Protection of Machinery Spaces in a Data Center –A Case Study

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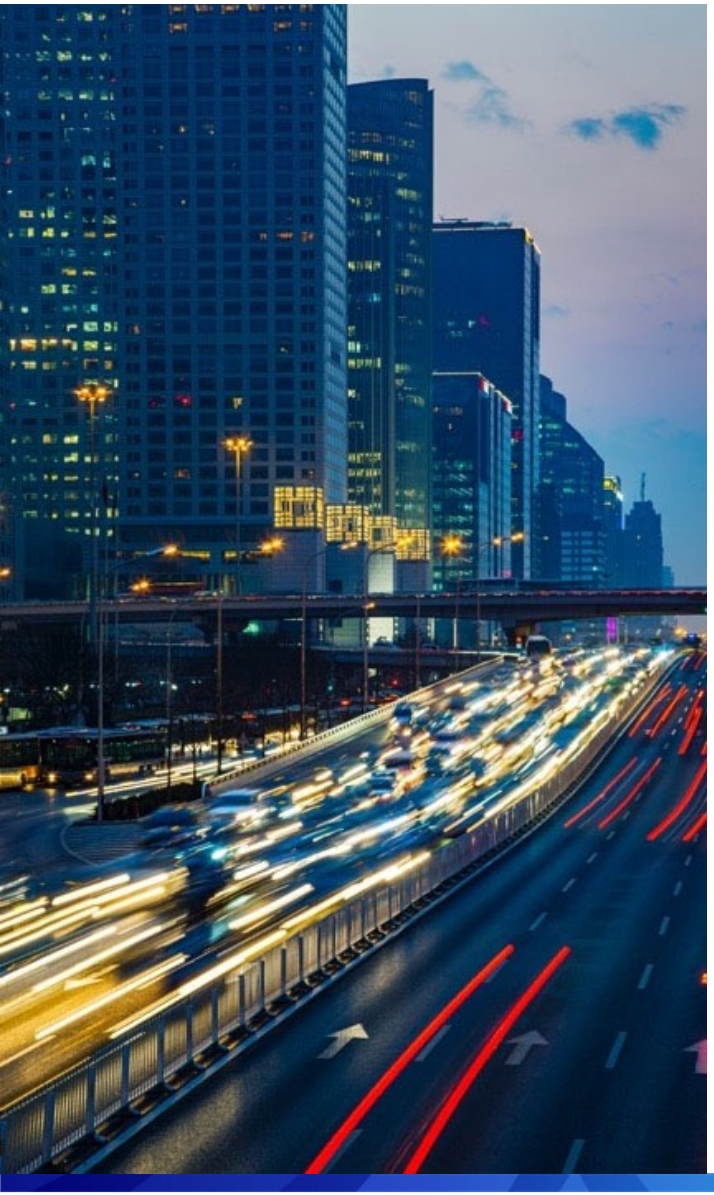
IWMC 2025, Manchester

The power behind **your mission**



Agenda

Johnson Controls

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Background

Data Centre

A data center is a physical facility that houses an organization's critical IT infrastructure, including servers, storage systems, and networking equipment. It's essentially a centralized location for storing, processing, and distributing data and applications. Data centers are vital for business operations, supporting everything from email and file storage to cloud computing and online services.

Data Centre Power Supply Resilience

UPS (Uninterruptible Power Supply):

Function: Provides a clean and continuous power supply to critical equipment during power outages, surges, and other electrical anomalies.

How it works: Contains batteries that instantly kick in when mains power fails, ensuring no interruption to connected devices. Also conditions the power, protecting against voltage fluctuations and noise.

Limitations: UPS batteries have limited runtime (a few minutes to an hour or more), depending on the load and UPS capacity.

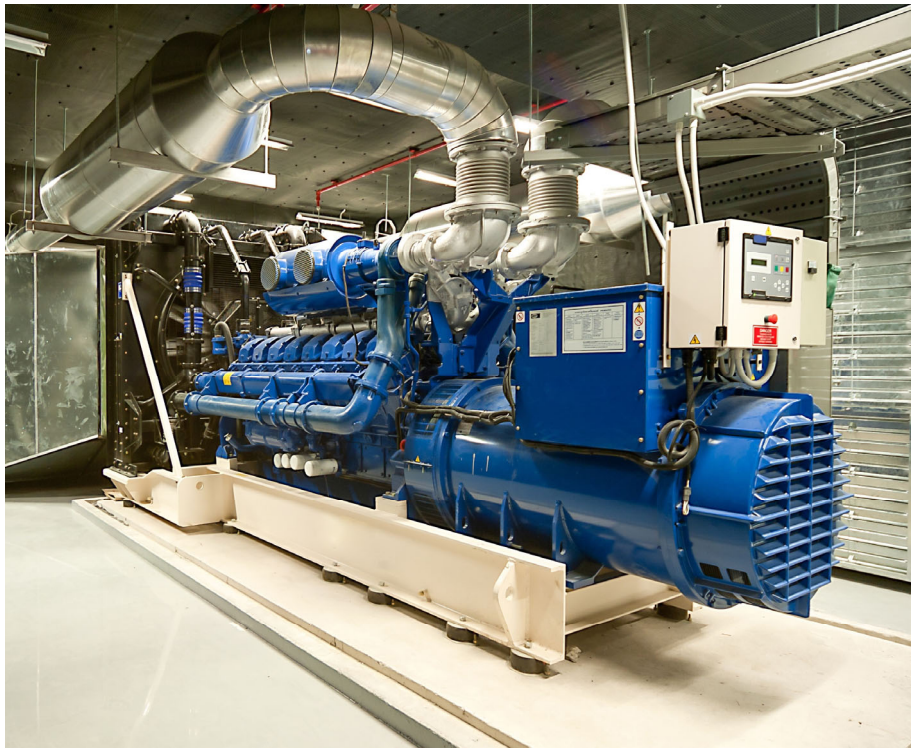
Generator:

Function: Provides long-term backup power for extended outages, typically starting up after the UPS battery runtime is depleted.

