the update of LHP Technology.
OCP ACF - Liquid-cooling guides

1.3 References

[1] "Passive Cold Plate Cooling Requirements", Dec.2022, OCP Foundation, pages 72, https://docs.google.com/document/d/1oe1RKendFmJjfjqZQ6gtyDcL1wcIaHnsVRWVzV61-RA/edit#heading=h.gjdgxs
[2]

2. Compliance with OCP Tenets

Please describe how this Specification complies to the following OCP tenets. Compliance is required for at least three of the four tenets. The ideals behind open sourcing stipulate that everyone benefits when we share and work together. Any open source project is designed to promote sharing of design elements with peers and to help them understand and adopt those contributions. There is no purpose in sharing if all parties aren't aligned with that philosophy. The IC will look beyond the contribution for evidence that the contributor is aligned with this philosophy. The contributor actions, past and present, are evidence of alignment and conviction to all the tenets.

2.1. Openness

The measure of openness is the ability of a third party to build, modify, or personalise the device or platform from the contribution. OCP strives to achieve completely open platforms, inclusive of all programmable devices, firmware, software, and all mechanical and electrical design elements. Any software utilities necessary to modify or use design contributions should also be open-sourced. Barriers to achieving this goal should be constantly addressed and actions are taken to remove anything that prevents an open platform. Openness can also be demonstrated through collaboration and willingness to share, seek feedback, and accept changes to design and specification contributions under consideration.

2.2. Efficiency

Continuous improvement has been a fundamental value of the industry. New contributions (and updates to existing contributions) shall be more efficient than existing or prior-generation contributions. Efficiency can be measured in many ways - OpEx and CapEx reduction, performance, modularity, capacity, power or water consumption, raw materials, utilization, size or floorspace are some examples. The goal is to express efficiency with clear metrics, valued by end-users, when the contribution is proposed.

2.3. Impact

OCP contributions should have a transformative impact on the industry. This impact can come from introducing new technology, time-to-market advantage of technology, and/or enabling technology through supply chains that deliver to many customers in many regions of the world. New technologies are impactful when such technology is enabled through a global supply channel. One example is the NIC 3.0 specification which achieved global impact by having over 12 companies author, adopt, and supply products that conformed to the specification. Another example is emerging and open security features that establish and verify trust of a product

2.4. Scale

OCP contributions must have sufficient enabling, distribution and sales support (pre and post) to scale to Fortune 100 as well as large hyperscale customers. Demonstration of this tenet can be accomplished by providing sales data or by providing go-to-market plans that involve either platform/component providers or systems integrator/VAR (direct and/or channel). Platform/component providers or systems integrators/VARs that can use this contribution to obtain product recognition (OCP Accepted™ or OCP Inspired™) and create Integrated Solutions which would also demonstrate scale. Software projects can also demonstrate this tenet when software is adopted across business segments or geographies, when software is a key factor in accelerating new technology, or when software provides scale of new hardware which meets OCP tenets.

2.5 Sustainability

OCP contributions must aim to provide solutions that enable the 17 developments goal of the United Nations and are enabling an economy that is net-zero or positive.
In comparison with air-cooled MDC, LHP-based MDC provide next goals:

- Power input and energy infrastructure is reduced by 46%
- Annual energy consumption is reduced by 35%
- Water usage is limited by 5% of the year and achieve WUE less than 0.1 l/kW
- Much fewer infrastructure components which reduce the embodied carbon of solution
- Facility water with outlet temperature 60℃ for Heat ReUse
- Less noise level of internal and external equipment

3. Version Table

Date	Version #	Author	Description
19.09.2022	Draft	Vadim, David, Karl	First Version.
24.09.2022	1.0.1	Vadim	General review
13.10.2022	1.0.2	Karl	updates on Power, etc
13.10.2022	1.0.3	Karl, David	updates Cooling, LHP, Electric, Appendix, etc
24.05.2023	1.0.4	Vadim, David, Karl	Final review.

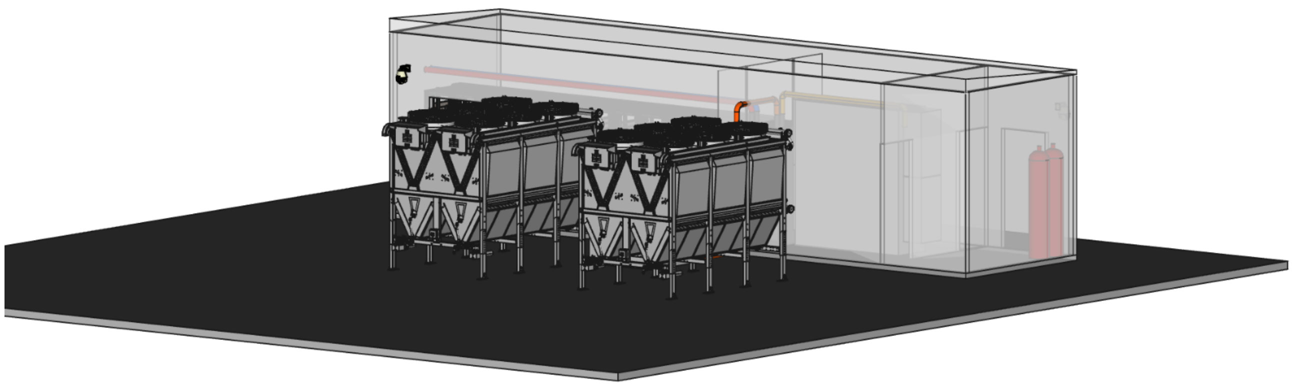
4. Scope

This document defines the technical details for a modification of the existing *Standalone 90 kW Modular Data Center Specification*. It is a complete revision update modifying the existing specification to accommodate Loop Heat Pipe (LHP) cooling Technology(please check Appendix B for a deep dive description of Loop Heat Pipe Technology. We designed this solution with the recommendations and documents from the OCP Advanced Cooling Group.

Any supplier seeking OCP recognition for a hardware product based on this Specification must be 100% compliant with any and all features or requirements described in this Specification.

5. Overview

This prefabricated modular data center specification is an all-in-one design, optimized for deploying Open Compute hardware in small quantities for edge applications up to 300 kW in IT load.



Module Specification Summary

Description	Specification	Comments
IT-load [kW] (total capacity)	Up to 300kW	Power system redundancy at N with internal UPS redundancy of N+1. Cooling systems at N+1 redundancy
Number of Racks (total capacity)	12	With UPS / without UPS
Average Density (kW/Rack)	25	12 racks deployed
Maximum Density (kW/Rack)	50	
Module Size[mm] (LxWxH)	13700 x 3300 x 3600	Outside dimensions
Module Size[mm] (LxWxH)	13500 x 3100 x 3400	Internal dimensions
Module Weight [kg]	27000 /	Empty = no IT racks or equipment Full = 12 racks @ 1500 kg
Input Power Type	400V, 5 wire, 1670 amp	AC Low Voltage
Cooling System	LHP, Adiabatic cooling, Air and liquid cooled chillers	Heat Reuse option available
PUE Type 1 City Frankfurt Germany	1.08	With Frigel adiabatic coolers(WUE-0.03) and UPS(5%). Temperature in cold aisle up to +31℃.
PUE Type 2 City Madrid Spain	1.06	With Frigel adiabatic coolers(WUE-0.02) and UPS(5%). Temperature in cold aisle up to +34℃.
PUE Type 3 City Dubai UAE	1.11	With Frigel adiabatic coolers(WUE-0.07), Air cooled chiller and UPS(5%). Temperature in cold aisle up to +25℃.

