

30 June 2025

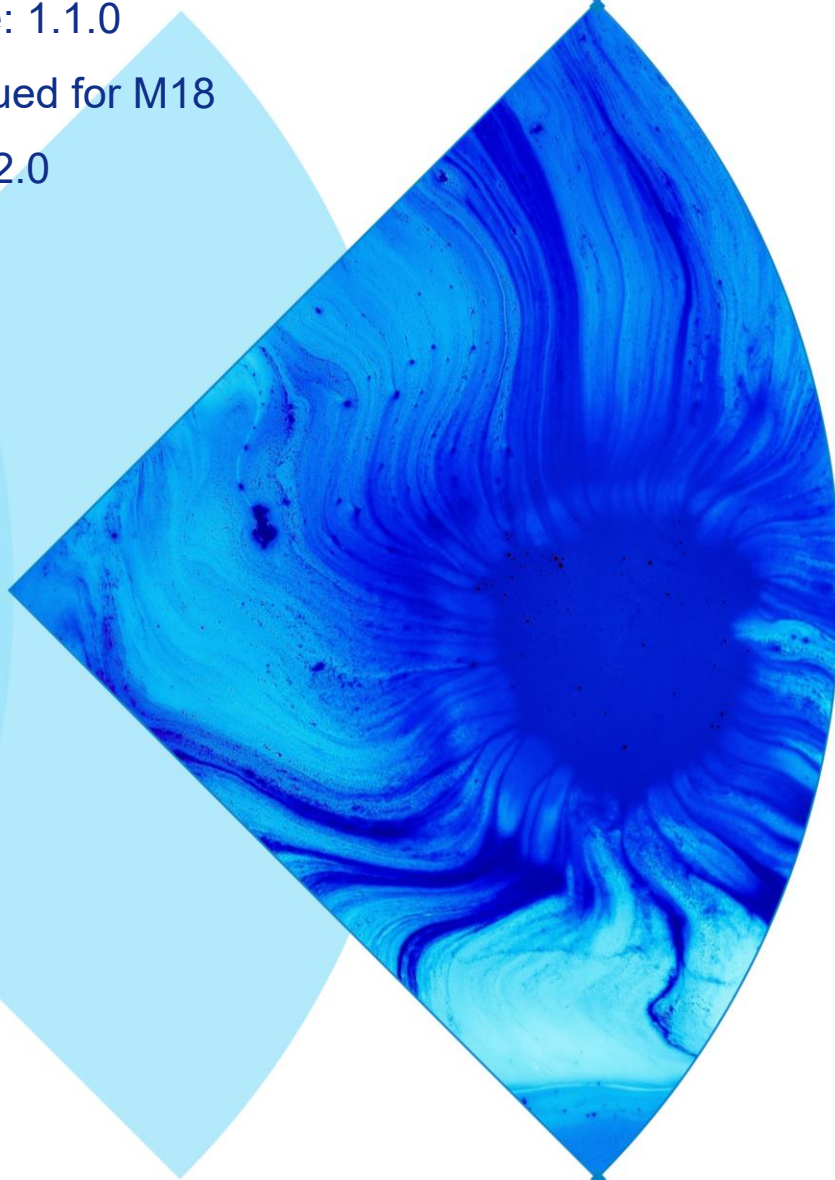
MISD Edge Data Centres

Technical Feasibility Study

Deliverable: 1.1.0

Status: Issued for M18

Version: v2.0



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Content

Version	3
Terms and Abbreviations	4
Introduction	5
Background	5
Executive Summary	6
Key performance indicators	6
Design Framework	7
Guidelines and Local Standards	7
Certification	7
EN50600	7
Uptime Institute	7
Site Investigation	8
Mechanical Design	10
General	10
Redundancy	10
External climatic conditions	10
Internal climatic conditions	10
Critical cooling system	10
Traditional air cooled system	11
Liquid cooled system	11
Ventilation	11
Heat recuperation	12
Modularity	12
Electrical design	13
General	13
Redundancy	13
MV system	13
Main site connection	13
LV system	14
Racks	15
UPS	15
Back-up power	15
Normal Operation	15
Emergency Operation	15
Lightning protection	15