How it works: Uses an engine (diesel, natural gas, etc.) to generate electricity, which can then be routed to the connected devices.

Limitations: Generators require a fuel source, may have longer startup times (compared to UPS), and can produce noise and emissions.

Data Centre Power Supply Resilience



A UPS (Uninterruptible Power Supply) and a generator serve different but complementary purposes in providing backup power. A UPS provides immediate, short-term power during outages, protecting against brief interruptions and allowing time for a generator to start up. Generators, typically fueled by diesel offer longer-term power during extended outages.

Best Practice: A UPS is often paired with a generator to provide the most reliable and comprehensive backup power solution. The UPS acts as a buffer during the generator's startup phase and ensures a seamless transition to generator power.

Example: During a power outage, the UPS immediately provides power. If the outage is prolonged, the generator will start, and a transfer switch will automatically switch the load to the generator once it is stable. The UPS then recharges its batteries.

Generator Fire Risk

Enclosure

Class B Flammable Liquids

Pressurised Fuel and/or Lubrication Lines

Hot Surfaces

Not Normally Occupied Spaces

Highly Ventilated Enclosures

Non Air-Tight Construction

Key Concerns

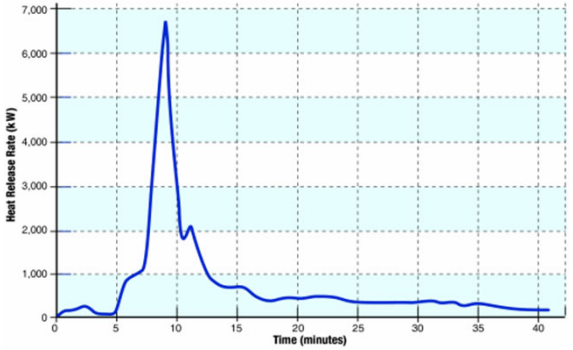
Spray Fires

Pool Fires

Fast Burning Fires

High Heat Release Rates

Large Amounts of Decomposition Products



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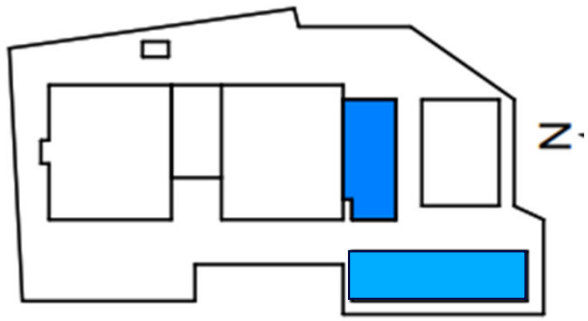
Site Challenges

Project History

- European Date Centre operator
  - 27 Facilities
  - 9 Locations
- South East Location
- Multiple building in UK Estate
- Multiple new campus development

Site 1- Campus

- 54Mw Capacity
- 2 Data Centre Campus
- Centralized Energy center
    - Adjacent packaged Generator pods
- Future Expansion