PUE Type 4 Wyoming USA	1.10	With Frigel dry coolers(WUE-0.00), liquid cooled chiller and UPS(5%). Temperature in cold aisle up to +25℃.
Scalable Yes/ No	Yes	Module is designed to be deployed independently with sharing support systems

Module Structure Specification

1. General
    a. Module Dimensions
        i. All materials and workmanship are of a suitable type and quality to ensure that the modular data center will operate satisfactorily and accordance with this specification
        ii. Outside: 137000mm x 3200mm x 36000mm (LxWxH)
        iii. The module and all fittings installed therein will be suitable for transport on paved dirt roads and standard sea freight.
        iv. This document is to detail the basic requirements.
        v. Module Enclosure shall be designed and built to meet IP55 according to EN60529
2. Construction
    a. Frame
        i. Module is built on a steel frame with a bottom frame or equivalent.
        ii. The enclosure frame design is formed from three primary elements, a structural base, a frame support for walls, and a frame support for the roof suitable for environmental and equipment loads specified within this document.
        iii. Steel frames shall be sandblasting or chemically cleaned and treated with a layer of antioxidant primer.
        iv. The primary structural element of the enclosure base is formed from structural steel at the outer edge of the base of the enclosure. Wall frame constructed of structural framing system to support wall panels, roof, and roof mounted equipment as specified within this document.
        v. Module base and upper frame shall be designed to support all floor mounted equipment and suspended systems (hanging all fire suppression and detection equipment as well as wiring trays, hot/cold aisle containment, and overhead cooling equipment) in addition to lifting and transportation stresses and specified environmental conditions.
        vi. Minimum 6 lifting anchor points (lifting brackets).
        vii. Module has 6 loading points that need support, plinths or foundation, concrete or steel.
    b. Roof, Walls & Floor
        i. Exterior roof designed to withstand the environmental loading while maintaining weatherproofing, preventing ponding, and diverting rainwater from roof.The module should offer thermal and fire protection as required by local codes.

ii. Exterior walls (typ): 80-150 mm thick insulated panels, with a minimum thermal resistance of 0.470 W/m^2k
iii. Interior ceiling(typ): 145mm thick insulated panels, , with a minimum thermal resistance of 0.470 W/m^2k
iv. Floor: steel plate or equivalent, with anti-static floor surface, insulating thermal barrier barrier required (ie. rockwool, sprayfoam)
v. Fire resistance (if required): EI60, per EN 13501-2
vi. The flooring on the base frame shall be designed to allow equipment to be mechanically bolted to the floor to avoid tipping or damage during shipment.

c. Exterior Protection and Finish
   i. Module Enclosure shall be designed and built to meet a minimum of IP55 according to EN60529.
   ii. Coating: all exposed steel has a C3 or C4 coating, depending on installation environment (Per ISO 12944 standard)– external roof and exposed beams top frame, and bottom frame.
   iii. Internal and steel that is built in or covered have an C1 coating (Per ISO 12944 standard).
d. External Doors
   i. The module doors shall fulfill all regular use requirements and emergency exit requirements.
   ii. The doors shall be made of steel and painted and protected against rust.
   iii. Doors must have panic bar, provisions for electronic monitoring, and automatic closure.
   iv. Doors are RC2 break-in resistance level in accordance with EN 1627/1630.
   v. Doors must meet local fire hour rating requirements
e. Load Requirements
   i. Wind loading - Wind pressure 1.7kN/m² with a span of 4.5m Eurocode EN1991-1-4, applied to the walls of the enclosure.
   ii. Wind suction 1.6 kN/m² with a span of 4.5m
   iii. Floor Loading: Withstand floor loads up to 1000kg/m^2 across the entire floor structure.
   iv. Roof/Snow Load: 245 kg/m^2 on the roof (minimum) .
   v. Shock Load: Withstand normal transportation conditions before installation on the site, without deformation or damage. Shock of 2g, 10 millisecond duration for transport conditions per IEC 60068-2-64.
f. Stackability
   i. This module is intended to be stand alone and is not required to be stackable. If stacking is required, contact the module manufacturer for specifications.
g. External connections
   i. Input Power: 400 VAC, 5 wire, 1200 Amp hard wired.

    ii. Backup Power: Provisions for weatherproof connection with (1 or 2) ~400kW Generators depending on redundancy requirements.
    iii. Cooling: Provisions for weatherproof connections of DX condensing pipes to external condensers or CW pipes to external chillers.
  h. Internal environmental conditions
    i. The internal conditions shall maintain ASHRAE 90.1 for recommended, fresh air, temperature and humidity ranges.
  i. External environmental conditions
    i. The internal conditions will maintain ASHRAE 90.1 for recommended, fresh air, temperature and humidity ranges.
  j. Altitude
    i. Sea level is used for the referred pPUE figures in the document.
    ii. Power and cooling system capacity must be derated based on site altitude.

Interior Layout

1. IT Space
  a. Cabling pathway
    i. Above racks with power and data network cables on separate ladders/baskets
  b. Aisle spacing
    i. 1150mm in the cold aisle (minimum with an Open Rack V2)
    ii. 900mm in the hot aisle (min)
    iii. Access to hot aisle when required, under supervision and restricted periods.
  c. Rack row must accommodate a maximum of height of 2400mm and depth of 1200mm.
  d. Air containment: Physical isolation of hot or cold aisles required to maintain maximum efficiency.
  e. Access & exit: The number of required exits shall meet local codes. At least one entry door shall be large enough to accommodate the removal/installation of racks or other equipment.
  f. If racks are to be installed or moved while fully loaded with equipment, additional provisions, such as point floor loads and smooth floor transitions.
2. Facility Space
  a. The following items are typically located in a designated area for data center facility support
    i. Main input paneled accessible with front access
    ii. House loads panel
    iii. Control & monitoring panels
    iv. Humidification/dehumidification equipment and controls
    v. Security/fire suppression/alarm panels

b. The space designated for supporting the data center facilities shall be design to meet maintenance clearances as defined by local codes.

Electrical System Specification

1. Electrical System Description
    a. Main power input from the power grid supported with redundant Diesel Generators (if required) connected to an ATS.
    b. Main Input Panel: 400V three-phase electrical panel, TN-S construction type. Panel incorporates 1 or 2 (depending on required redundancy) 1200 A main breakers. The panel will distribute power to all critical and non-critical loads. The main panel includes the capability to monitor the input power for all incoming feeds into the module and Ethernet gateway for external monitoring
    c. Critical AC power distribution feeds from UPS to OCP racks can be delivered via overhead busway or end-row PDU at N or 2N redundancy (based on customer requirements) to rack mounted rectifiers for DC 48V to the IT-equipment.
    d. Non-Critical Panel - Size appropriate 400V three phase electrical panels support loads that do not require UPS protected power such as house loads, fire suppression, and cooling units.
    e. Auxiliary equipment (house loads)
        i. Lighting: LED light fixtures providing a minimum of 300 lux measure at the front and rear of the rack rows
        ii. Emergency lighting: Exit Sign/Emergency lighting block mounted above each door at the aisle containment system and module entry/exit doors
        iii. Electrical convenience outlets as required by local codes for maintenance
        iv. Fresh air ventilation system
        v. Fire suppression/detection control panel
        vi. Security/access panel
    f. Grounding/Bonding
        i. All internal components will be grounded to a common internal copper busbar. The module is designed to connect to a TN-S type grounding system.
        ii. External copper ground bar will be provided on the outside of the module for attachment of earthing ground on-site by customers.

Cooling System Specification

Cooling System Description

The OCP server (Leopard, Tioga Pass) CPU cooling is based on Loop Heat Pipe with passive heat transfer to the end of the OCP rack V3 with tubes and dry lock connections.

The air cooling part are possible in five options

Type 1: Air cooler and outdoor adiabatic cooler with heat exchanger (two circuits) and optional heat reuse connections.

Internal air coolers: (2) Units, which can provide up to 100kW of sensible cooling each and LHP circuit up to 250kW with heat exchangers and pumps: (2) Units up to 350kW

Outdoor Ecodry liquid coolers with pumps: (2) Units, which can provide up to 350kW each

Redundancy: N+1

Water: WUE=0.1 l/IT kWh or lower, city water without treatment

Type 2: Air cooler and outdoor adiabatic cooler(common circuit) and optional heat reuse connections.