Lighting	16
Internal lighting	16
Emergency lighting	16
Design Considerations	17
Operational Requirements (Service level agreement)	17
Resiliency & Availability	17
Fire suppression	17
Gas suppression	17
Water mist	17
Security & Accessibility	17
Maintenance	17
Layouts	18
Next Steps	21

Version

Version	Date	Author(s)	Description
v1.0	20 June 2025	AS	Issued for feedback
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Terms and Abbreviations

Abbreviation	Description
ATS	Automatic transfer switch
CDU	Cooling distribution unit
CHW	Chilled water
DC	Data centre
DLC	Direct to chip liquid cooling
eDC	Edge data centre
EIA	Environmental impact assessment
FWS	Facility water system
GWP	Global warming potential
HFK	Hydrofluorocarbons
LED	Light Emitting Diode
LV	Low voltage
ODP	Ozone Depletion Gradient
MEP	Mechanical, electrical and plumbing
MV	Medium voltage
PUE	Power usage effectiveness
RDC	Rear door cooler
SLA	Service level agreement
TWS	Technology water system
UPS	Uninterruptable Power Supply

Introduction

Background

New hyperscale data centre developments in the Netherlands are facing increasing challenges due to land scarcity, high energy consumption and stricter regulations surrounding large-scale new builds. These limitations, combined with concerns over grid capacity and sustainability, make edge data centres a more viable and scalable solution for Europe's growing cloud computing needs. By strategically deploying these facilities, businesses can meet the rising data demands while improving efficiency and supporting Europe's broader digital and environmental goals.

Executive Summary

This report presents high-level MEP design requirements for edge data centres based on field experience and outcomes from the staging & field lab. The study aims to define the design requirements for a modular edge data centre that is aligned with the findings of the preceding market research report.

It is conducted alongside Eurofiber's implementation of the staging lab within their existing facility in Arnhem, on Tivolilaan 251.

Key performance indicators

KPI	Target
Site Type	Mostly greenfield, potentially make use of brownfield
Facility Type	Colocation or dedicated facility
Total required footprint	Between 22-44m ²
Total net data centre space	Between 9-17m ²
Floor load	175kg/m ²
Target Rating	Aim for an Uptime Institute TIER III (this is not necessary, but is recommended); the Eurofiber Arnhem facility is TIER III, and so is the majority of other DC builds aiming for an Uptime Institute rating
Rack power	10kW (traditional) – 80kW (ready for liquid cooled); with a future capacity expected to be >100kW
Grid power	Depends on specific location and what is available; to be elaborated as part of the WP2 mapping tool.
Resilience	Redundant capacity components, concurrently maintainable or fault tolerant. 2N power provision N+1 cooling production and heat extraction Cold/hot aisle containment
Modularity	100kW blocks, ISO container sizes (20 foot, 20 foot extra width, 40 foot)
PUE target	1.15 annual average (<1.2 after operation July 2026) 1.2 peak power ratio
Computer room thermal window	TBC at milestone 24 (M24)

Design Framework

This report is intended to outline the basis of design for the eDC, listing key assumptions and starting points for the mechanical, electrical and plumbing disciplines.

Guidelines and Local Standards

The definition of the design criteria for this project is meant to convey the general requirements of MISD; and be generically applicable to a European project. All works will be designed and constructed fully in accordance with all current statutory requirements of the project location, including the requirements of the relevant Statutory and Local Authorities.

At project implementation, the design team must account for any required localisation. The design criteria must be reassessed to ensure compliance with local regulations that may differ from the codes and standards referenced within each discipline in this report. Where local jurisdictional requirements differ from those set out in this standard, the most stringent requirement is to be followed. Where local material availability or construction methods provide a more efficient method to achieve the same intent, a deviation request should be subject to approval.

Certification

EN50600

EN50600 is a European standard for the planning, construction, and operation of data centres. This is the most appropriate standard to be applied to MISD as it is applicable to the European Union, including a code of conduct. It provides a framework for ensuring data centre availability, security, and energy efficiency. The standard is modular and allows for flexibility in its application to different data centre designs and sizes. With an EN 50600 certificate, you objectively prove that your data centre meets the extensive requirements of the standard for physical security & availability.