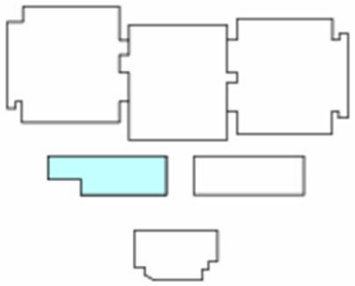


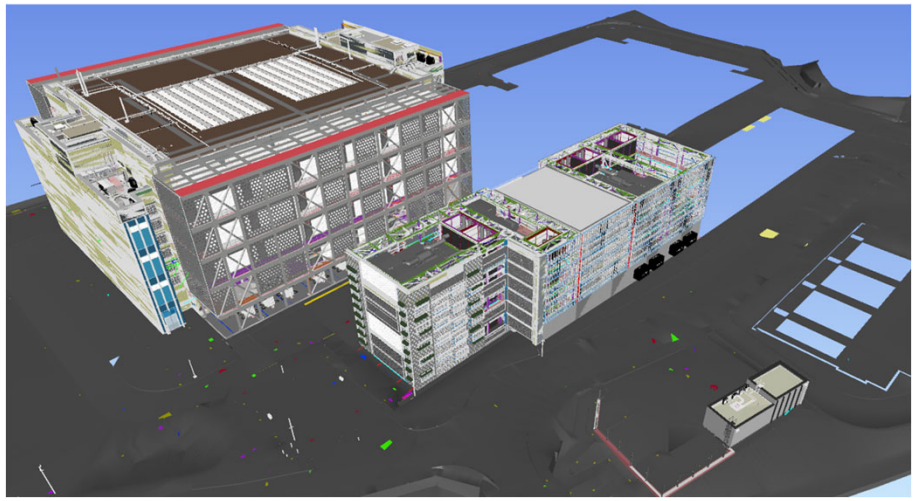
Site 1 – Energy Centre

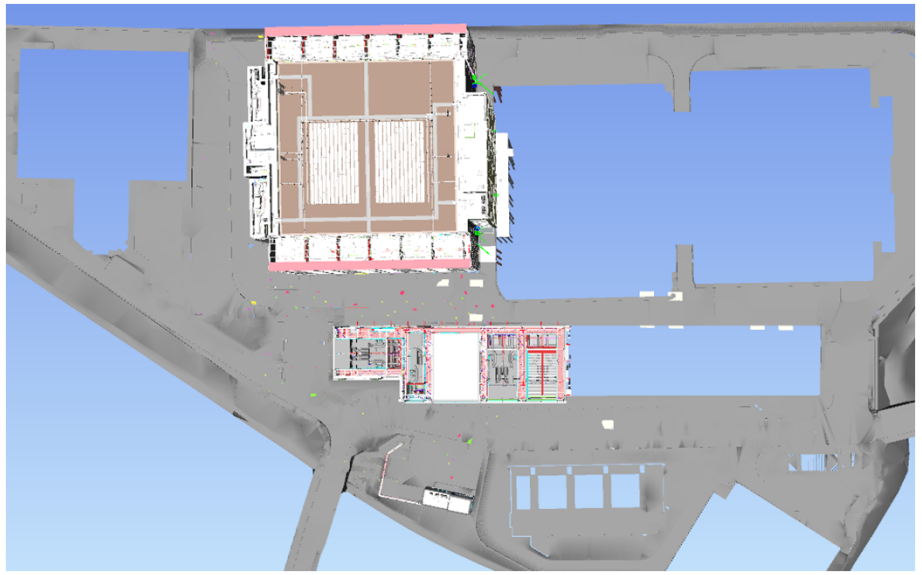
- High level of redundancy and resilience required
    - Independent fire protection system
- Supplying power streams to each building independently
- Multiple risks present in the building called for a range of fire protection solutions:
    - Centralized system
    - FM Base of Design
    - Duty and Standby Water Supplies
    - **Li-ion Battery Risks**
    - Electrical Risks
    - **Generator Risks**

Site 2 - Campus

- 99Mw Capacity
- 56,000m2
- 4 Data Centre Campus
- Dedicated Energy center per Data Centre
    - Remote

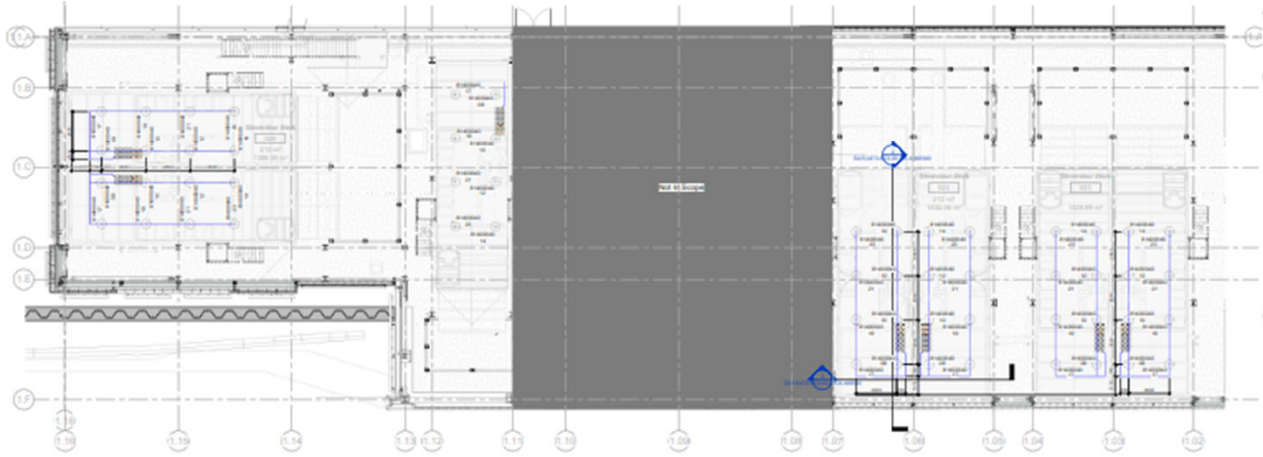


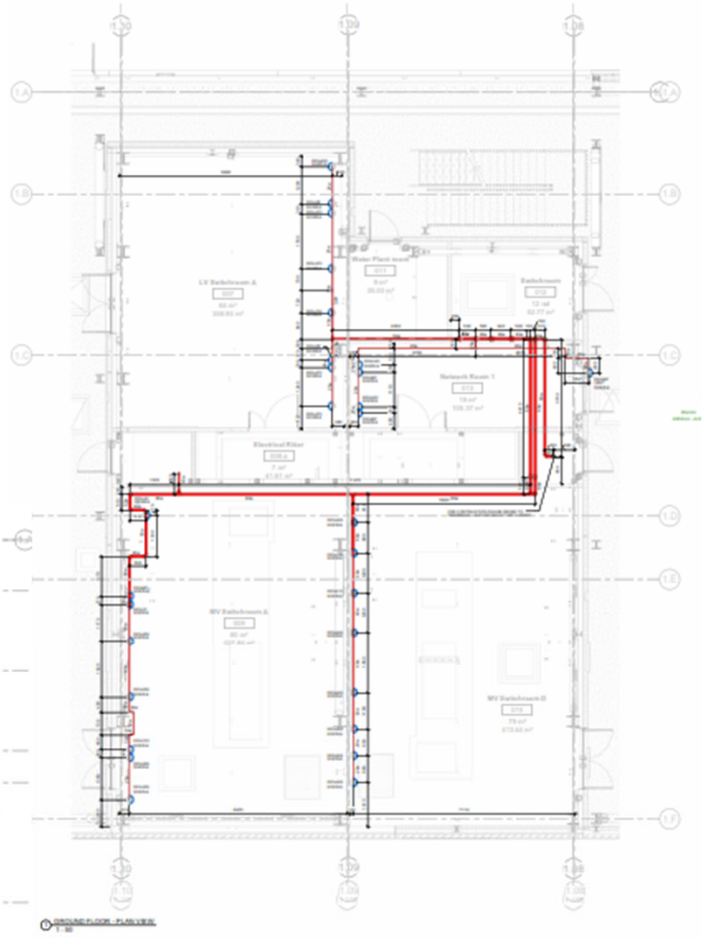




Site 2 – Energy Centre

- Resiliency in the power stream design
- Dedicated power streams to each building independently
- Multiple risks present in the building called for a range of fire protection solutions:
    - No capacity for centralized system
        - Dedicated local protection required
    - FM Base of Design
    - Electrical Risks