Internal air coolers: (2) Units, which can provide up to 100kW of sensible cooling eachand LHP circuit up to 250kW

Outdoor Ecodry liquid coolers with pumps: (2) Units, which can provide up to 350kW each

Redundancy: N+1

Water: WUE=0.1 l/IT kWh or lower, city water without treatment

Type 3: Air cooler with outdoor air cooled chiller and LHP circuit with outdoor dry cooler both with optional heat reuse connections.

Internal air coolers: (2) Units, which can provide up to 100kW of sensible cooling each and LHP circuit up to 250kW

Outdoor Heavygel air cooled chiller with pumps: (2) Units, which can provide up to 100kW each and and Ecodry liquid coolers with pumps: (2) Units, which can provide up to 250kW each

Redundancy: N+1

Water: WUE=0.0 l/IT kWh, No water usage

Type 4: Air cooler with indoor liquid cooled chiller and LHP circuit with outdoor dry cooler both with optional heat reuse connections.

Internal air coolers: (2) Units and Heavygel water cooled chillers:(2) Units, which can provide up to 100kW of sensible cooling each and LHP circuit up to 250kW

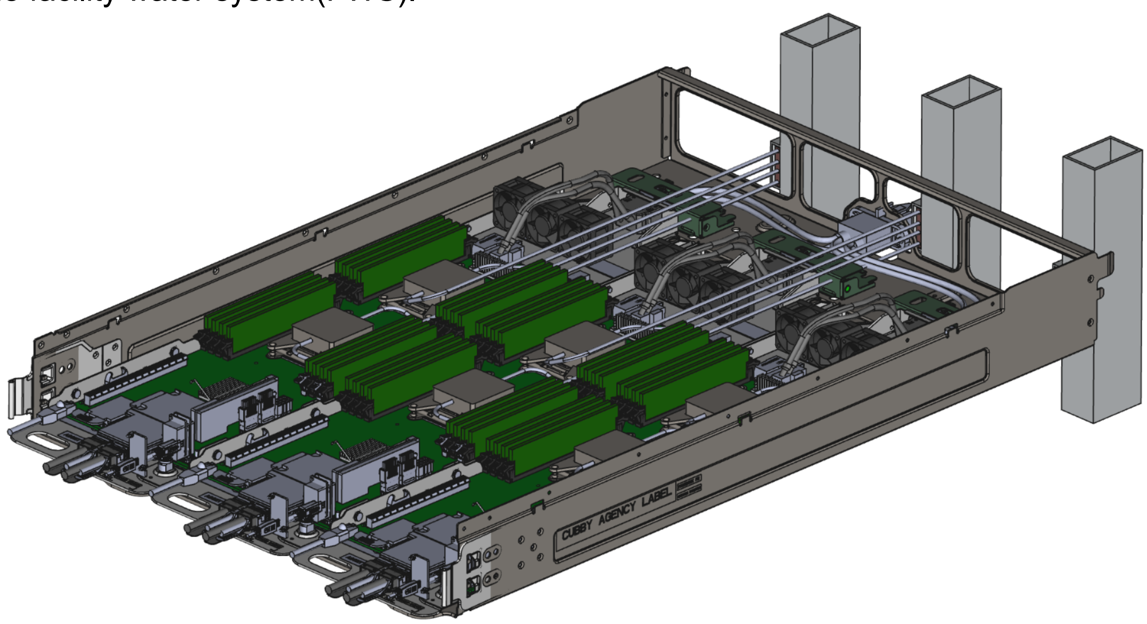
Outdoor Ecodry liquid coolers with pumps: (2) Units, which can provide up to 380kW each

Redundancy: N+1

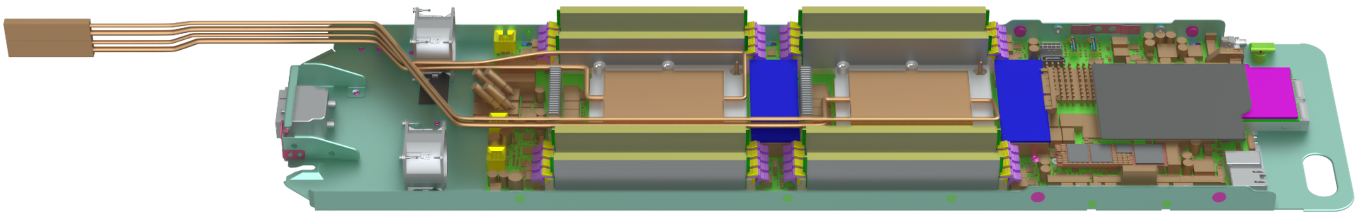
Water: WUE=0.0 l/IT kWh No water usage

Rack System & Server

1. Rack and Rack Solution
    a. The Focus for this specification are the deployment of the Open Rack V2 and V3. Optionally EIA-19 Racks can be mixed and matched with some limitations.
    b. The LHP System moves the heat out to the Rack Manifold (Thermal collector) at the back of the rack, which is liquid-cooled and via the piping system connected to the facility water system(FWS).



Example: 3 Servers Leopard 1 OU.



Example: 1 Inspur Server with passive cold plates

Rack layout:

Rack: Open Rack V2 with Thermal Manifold, standard Cubby chassis 48 Server

Rack 2: Open Rack V2 with Termal Manifold, 1 OU Cubby Chasis, 72 LHP Servers, 12 Air-cooled Servers

Supporting Systems

1. Monitoring & Control (DCIM)
    a. Standard set up for data communication from the supporting infrastructure and the environmental conditions from the Data Center. IP, ModBus (or equivalent)
2. Fire detection & suppression systems
    a. Extinguishing media, control systems, and alarms to be defined by customer and meet local codes
    b. Coordination with local agencies may be required
    c. Considerations shall be made to manage and accommodate cooling and ventilation systems in coordination with fire suppression.
    d. Novec 1230 fire extinguishing Media and Early detection system type VESDA Aspirating Smoke Detection (or equivalent)
3. Security
    a. Access to door system by card reader (biometric system is an Option)
4. Lighting

a. LED Lighting in accordance with working environmental regulation demands

Transportation

1. Transport Considerations
   a. All input and output power lines are disconnected.
   b. Coolant pipes/water lines are disconnected and the coolant/water is completely drained and purged.
   c. UPS batteries are removed from the IT Module.
   d. All breakers are turned off (Open circuit).
   e. Any loose items are secured or removed.
   f. Outside ground connections are removed.
   g. All doors are secured.
   h. No other outside attachments remain (i.e. security cameras, cable tray, etc).
   i. Module is designed for lifting and transport of equipment load within the specified weights in the Module specification summary.
2. Lifting

a. Always adhere to local and national codes. All transport, lifting, and installation operations must be done by certified personnel.
b. An overhead crane is required for unloading and positioning of the IT Module. Sufficient preparations must be made to the site to accommodate the crane. The exact load distribution will not be known until the unit is constructed.
c. All lifting equipment must have the necessary capacity to withstand specified final, constructed weight of the module [including Factors of Safety].
d. Please note that the center of gravity of the IT Module does not align with the geometric center. One option is to use an "H" style Adjustable Lift Beam. Horizontality must be verified on site and the central lifting cable must be adjusted (in both perpendicular directions) before starting the lifting operation to ensure that no tilting or swinging occurs. The IT Module must be lifted using standard load spreading techniques from the lifting attachment points provided.

3. Leveling
   a. The IT Module must be placed on a level foundation with continuous support at locations specified by the manufacturer.

Site Preparation

1. Safety Information
   a. All electrical, cooling system modifications and maintenance to and within the IT Module must be performed by certified technicians. All work must comply with local and national codes.
   b. Refer to the safety instructions for each component of the IT Module for specific safety requirements of said component. The instructions shall be provided by the manufacturer.
   c. The IT Module is not intended for continuous human occupancy except for short-duration maintenance access.
   d. Consult your local planning office for applicable codes and to review necessary permitting and guidelines for your specific site.
2. Foundation
   a. A level base shall be supplied at the site to act as a foundation for the IT Module. The base must be capable of supporting the weight of the final unit distributed equally around the perimeter.
   b. There should be sufficient foundation extending outward beyond the IT Module to allow the hold-down brackets to bolt into the foundation.
   c. Site shall be graded to drain water away from the IT Module and foundation. The foundation should be raised by a minimum of 150mm above the surrounding ground surface level to prevent water ingress.
3. Power / water
   a. Main feeder for low voltage support of the Data Center need to be prepared.
   b. Tap water for humidification when required.
   c. City water connection for adiabatic cooler.