Uptime Institute

The Uptime Institute's Tier Standards are the globally recognized standard for data centre availability and overall performance. It allows for various performance levels that consider both the built environment, as well as the approach and performance of the operations team.

(<https://uptimeinstitute.com/professional-services>)

Getting a project Uptime Institute certified will ensure global recognition and consistent standards being applied to the eDC's. The Uptime Institute works with enterprise data centre owners, cloud, and colocation services providers to guide a project through all phases of the lifecycle, from business case development to data centre design, construction, and facilities operations. They can offer tailored advice across a range of sectors: AI support, Management and operations, risk assessment, sustainability assessment, digital resiliency assessment, FMO advisory services and facility security assessments. Given their unique position in the data centre field, it will be beneficial to include consultation with an Uptime Certified expert to understand how they can support this venture.

Site Investigation

Once a viable site has been selected, site specific investigation must be conducted to assess the potential risks associated with the chosen location. A comprehensive risk assessment should be carried out to ensure safety, compliance and long term viability of the eDC location. This should take into account various environmental, occupational and operational risks. Below is a guideline for typical risks to be considered, the investigative strategies to be applied and potential mitigation measures:

Notes:

- *The items in orange are out of scope for Deerns to provide input*
- *This risk assessment guideline is tailored to sites within the Netherlands*

Risk Category	Risk Type	Method of Investigation	Mitigation action
Environmental & Climatic	Flooding	Use Atlasleefomgeving and Rijkswaterstaat maps to assess the risk. Use Waterschap Locator to take necessary steps for construction near dykes	Elevation increase to floor level or critical systems. Implement water barriers or waterproofing to structure. Design drainage appropriately.
	Strong wind/storms	Civil/Structural engineer to assess	Civil/Structural engineer to assess
	Seismic activity	Civil/Structural engineer to assess	Civil/Structural engineer to assess
Power and connectivity reliability	Grid overload in urban zones	Request location specific data from the local grid operator, eg: TenneT , Liander , etc.	Design for dual feeds, battery back up systems (UPS).
	Limited capacity for new builds	Request location specific data from the local grid operator, eg: TenneT , Liander , etc. Work with local municipal plans for future developments	Connect to smart grid or use on site renewables if possible. Liaise with regional electricity provider using this map .
	Redundancy issues with network fiber	Retrieve location specific data from network providers, eg: Eurofiber , KPN Netwerk	Use multiple fiber entry points, SD-WAN for network resilience
Permitting and regulatory compliance	Zoning restrictions for build type	Zoning permissions and plans to be discussed with local municipality , engage with Omgevingsdienst	Perform zoning checks early in the design process, engage with municipality early
	Noise limitations	EIA required, check Omgevingsloket	Adjust design accordingly as per discussion with the municipality / applicable standards
Cooling efficiency and Waste Heat Reuse	Urban heat island effect	Check ASHRAE weather conditions, download weather files	Make use of free cooling where possible, design for future weather
	No heat sink or opportunity for waste heat reuse	Locate district heating networks or nearby greenhouses	Partner with organizations for heat recapture. Add a heat pump to generate the ideal water temperatures.
Physical security and Accessibility	Theft of equipment, no on site security	Local crime indices and statistics, engagement with local law enforcement	Install fences, CCTV or 24/7 monitoring, biometric access technology
	Access challenges for rural locations	Check accessibility routes for maintenance staff and vehicles	Ensure alternate access routes and emergency response plans
Fire Hazards	Electrical fires, battery hazards	Fire engineer to assess . Use Besluit bouwwerken leefomgeving and NEN standards.	Gas suppression system, VESDA system (early detection)
Community Engagement	Protests from locals	Engage with stakeholders	Visually hide eDC container with landscape/naturally. Include community focused waste heat reuse

Mechanical Design

General

The design of the mechanical system shall, as a minimum, comply with all local energy code requirements. The cooling system will be designed to provide sufficient capacity to satisfy the cooling load for all critical equipment in addition to all other loads (e.g. building envelope, ventilation, electrical and distribution losses etc). The refrigerant type used will comply with local and national regulations and be future proof in terms of its GWP, ODP and HKFs.