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Design Options
Machinery Spaces Protection

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“Machinery Spaces (Definition FM5560 & FMDS 4-2; EN14972)

- Enclosures with; Internal combustion engines, engine test cells without forced ventilation, Oil pumps, Oil tanks, Fuel filters, Indoor transformers vaults, Gear boxes, Drive shafts, Lubrication skids, Hydraulic press pits,, Hydraulic, heat transfer, and lubrication fluids, Pulp & paper industry; tissue embossed folders and log saw Booths, Similar equipment using liquid hydrocarbon fuel
- Enclosures with incidental use or storage of hydrocarbon ignitable liquids (also known as flammable liquids) of not more than two 55 gal (208 L) drums.

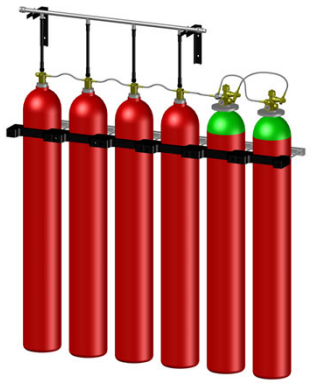
Turbine Enclosures

- Enclosures with combustion turbines & Steam Turbines”

Design Options Machinery Spaces in accordance with FM5560/FM DS 4-2, EN14972-1 and BS8489-1

Standalone
AquaMist FOG Cylinder System (High Pressure)

FOG HP Water & Gas
Cylinder/Container Bank



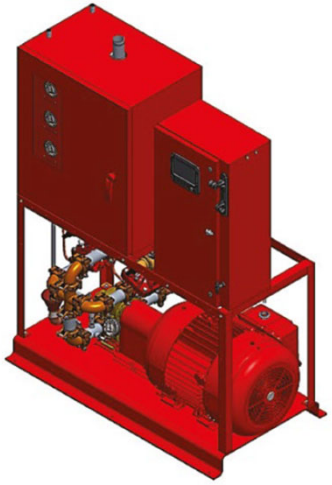
FM Approved
BS8489-1 & EN14972-1
Compliant
Standalone Solution
Modular Design

FOG
HP Nozzles

Stainless Steel
Open Nozzle
Pendent
FM approved
BS8489 & EN14972-1
Compliant

Centralised
AquaMist ULF Pump System (Low Pressure)

ULF Pump Unit
MCC



FM Approved
BS8489-1 & EN14972-1
Compliant

ULF Sectional Valve
DV5A

“Deluge” Type
Electric Trim
FM approved
BS8489-1 & EN14972-1
Compliant

ULF LP Nozzle
AM4

Stainless Steel
Open Nozzle
Pendent
FM approved
BS8489 & EN14972-1
Compliant

FM5560 Approval Standard (EN14972ff) - Standalone

Member of the FM Global Group

Examination Standard for Water Mist Systems

FM5560 Approval Standard (EN14972 series)

- Fire Tests for water mist systems for the protection of;
  - Appendix C: Special hazard machinery spaces.
  - Appendix D: Combustion turbines
- Each with volumes up to, and including 9175 ft^3 (260 m^3)
- (Examination Standard EN14972 parts 9 &15)

AquaMist FOG Nozzles

- 260m^3 Compartment
- 12 Test Scenarios

FM5560 – 260m^3 compartment - Standalone

- Enclosure dimensions of 7.5m x 7.5 m
- 5.0m ceiling height
- Single doorway of 0.8m (w) x 2.0m (h)
- Using Diesel & Heptane Fuels