4. Clearance and Space Restrictions
    a. Place IT Module away from objects which may impede performance, or damage the equipment.
    b. Do not place the IT Module or any support equipment near or under trees or other objects which may become dislodged in a natural event (storm, earthquake, etc).
    c. The site should be laid out in such a way as to diminish or prevent the possibility of a vehicular collision with the IT Module. It is also helpful to design the site so that a forklift or other material handling device can deliver equipment near the entry door.
    d. Consult with the manufacturer regarding planned routing of electrical lines, water/refrigerant piping, drain lines, grounding connections, and fastening points.
5. Environmental
    a. Environmental conditions such as elevation, storm winds, snow loads, and max/min temperatures can affect performance and longevity of the module. Determine site specific conditions and specify minimum environmental requirements to the manufacturer.

Onsite Module Deployment

1. Base Anchors and Fixtures: Anchor locations/brackets to be provided by manufacturer.
2. Coordination of cable entrance locations and cable sizes between module manufacturer, installing contractor, and consultant must be performed to ensure proper installation and must follow all local and national codes for the application.
3. The upstream breaker should be sized based on the IT Module load, and the input wiring
4. Follow the breaker instructions provided with the IT Module for conductor installation.
5. Ensure the IT Module is properly grounded according to local codes.
6. Stairways, ramps, and access platforms must comply with all local and national codes. They must be suitable for in-service conditions. Stairways, ramps, and access platforms are not included with the IT Module.

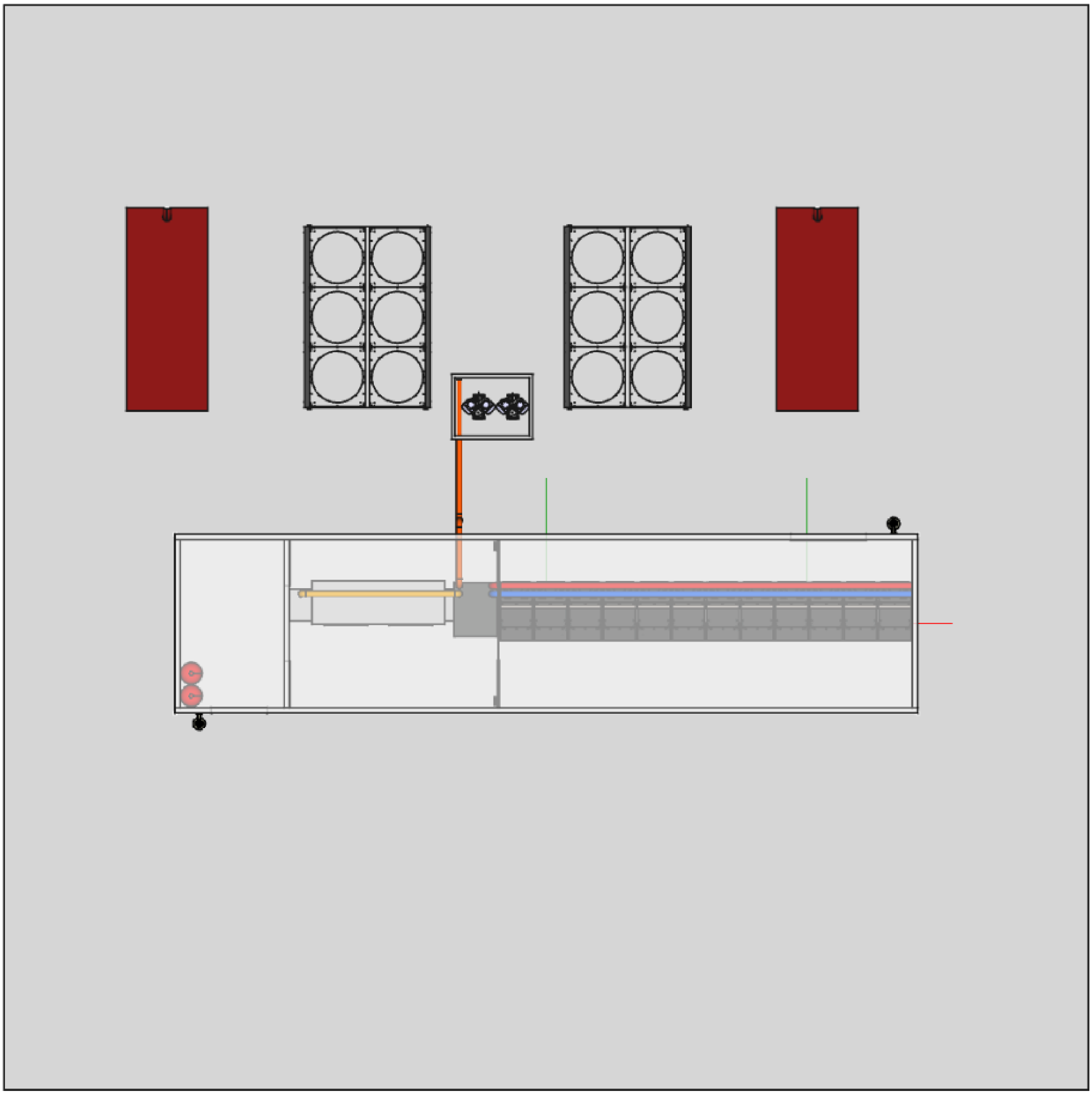
Operations and Maintenance

1. Module to be delivered with the following:
    a. Specifications and drawings
    b. Operations and Maintenance manuals
2. Services and/or training services shall be available.
3. Operations and Maintenance procedures shall meet applicable Codes and Standards.