Redundancy

Cooling equipment serving the IT equipment shall be designed with a minimum resilience of **N+1 (concurrently maintainable)**. External equipment shall have a redundancy of **N+20%** for maximum effectiveness. There will be a battery back up for the CDUs.

External climatic conditions

The building shall be designed to operate and maintain internal conditions for the ASHRAE N=20 weather conditions under full load. (where n = 20 year return period values of extreme temperature) The most appropriate ASHRAE weather station for the selected eDC location shall be agreed directly after the site selection phase.

The ambient design conditions must be based on the latest ASHRAE fundamentals handbook (currently 2025), as per the below example table:

Summer / Winter	Temperature
Peak summer	39.1°C dry bulb
Peak summer	25.6°C wet bulb
Peak winter	-14.7°C dry bulb
Peak winter	-15.0°C wet bulb

Internal climatic conditions

The climatic conditions for the computer room will be maintained for 100% of the time as shown in the below table:

Temperature	Humidity
20°C – 27°C – A1	20% - 80%
Or	
20°C – 32°C (27°C set point) – A1 Allowable window	

This is aligned with ASHRAE TC 9.9. The supplier will install temperature and humidity sensors to measure and record the indoor conditions.

The chosen set point is 27°C in order to maximize the opportunity for free cooling, this is required as per EML (erkende maatregelenlijst 2023), requirement number PH1.

Critical cooling system

The facility water will be pumped to the eDC via pipework from the hybrid/dry cooler / (free cooling) chillers. The CHW plant will be sized to meet the cooling demand of 60-180kW IT over the racks. The

chilled water system shall be designed to operate based on **22°C / 32°C** CHW flow and return temperatures. There will be no buffer tanks.

To keep the external positioned equipment protected against freezing, a glycol ethylene mixture should be used for the FWS. Using the nearest ASHRAE ambient winter conditions, the percentage of the glycol ethylene and water mixture will be based on the below table. There will be no separation of the system containing the glycol mixture as this will make the overall installation simpler.

Glycol Ethylene (%)	Point of freezing
10%	-3°C until -4°C
15%	-6°C until -7°C
20%	-9°C until -10°C
30%	-15°C until -16°C
40%	-24°C until -25°C
50%	-36°C

Note: The entire edge data centre is to be considered a critically cooled space, therefore, there are zero non-critical cooling systems.

Traditional air cooled system

Air has a lower thermal conductivity and heat capacity compared to water. Therefore, an air-cooled system would not be able to cool high density IT loads as efficiently as a system making use of liquid cooling. Air cooled systems also require more space for airflow, and a key criteria for edge data centres is to maximize its footprint effectiveness.

Liquid cooled system

Liquid is much more effective at conducting heat than air, therefore, liquid immersion cooling is a very efficient cooling system when compared to traditional air cooled systems. With compute power demand rising, liquid cooling is a futureproof solution that is able to support higher rack densities without needing significant modifications. This will allow for modular expansion. Specialized maintenance and higher upfront costs are associated with liquid cooled systems. There are 3 main options considered for sizing the eDC and the associated IT capacity:

- Option 1: Immersion cooling

IT racks are submerged in a dielectric fluid (single phase hydrocarbon); estimated 60kW per tank.

- Option 2: Direct to chip liquid cooling (DLC)

The coolant is pumped to cold plates that are attached to the rack GPU's; estimated 30kW per rack.

- Option 3: Rear door coolers

Coolant pumped through pipework at high level and to passive RDC's, estimated 10kW per rack.

Or Liquid to air

Ventilation

The edge data centre will be considered a non-occupied space, and the ventilation requirements will be based on the maximum requirement as per the below table:

Ventilation rates	
Computer room / plant room	As required to suit equipment. 0.5-1 air change per hour (typical)
Battery Rooms	Ventilation for hydrogen gas leakage: In accordance with IEEE Std 1635-2018 / ASHRAE Guideline 21-2018 (or as required to meet local code) PGS 37-2 for Lithium Ion NPR 3229:2019 ARBO

The ventilation system serving the critically cooled space will be designed with no redundancy as there is no fresh air requirement from the Uptime Institute.