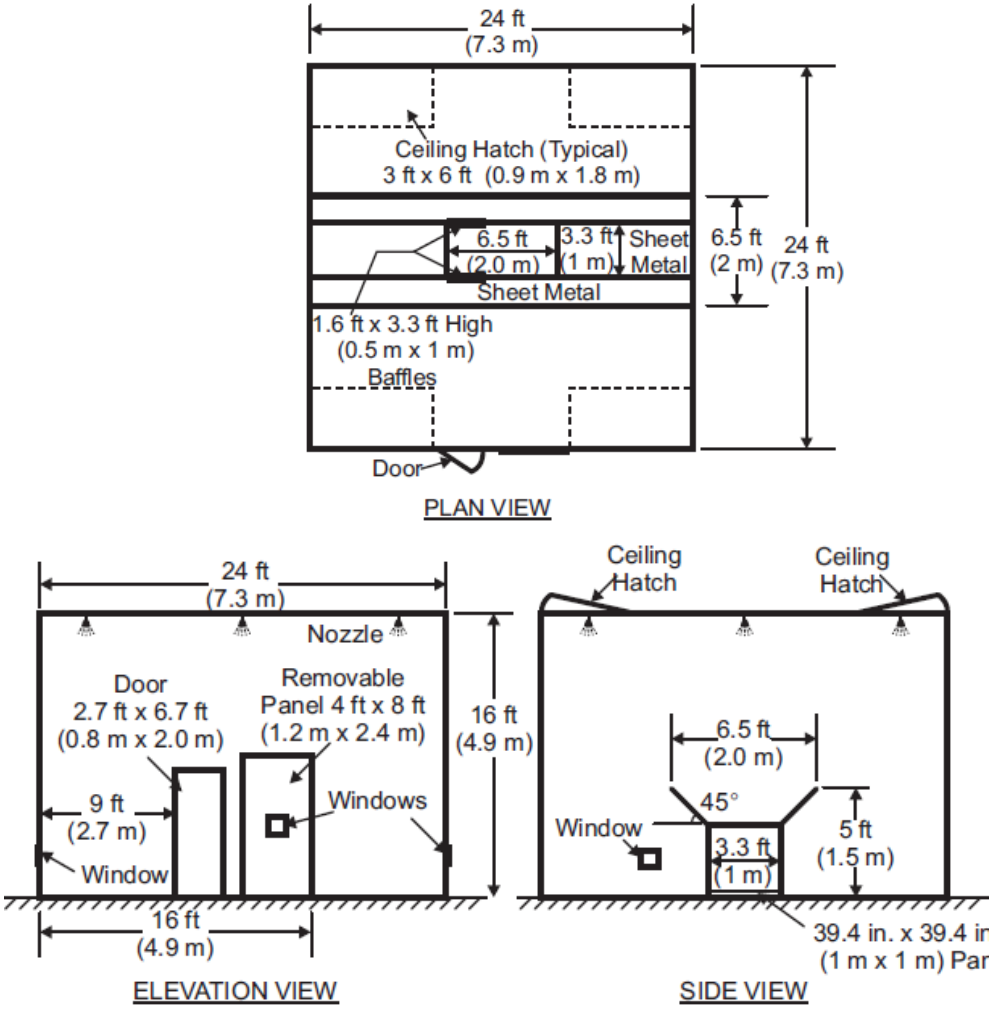
Approval Criteria

- Extinguish fires in all scenarios/tests with no manual intervention

The Agent Supply Shall Be Twice The Time To Extinguish a "Worst-Case" Fire In An Accepted Fire Scenario

or

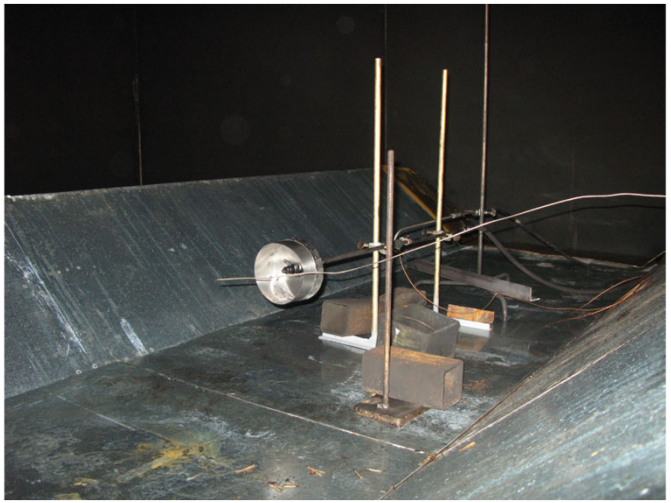
10-Minutes (Whichever is Greater)

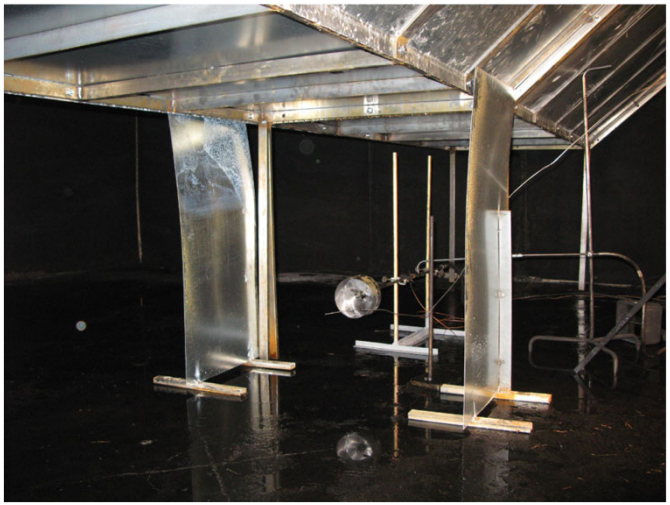


FM5560 – Summary of Testing - Standalone

Test	Description of the fire scenario	Test fuel
1	Unshielded 1 MW Spray Fire (On Top of the Table)	Heptane
2	Shielded 1 MW Spray Fire (Beneath the Table)	Heptane
3	1m^2 Shielded Pool Fire	Heptane
4	Shielded 2 MW Spray Fire (Beneath the Table) – with Limited Natural Ventilation	Heptane
5	Shielded 2 MW Spray Fire (Beneath the Table) – Small Enclosure (50% Volume)	Heptane
6	Unshielded 1 MW Spray Fire (On Top of the Table)	Light diesel oil
7	Shielded 1 MW Spray Fire (Beneath the Table)	Light diesel oil
8	1m^2 Shielded Pool Fire	Light diesel oil
9	Shielded 2 MW Spray Fire (Beneath the Table) – with Limited Natural Ventilation	Light diesel oil
10	Shielded 2 MW Spray Fire (Beneath the Table) – Small Enclosure (50% Volume)	Light diesel oil
11	Saturated Mat (0.1m^2 4.3 litres of Fuel) and Shielded 1 MW Spray Fire (Beneath the Table)	Light diesel oil
12	Large Mat Pool Fire (1.0m^2, Saturated with Fuel)	Light diesel oil

FM5560 – Summary of Testing - Standalone





FM5560 Approval Standard - Centralised

FM Approvals
Member of the FM Global Group

Examination Standard
for
Water Mist Systems

Class Number 5560

FM5560 Approval Standard (EN14972 series)

- Fire Tests for water mist systems for the protection of;

  Appendix C: Special hazard machinery spaces.