Appendix A

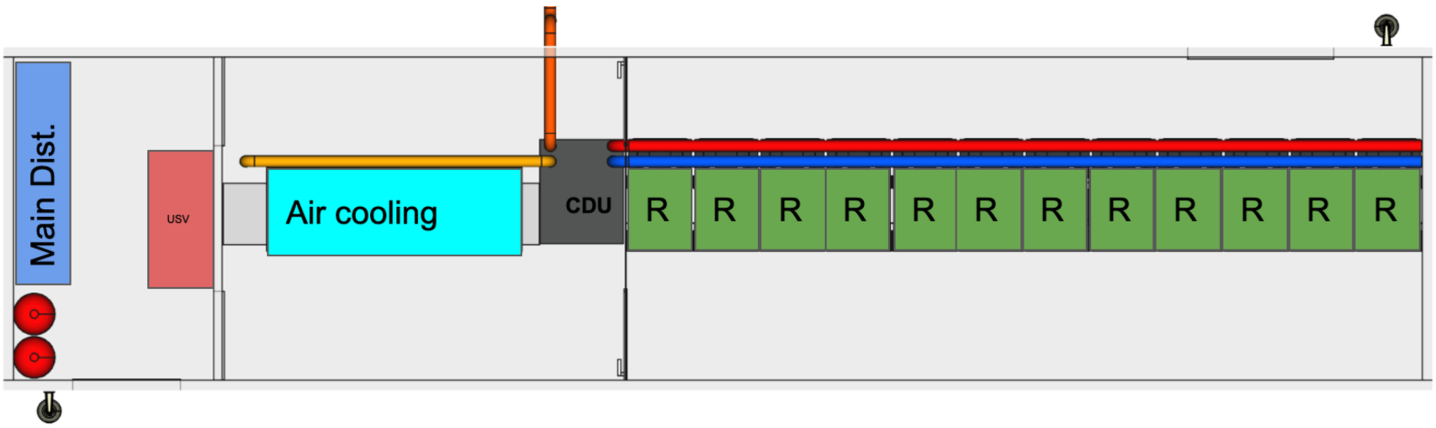
Example Drawings

1. Module
    a. External

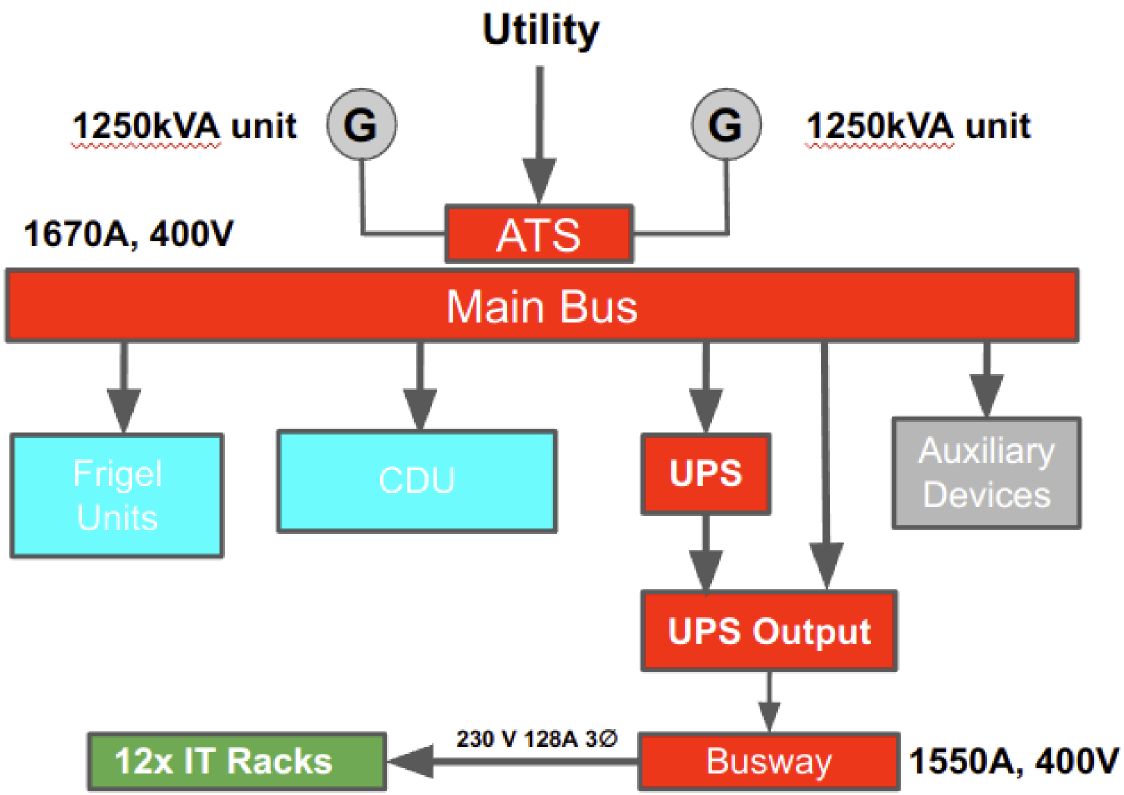


b. IT Space

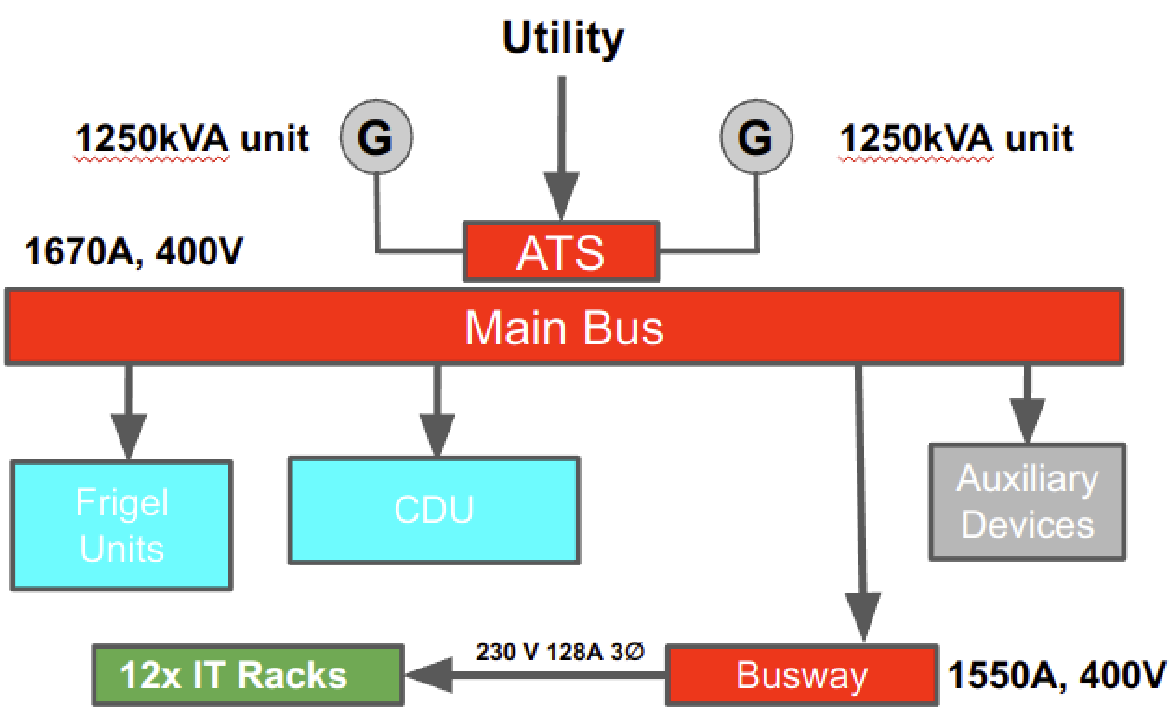
i. Module with UPS



2. Electrical
   a. With UPS

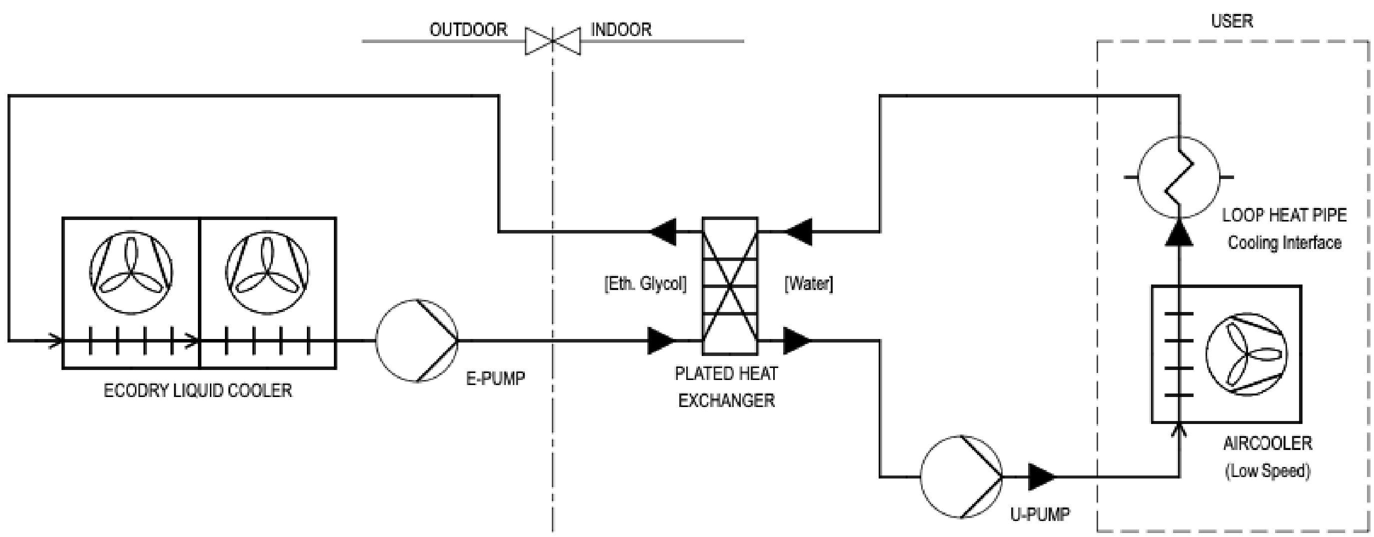