Heat recuperation

The design will facilitate potential external waste heat recuperation. This can be used for heating a nearby facility/district heating system as identified during the site selection process. A provision for a heat pump with hydraulic connections will be made for external tie in.

Modularity

It is important for the IT racks and cooling loops to be designed efficiently for simple expansion or replacement during failure or end of life scenarios. Implementing a standardized cooling skid will also facilitate faster deployment. The cooling skid should consist of the CDU, pump and potential heat exchangers / heat pumps.

Electrical design

General

The design of the electrical systems shall, as a minimum, comply with all local energy code requirements. This section details the necessary infrastructure, major components which will supply the electrical energy demand to the edge data centre, associated electrical services and external support services.

The modular design is based on an IT load of 132 kW for a 20-foot container and 246 kW for a 40-foot container.

Redundancy

The electrical distribution will be based on either a Distributed Redundant system or a Block Redundant configuration. Block Redundancy makes use of redundant systems typically connected in parallel, while Distributed Redundancy features multiple independent UPSs capable of sharing the load.

	N	$N+1$	$N+1$	$N+1$	$2N$
	No redundancy	Parallel UPS redundant	Block redundant	Distributed redundant	
Redundancy	No redundancy	One UPS capacity worth of redundancy	One system capacity worth of redundancy	One system capacity worth of redundancy	Maximum redundancy, two identical systems
Pros	- Less electrical equipment required - Lowest cost: initial build and maintenance	Easier load management because the power is shared across UPS bus	- Reserve bus is always available in case of outages and maintenance - Easy load management	- All equipment is utilized - Cost-effective solution	System separation provides true redundancy on every level
Cons	Outages and failures will bring down server cabinets	UPS bus is a single point of failure	- Requires installation of load transfer capability equipment - Low utilization of redundant system leading to decreased efficiency	- Requires installation of load transfer capability equipment - Strenuous ongoing load management exercises to ensure adequate distribution	- High equipment cost - Increased maintenance cost

Figure 1: Comparison of distributed redundant vs block redundant system (academia.edu)

MV system

Main site connection

The nearest substation will need to be identified as part of the site selection process. During this process, the available capacity will be apparent. TenneT manages the Netherlands' national HV grid, which transmits electricity at 110kV, 150kV, 220kV or 380kV. Thereafter, the regional electricity grids have voltages typically between 10 kV and 25 kV, and are managed by seven [regional grid operators](#). The next step will be to engage with the local electricity provider to understand how to get power to the chosen site location, as they will advise on the engineering feasibility of a connection.

Medium Voltage Power Distribution

The MV distribution on site will comprise of the following equipment:

- MV incoming switchgear.

- Step-down dry type transformers
- Internal MV ring main units (RMU's)

These components will be designed with N+1 redundancy to meet Tier III standards. The entire architecture must be designed to allow concurrent maintainability and eliminate single points of failure.

Emergency Power

The redundant (N+1) emergency power system will typically include diesel generators, Battery Energy Storage Systems (BESS), and may explore alternative technologies such as gas-powered or renewable-fuelled generators.

Diesel Generator

The generators will be connected to the medium voltage distribution system through automatic transfer switches (ATS), allowing for rapid switchover during a grid outage.

- The configuration will follow an N+1 redundancy scheme.
- Each generator will be sized to support a portion of the full load, ensuring one additional unit is always available in case of failure or maintenance.
- Fuel storage capacity will be designed for at least 24–48 hours of autonomous operation, with provisions for refuelling during extended outages.

Other alternatives (Gas Generators, Renewable diesel Generators...)

Given the rapid advancements in the energy sector, especially in the search for more sustainable and reliable backup power solutions, various alternatives to conventional diesel generators should be considered. These include BESS, gas-powered generators, renewable diesel generators, and emerging technologies such as Solid Oxide Fuel Cells (SOFCs).