  Appendix D: Combustion turbines

- Each with volumes exceeding 9175 ft^3 (260 m^3)
- (Examination standard EN14972 parts 8 & 14)

AM4 Nozzle

1280m^3 Compartment

12 Test Scenarios

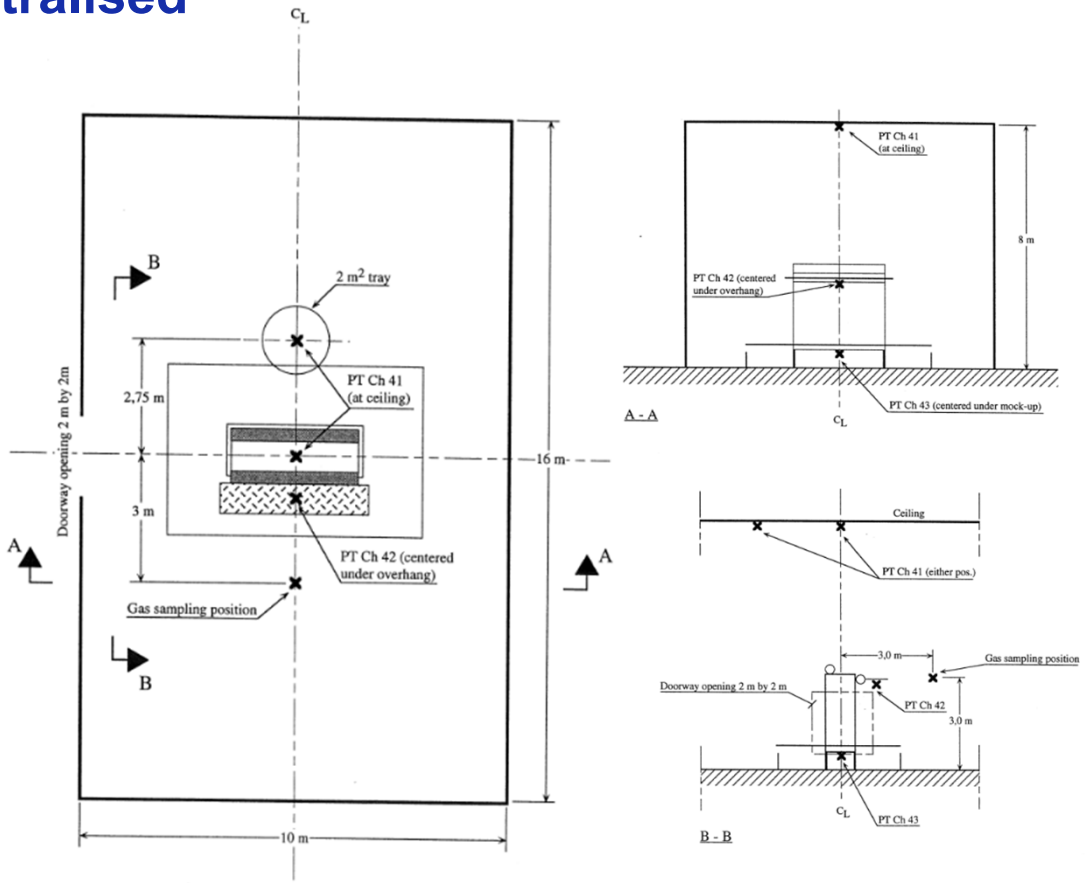
FM5560 – 1280m3 compartment - Centralised

Enclosure dimensions of 16.0m x 10.0 m

8.0m ceiling height

Single doorway of 2.0m (w) x 2.0m (h)

Using Diesel & Heptane Fuels



Approval Criteria

- Extinguish fires in all scenarios/tests with no manual intervention

FM5560 – Summary of Testing - Centralised

Test	Description of the fire scenario	Test fuel	Estimated HRR (MW)
1	Low-pressure, horizontal spray on top of the simulated engine.	Light diesel oil	6.6 MW
2	Low-pressure, spray on top of the simulated engine, centred, angled upwards 45 degrees	Light diesel oil	6.6 MW
3	Low-pressure, concealed horizontal spray on the side of the simulated engine.	Light diesel oil	6.6 MW
4	Combination of the worst spray fire (from tests 1-3), with fires in trays ($4m^2$) under the engine and ($3m^2$) on top of the engine	Light diesel oil	6.6 MW
5	Horizontal high-pressure spray, on top of the simulated engine.	Light diesel oil	15.8 MW
6	Low-pressure, low-flow, concealed horizontal spray on the side of the engine.	Light diesel oil	2.0 MW
7	Square $0.5m^2$ tray on top of the solid bilge floor plate, under a solid overhang	Heptane	1.1 MW
8	Flowing fire (0.25 kg/s) (15 kg/min) from the $3m^2$ tray, on top of the engine, down into a square $4m^2$ tray, centred under the engine.	Heptane	1.3 MW
9	Class A wood crib in a circular $2m^2$ tray, positioned 750mm above the floor, with 30 seconds pre-burn.	Heptane	28.4 MW
10	Repeat of “Test 9” without the wood crib	Heptane	7.4 MW
11	Low-pressure, low-flow, horizontal spray on top of the simulated engine, directed against a heated steel plate.	Heptane	1.2 MW
12	Square 4m2 tray, centred under the simulated engine	Light diesel oil	5.3 MW