   b. Without UPS

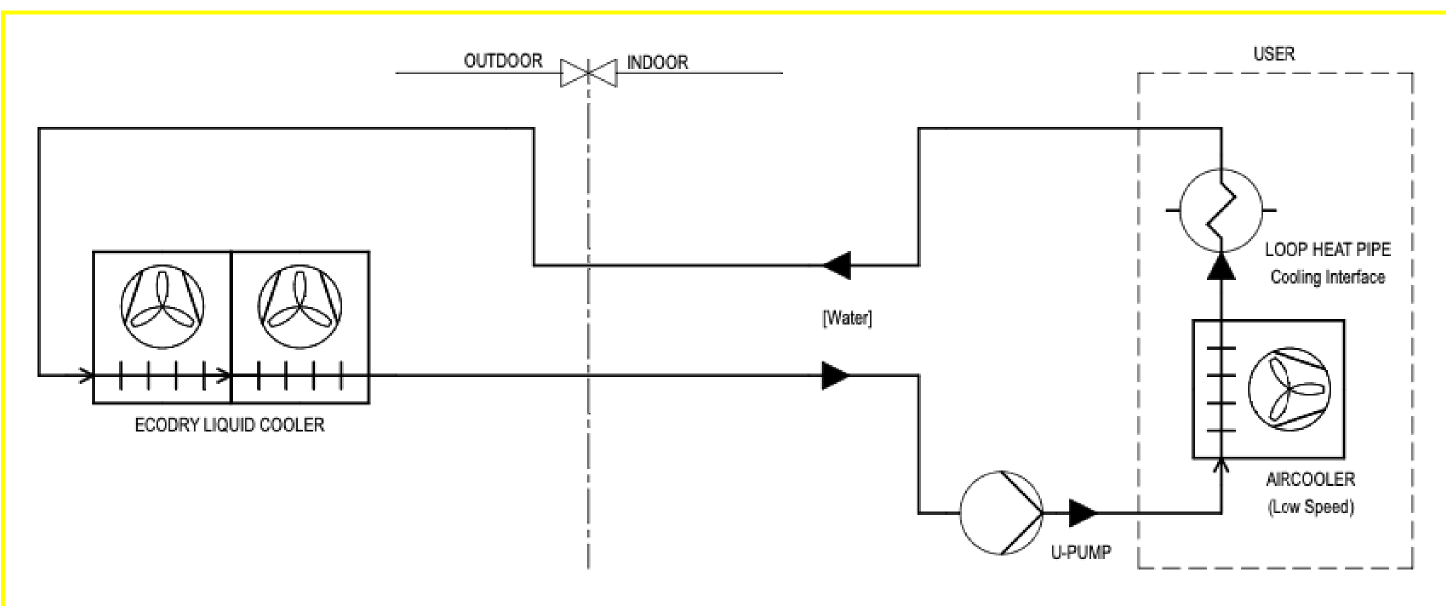


3. Cooling piping diagram

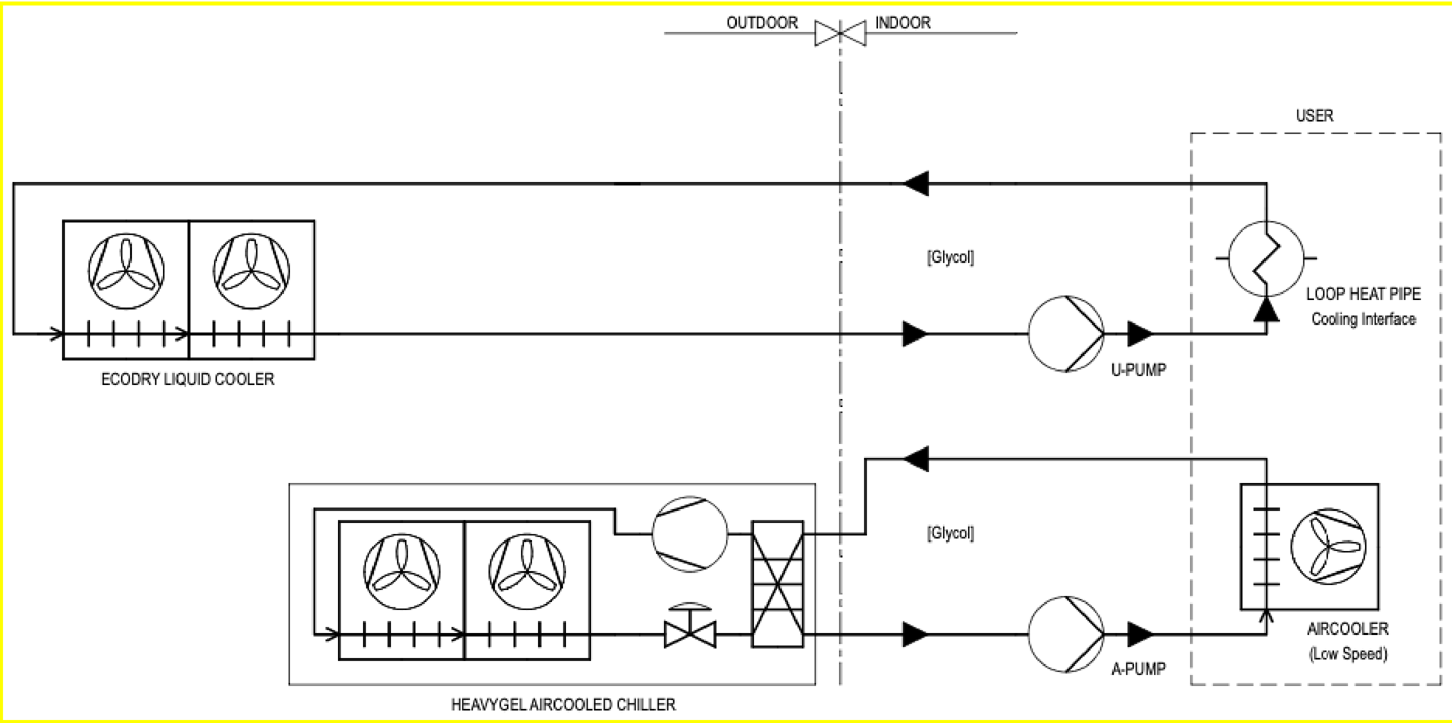
Type 1: Air cooler and outdoor adiabatic cooler with heat exchanger (two circuits) and optional heat reuse connections.