Each option will be evaluated on a case-by-case basis, taking into account factors such as fuel availability, environmental impact, regulatory requirements, and the overall sustainability goals of the project.

LV system

The edge data center LV infrastructure will be split into the following categories:

- Supply to the IT racks
- Supply to mechanical and ancillary loads
- Supply to non-critical systems

The low-voltage power stream will consist of the following components, differing for the 20-foot and 40-foot containers, respectively:

- 20-foot container
 - MV/LV 400kVA dry type transformers (cast resin).
 - 2No. 300A LV switchboard (combined input/UPS output board)
 - 2No 150kVA UPS (space provision to be allowed based on individual customer requirements)
 - Load bank connection for provision for UPS
- 40-foot container
 - MV/LV 800kVA dry type transformers (cast resin).
 - 2No. 600A LV switchboard (combined input/UPS output board)

- 2No 300kVA UPS (space provision to be allowed based on individual customer requirements)
- Load bank connection for provision for UPS

Racks

This should be standardized as much as possible to enable modularization. Installing an edge data centre with a footprint of 24 m² for a 20-foot container or 30 m² for a 40-foot container can provide an IT load of 132 kW in the first case and 264 kW in the second.

UPS

UPS technology focusses on power quality, reliability, and high efficiency.

- UPS (in economy mode or bypass mode).
- UPS battery autonomy 5-minutes end of life (EoL)
- Li-ion batteries shall be used (or upgraded depending on new technology available on the market).
- Battery system shall provide a minimum of 5 minutes of runtime at 100% load.
- Batteries to have a minimum life expectancy of 12 years.
- Batteries to be provided with a battery monitoring system.

Back-up power

Supplying back up power to data centers is critical for operations and mitigating downtime. Battery backup will be used to ensure the identified critical components have uninterrupted power for the duration of a switchover from the affected eDC to an unaffected eDC.

Normal Operation

- Utility Power is routed through the ATS and into the switchgear.

Emergency Operation

When utility power is lost, the following chain of events occur:

- UPS supplies power to security and edge data center.
- Emergency battery back-up and ATS transfers to emergency power.
- Switchgear routes power to Critical and Non-Critical Loads.
- UPS transfers to normal operation and the eDC critical loads + security are powered by emergency battery back-up for the duration of a full switchover from the affect eDC to another unaffected eDC.
- When normal power is resumed, the automatic transfer switch routes power to utility and critical and non-critical loads are powered as per normal operation.

Standby power generation to site will consist of at least, 2 units of Li-ion batteries. The battery size will be sufficient to transfer the entire operation of the failed data center to another operational data center. (TBC in Milestone 24)

Lightning protection

The lightning protection system shall be installed to protect the structure as part of the base build. The lightning protection system will be bonded to the ISO container's earth bar. The zone of protection provided by the lightning protection system will be extended to protect equipment directly outside the eDC. A lightning protection risk assessment is required to be carried out by a local specialist. This must be designed at the detailed design phase.

The lightning protection system will be in accordance with IEC 62305. The mechanical hybrid/dry cooler will be located outside the eDC and will need to be provided with independent air termination networks connected to the common site earth termination system.

Lighting

Internal lighting

The internal general lighting and the associated lighting controls will be designed to comply with current EN 12464-1 and local codes.

The lighting will be controlled locally via manual switches, and a photocell with a time clock. All internal luminaires will be LED. Integrated smart lighting is possible, in order to reduce PUE. The lighting colour temperature shall be maximum 3500K. Lighting colour rendering index shall be greater than 100.

The edge data centre will be considered a non-occupied space and the general lighting requirements are the following:

Internal areas

- Minimum maintained average illuminance: 500lux
- Uniformity Ratio: 0.6
- Lighting Control: Manual

External areas

- Minimum maintained average illuminance: 20lux
- Uniformity Ratio: According to local regulations
- Lighting Control: Control system

Emergency lighting

An integral emergency lighting system will be designed and provided to serve emergency exit and escape route lighting within the eDC, designed to meet EN 1838 and all applicable local codes.