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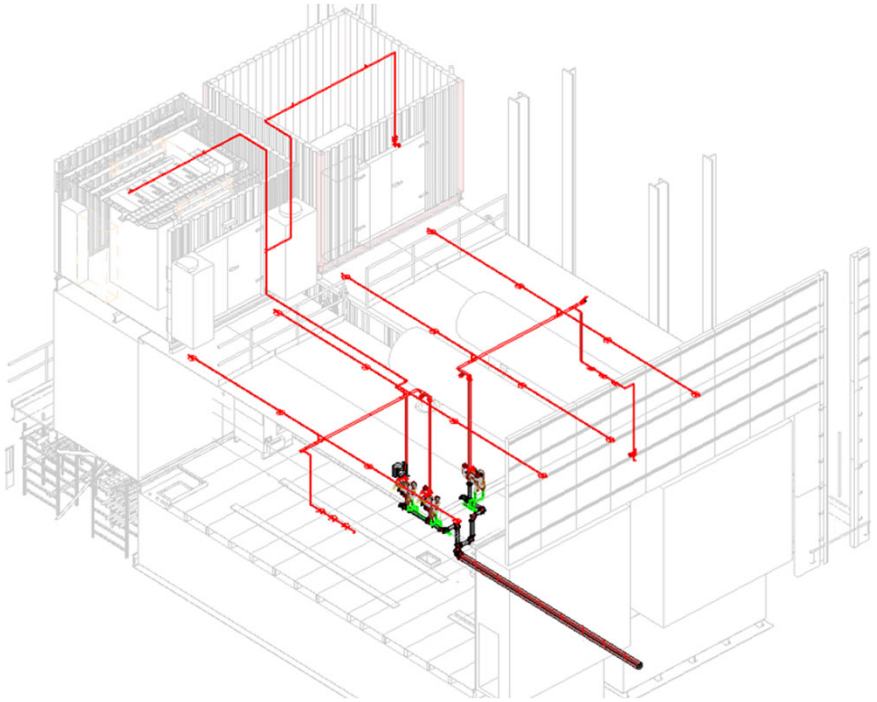
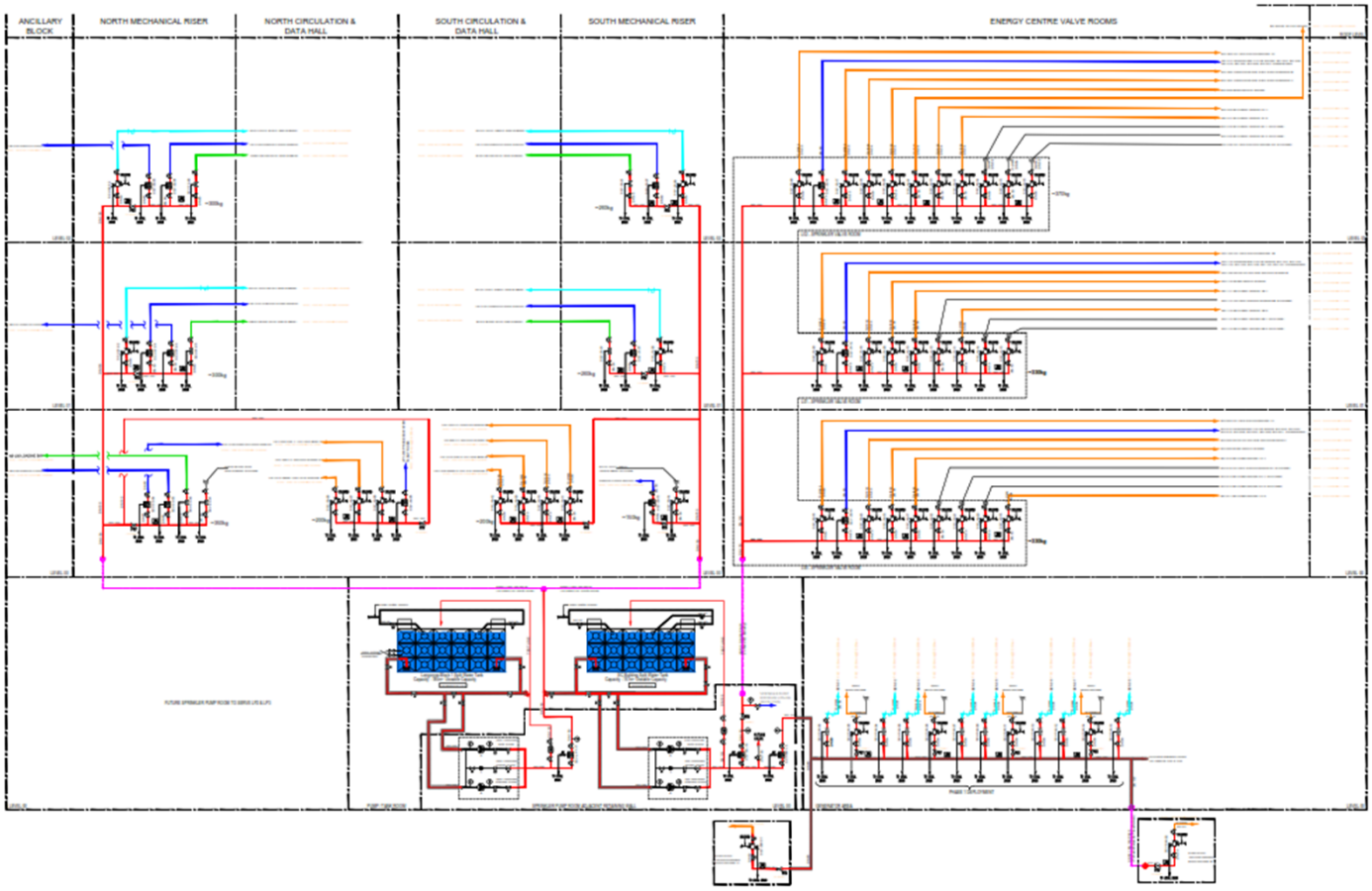
Case Study Solutions for Machinery Spaces