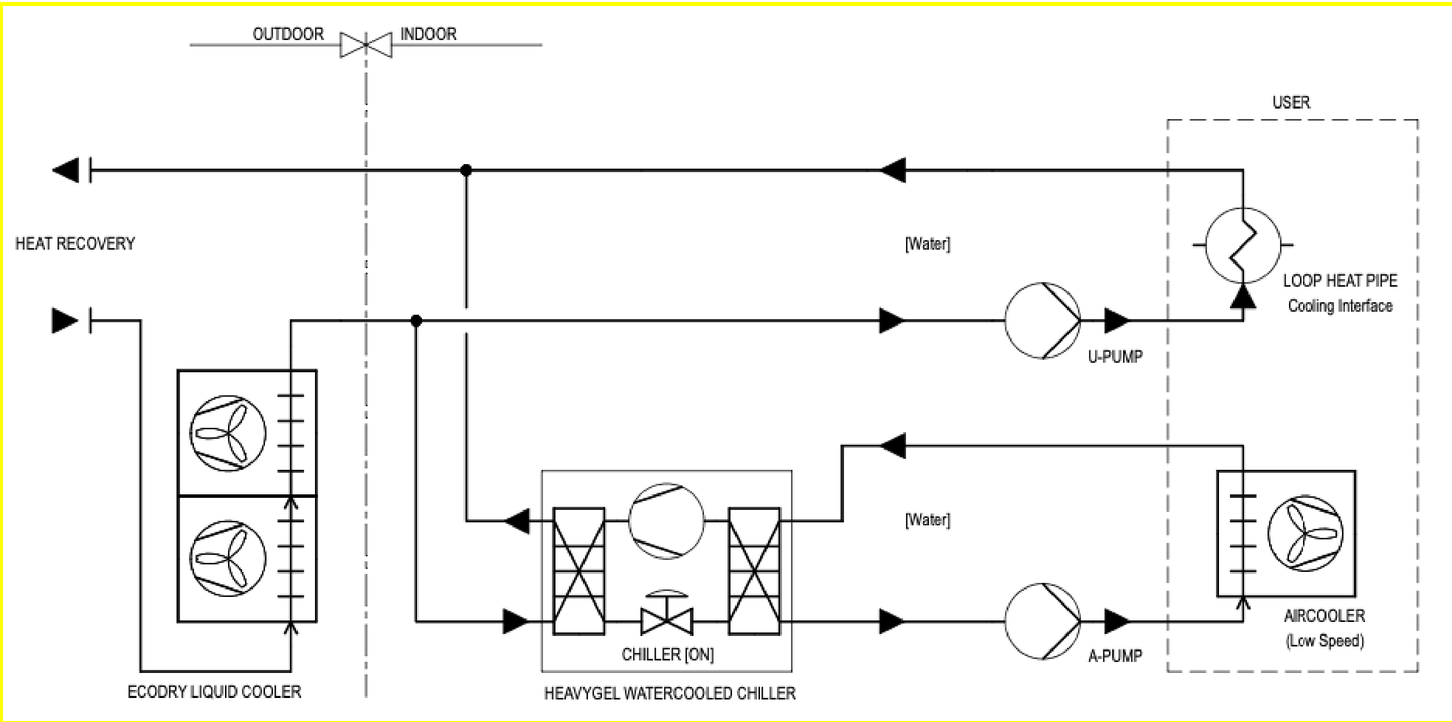
Type 2: Air cooler and outdoor adiabatic cooler(common circuit) and optional heat reuse connections.



Type 3: Air cooler with outdoor air cooled chiller and LHP circuit with outdoor dry cooler both with optional heat reuse connections.



Type 4: Air cooler with indoor liquid cooled chiller and LHP circuit with outdoor dry cooler both with optional heat reuse connections.



Appendix B

Loop Heat Pipes (LHP) Technology Description

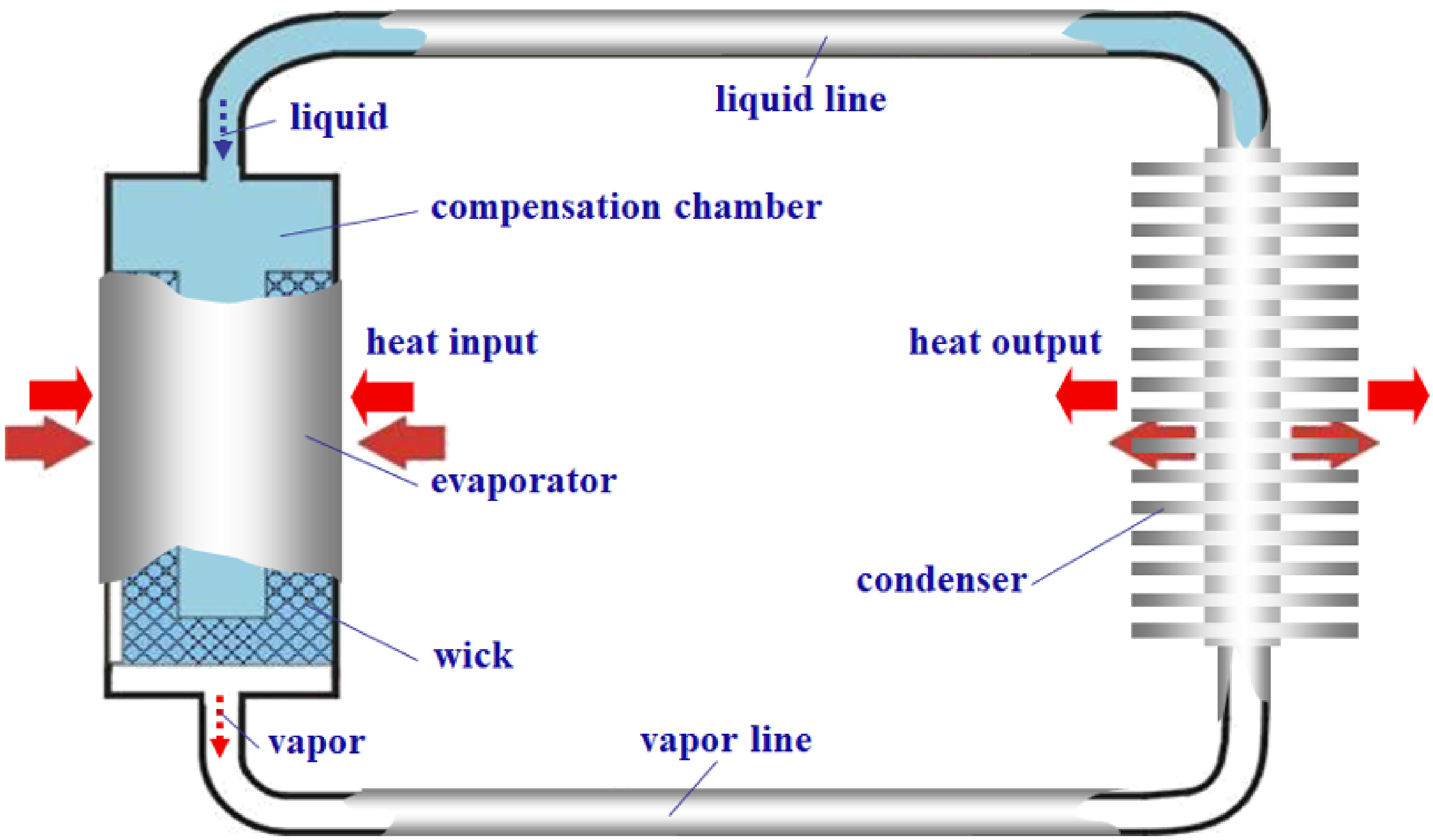
General Description

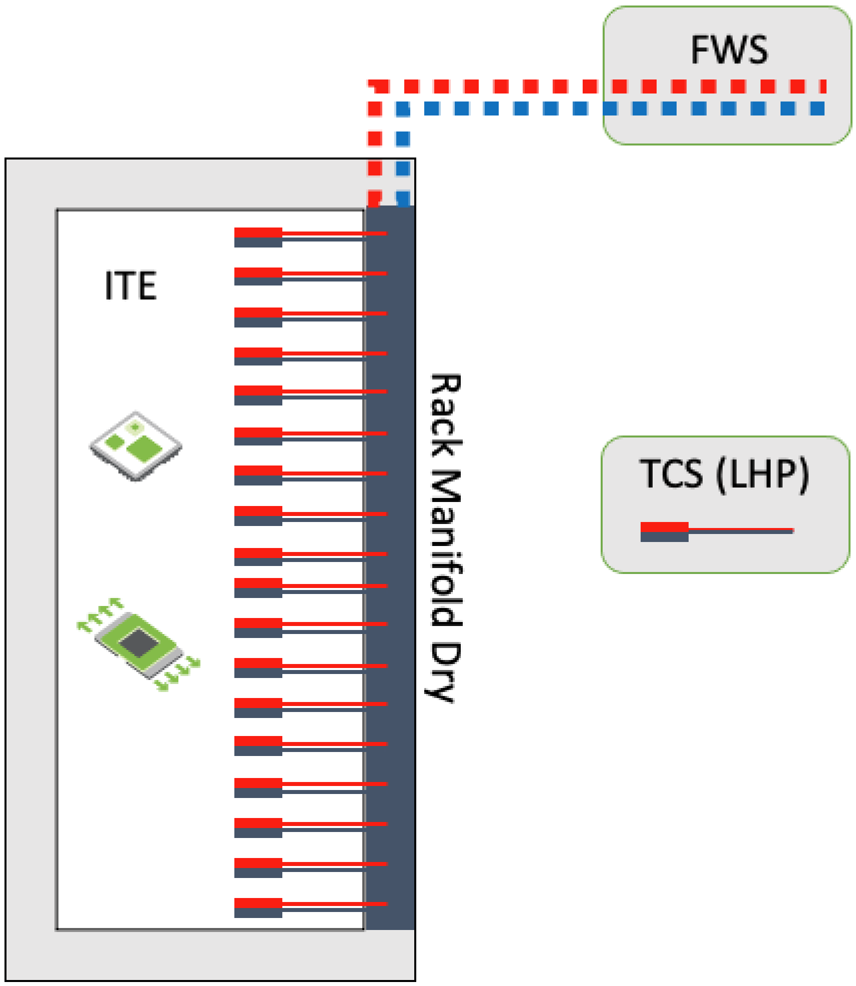
Modern electronics tends to be more powerful and compact every day. Both trends lead to the problem of heat control and elimination. Such problems are critical in the wide spectrum of industries from data centers to precise electronics management and measurement. The "hottest" alleys in the modern data centers are those which are serving Artificial Intelligence (AI), Machine Learning (ML) and other Hyper Performance Computing (HPC) processes – the most important and the highest growing segment of the data processing infrastructure.