For all signed exit luminaires, the lighting source will be powered by an LED-type fitting mounted above each exit door and available for both travel directions (in a case of 2 emergency exist required). During a power outage, the exit and escape lighting will operate for 30 minutes minimum, allowing occupants sufficient time for egress.

Emergency Lighting Requirements

Space	Minimum Maintained Average Illuminance (LUX)	Uniformity Ratio (min/average)
Escape routes (central axis)	1 lux	0,4
The sides of the evacuation route	0,5 lux	0,4
Fire protection equipment (extinguishers)	5 lux	0,4
Emergency exit signs	5 lux	0,4

Design Considerations

Operational Requirements (Service level agreement)

Resiliency & Availability

The edge data centre is to achieve N+N or N+3 by automatically switching over to the nearest edge data centre (as per the mesh network described in Work Package 2) while the point of failure is identified, managed and resolved. According to the mesh structure, each edge data centre will be connected to a minimum of 3 other edge data centres to achieve redundancy. Each data centre will be at 75% capacity and can absorb an additional 25% load during a failure scenario.

Fire suppression

Gas suppression

A gas suppression system will release an inert gas (like Nitrogen or Argon) to extinguish a fire, without damaging sensitive equipment within the edge data centre. This avoids water damage to equipment and does not leave any residue on surfaces. Gas suppression is typically more expensive to install compared to a water mist system and requires an airtight eDC installation.

Water mist

A water mist system will use a fine spray of water droplets to cool flames and displace oxygen to extinguish a fire. There is potential for water damage to sensitive equipment. Modifications are required to the electrical controls system to avoid short circuiting during a fire scenario. Installing a water mist system is typically more cost effective than a gas suppression system.

A gas suppression system is recommended due to ease of installation and modularity.

Security & Accessibility

Due to the nature of eDC's, it is not realistic to provide manned security to a location. Security will need to be managed through site surveillance using CCTV cameras, and access control into the containerized eDC. If the risk assessment outcome for physical security requires fencing, it is possible to include this as part of an architectural/civil build. CCTV cameras should be implemented facing the entrance of the eDC and nearby surrounds. CCTV monitoring should be managed remotely, with a portion of an internal rack dedicated to the controls and monitoring of the eDC.

Access control should be managed remotely, and on a needs basis. This should be granted for dedicated staff and site maintenance teams on a time basis, not indefinitely.

Maintenance

Equipment maintenance will be required on a periodic basis, according to supplier recommendations. Following the site selection process, all accessibility routes must be identified for the chosen eDC location. During a failure scenario, automatic switchover to the nearest edge data centre will occur as part of the redundancy within the system, and to avoid SLA infringements.

Layouts

20 foot container

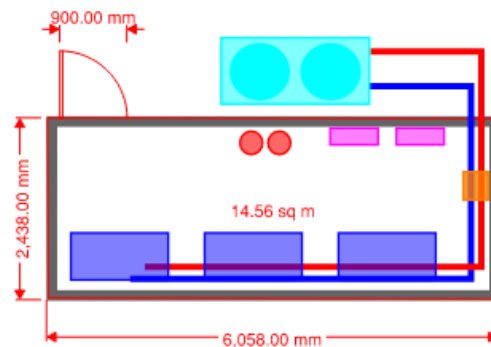


Figure 2: Option 1 - Liquid immersion cooling 20 foot ISO container

MEP specs:

Gas suppression
Cooling capacity:
180kW max
IT capacity: 12U
240V facility supply

20 foot container length (extra width)

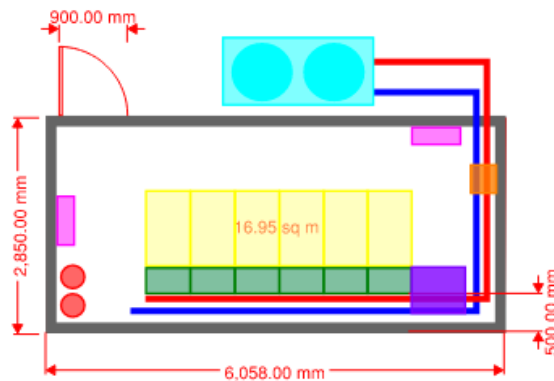


Figure 3: Direct to chip cooling 20 foot ISO container with extra width

MEP specs:

Gas suppression
Cooling capacity
180kW max
IT rack: 42U
240V facility supply

20 foot container length (extra width)

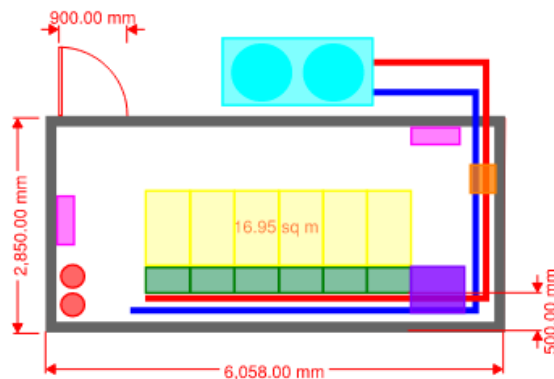
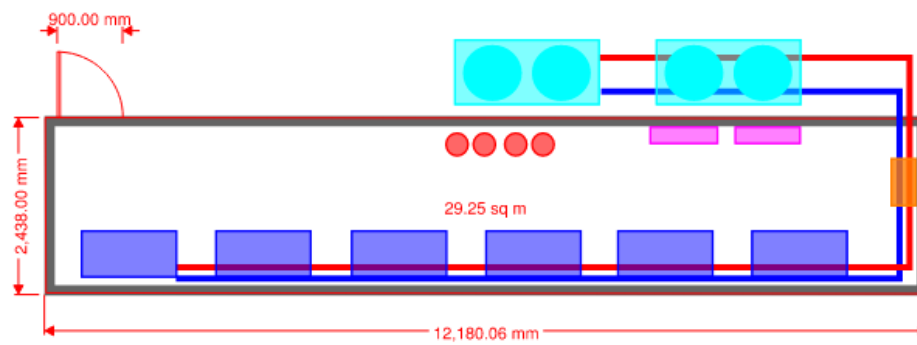


Figure 4: Option 2 – Rear door cooling 20 foot ISO container with extra width

MEP specs:

Gas suppression
Cooling capacity 60kW
max
IT rack: 42U
240V facility supply

40 foot container



MEP specs:

Gas suppression
 Cooling capacity:
 360kW max
 IT capacity: 12U
 240V facility supply

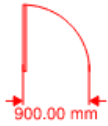
Figure 5: Option 1B Liquid immersion cooling 40 foot ISO container

Legend

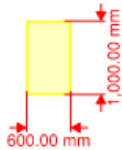


ISO container

Height = 2590mm or 2890mm

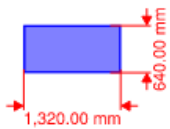


Single leaf door



Standard 42U rack

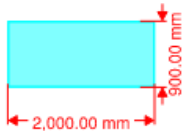
Height = x mm



Standard 60kW cooling capacity Asperitas tank (5kW/U)

Height = 2004mm
Weight = 1274kg with IT

IT capacity = 12U 19"/21" servers up to 1000mm in height or 2x 19" air based depths of 480mm

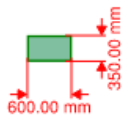


Hybrid/dry cooler xkW

Height = x mm



Gas suppression tank



Rear door cooler



Circulation pump



Cooling distribution unit



Controls cabinet

Next Steps

This MEP design requirement report serves as a basis of design template for a modular eDC to be implemented across the Netherlands and greater Europe. Taking into account the market trends and regulatory restrictions from the preceding report in Work Package 1, this report outlines the importance of a simple (but scalable) design.

The next steps include:

- Finalizing design specifications based on lab findings from Eurofiber. To be further developed in the following milestones.
- Selecting appropriate technologies for Eurofiber's field lab.
- Planning for iterative testing to refine the equipment selections and overall design.

By addressing key challenges for data centres – eg: land scarcity, grid constraints, and future regulatory limitations - this study provides the initial design requirements for implementing efficient, high IT performance edge data centres across Europe.

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