Site 1 – Solution

- Centralized FM Approved Hybrid Sprinkler-Watermist System
  - FM Base of Design
  - Duty and Standby Water Supplies
  - Li-ion Battery Risks - Sprinkler
  - Electrical Risks - Sprinkler
  - Generator Risks – Watermist
    - Simultaneously generator protection possible

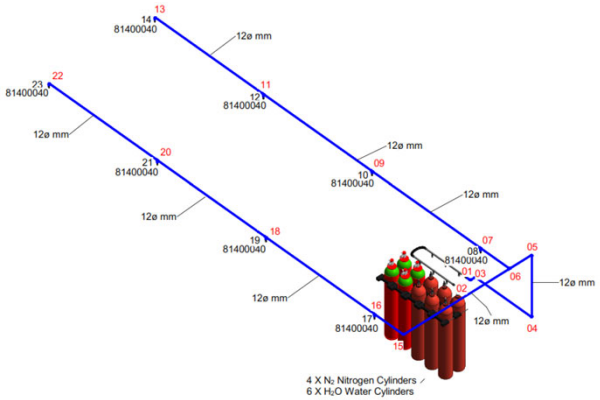


Site 1 – Solution - P&ID



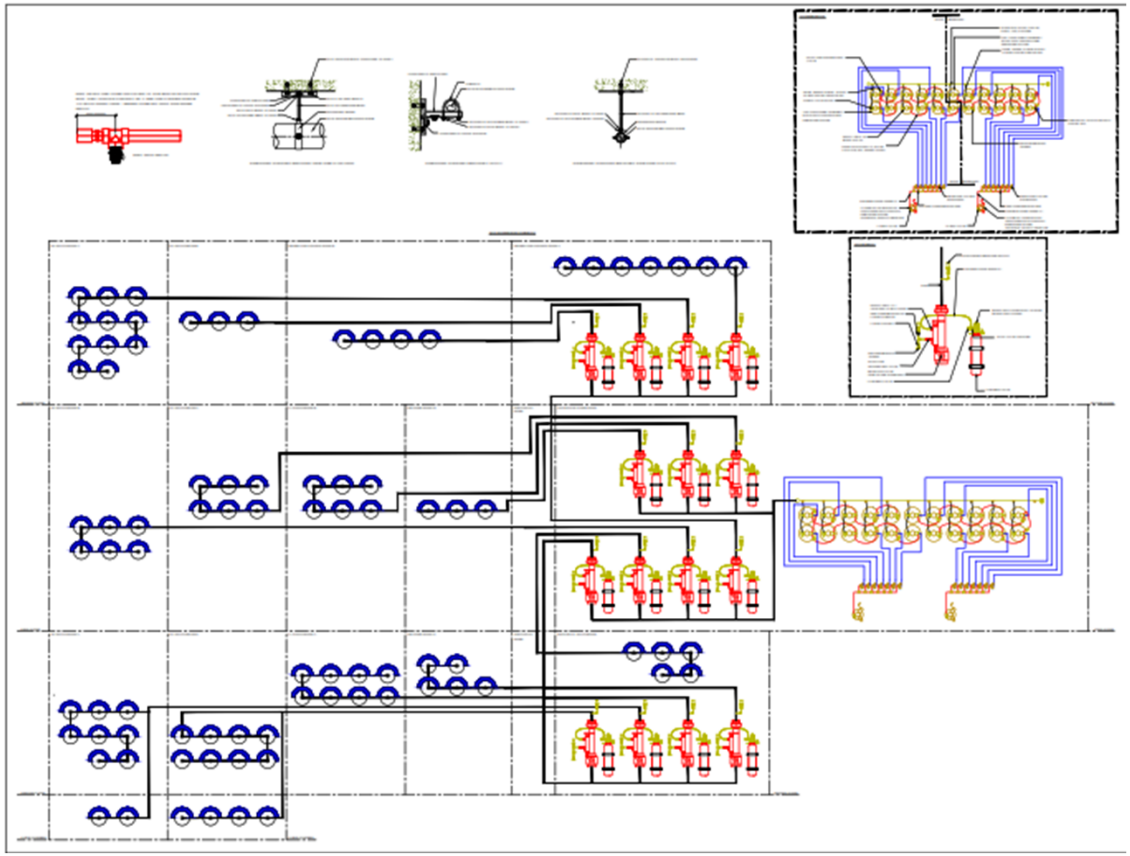
Site 2 – Solution

- Standalone protection to each risk
  - FM Base of Design
  - Electrical Risks – Gas Suppression
  - Generator Risks - Watermist



3D - Ground Floor Typical Watermist
4 Isometric View

Site 2 – Solution– P&ID



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Summary

Thankyou

EA-RS
Fire Engineering

Machinery Spaces Watermist System
AquaMist FOG System (HP) – FM5560 Appendix C&D (MS <= 260m³)

Machinery Spaces Watermist System
AquaMist ULF System (LP) – FM5560 Annex E&F (MS > 260m³)

Summary

- Multiple factors over and above fire risk impact the selection of fire suppression solutions:
    - Location
    - Space
    - Adjacent risk
    - Approval
    - Resiliency
- **Watermist is a viable and reliable solution for generator/Machinery Spaces protection**
- **Watermist system can be integrated into Hybrid Solutions with traditional sprinklers without compromising compliance**
- **To get an FM approval FM fire tests and FM component testing must be passed!**
  This ensures rigidly tested Watermist Systems and their acceptance by insurance bodies and AHJs. The manufacture's DIOM is an essential part of a Watermist System and must be considered.

AquaMist®

Thank You!

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Water Mist & Special Hazard Systems

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