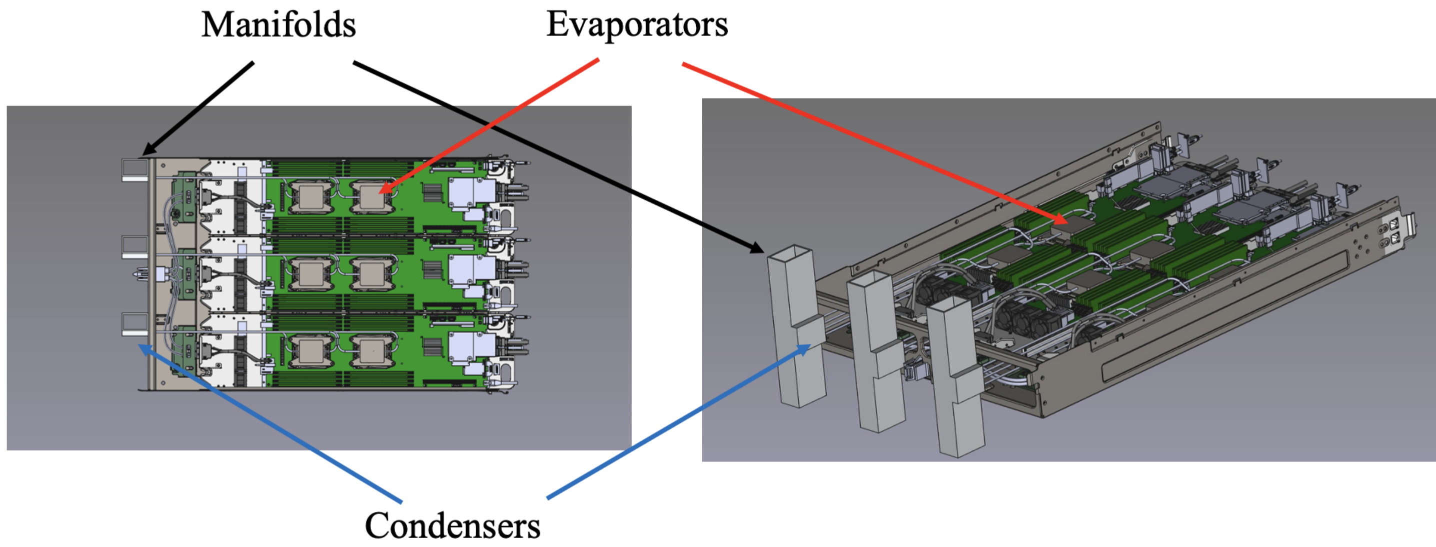
Direct water cooling can be used now to remove heat from those areas inside data centers. But it will require energy for pumping, lead to a complexity of maintenance and to the risks of leakage to electronics and cooling water pollution. And even direct water cooling may not be enough to cool down data centers' systems with energy density higher than 500W per sq. cm. (next generation switches and servers).

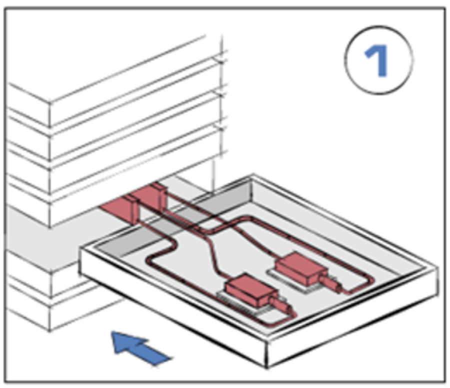
Loops Heat Pipes (LHP) technology was created as a solution to existing issues of the regular heat pipes. The heat pipes efficiency depends on direction significantly; having a limited capability to transfer a significant amount of heat, especially for long distances. Unlike traditional heat pipes LHP does not depend on the gravity field direction and they are able to move a massive amount of heat to a very long distance.

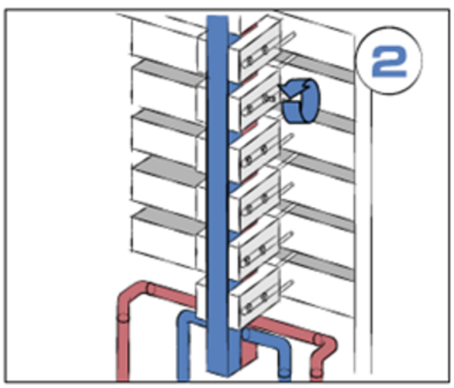
Two-phase heat transfer device operating on a closed evaporation - condensation cycle and using capillary forces as a "driving" mechanism.

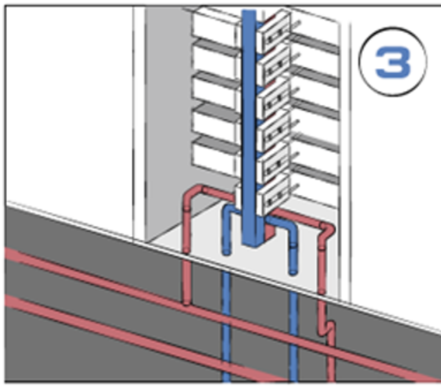

liquid
liquid line
compensation chamber
heat input
heat output
evaporator
condenser
wick
vapor
vapor line


FWS
ITE
Rack Manifold Dry
TCS (LHP)





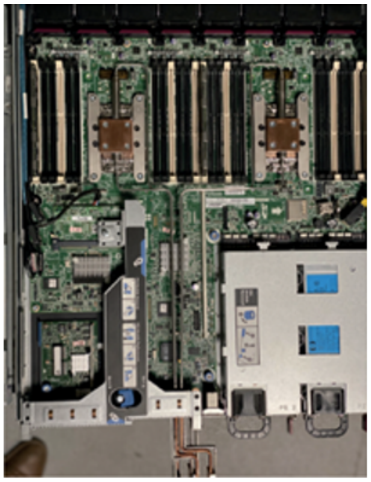




LHP installation on the server

LHP condensers "drylocked" to manifold

Connecting manifold to Facility Water System



Revision History

Appendix C - Checklist for IC approval of this Specification (to be completed by contributor(s) of this Spec)

Complete all the checklist items in the table with links to the section where it is described in this spec or an external document .

Item	Status or Details	Link to detailed explanation
Is this contribution entered into the OCP Contribution Portal?	Yes	If no, please state reason.
Was it approved in the OCP Contribution Portal?	No	in review
Is there a Supplier(s) that is building a product based on this Spec?	Yes	List Supplier Name(s) SE PCX WDC, RackWorx
Will Supplier(s) have the product available for GENERAL AVAILABILITY within 120 days?	Yes	If more time is required, please state the timeline and reason for extension request. Please have each Supplier fill out Appendix B.