Water Mist Protects the Natural History Museum in Copenhagen

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Natural History Museum of Denmark

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- Project description
- Fire protection concept and challenges
- Evaluation process including fire test basis
- System implementation
- Conclusion

Natural History Museum of Denmark


Source: University of Copenhagen


Source: blooloop

Project Description

- One of the largest museum constructions in Denmark located in the heart of Copenhagen
- 14 million natural history objects collected worldwide over 400 years
- Natural History Museum covers 30.000 m^2 of which 50% is located in existing historic buildings
- New exhibition areas are located underground
- Wide open spaces and complex architecture in the underground exhibition area required compensation by an automatic fire fighting system to prevent fire propagation and to secure safe escape conditions
- New museum is expected to be completed 2023

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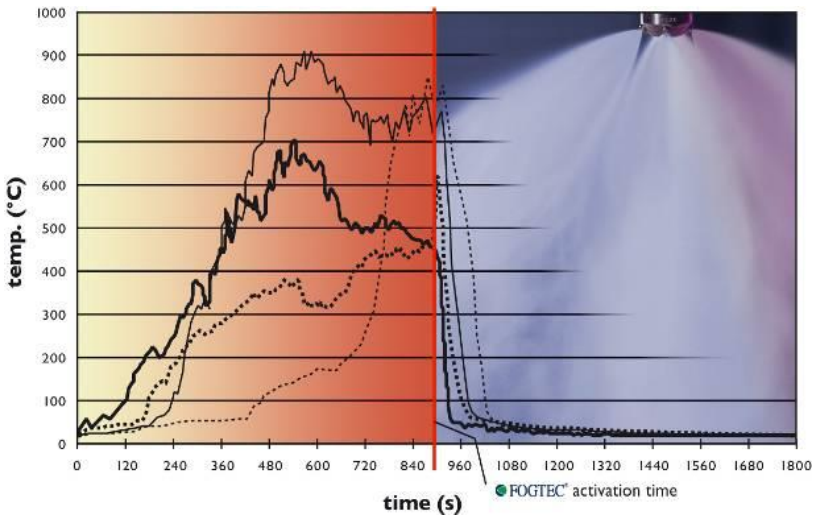

- To fulfil actual fire regulations after global refurbishment and extension, the building had to be retrofitted with an active fire fighting system

- Water mist technology offers high cooling ability and partly reduces smoke spread, thus creates tenable conditions for evacuation and access to fire services
- Water damages and museum operation interruptions are reduced to a minimum
- Technology 100% full scale fire tested for each application including public spaces, exhibition areas and exhibits magazines
- Eco-friendly and sustainable technology with long life cycle due to corrosion resistant stainless steel components

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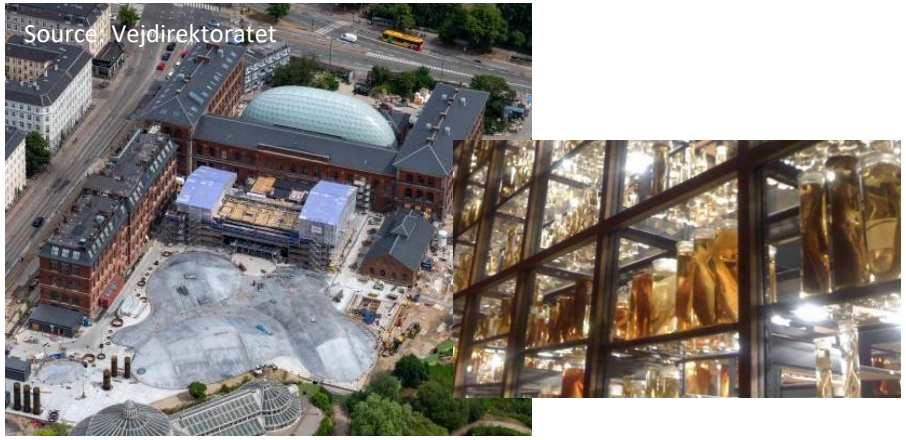
Source: Lundgaard &Tranberg Architects



Source: Vejdirektoratet

Protection Concept

- Protection of exhibition areas and escape routes applying a VdS certified system based on VdS 3883 fire test protocols

Project Challenges

- Exhibition areas with greater heights and connections between floors via stair cases
- Magazines storing exhibits in alcohol and formalin filled vessels

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- Fire risk assessment and evaluation of the protection concept based on full scale fire test results in accordance to EN 14972 respectively VdS 3883

Evaluation Process

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 14972-1

December 2020

ICS 13.220.20

Supersedes CEN/TS 14972:2011

English Version

Fixed firefighting systems - Water mist systems - Part 1: Design, installation, inspection and maintenance

Installations fixes de lutte contre l'incendie - Systèmes à brouillard d'eau - Partie 1 : Conception, installation, inspection et maintenance

Ortsfeste Brandbekämpfungsanlagen - Feinsprüh-Löschanlagen - Teil 1: Planung, Einbau, Inspektion und Wartung

This European Standard was approved by CEN on 11 October 2020.

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 14972-1:2020 E

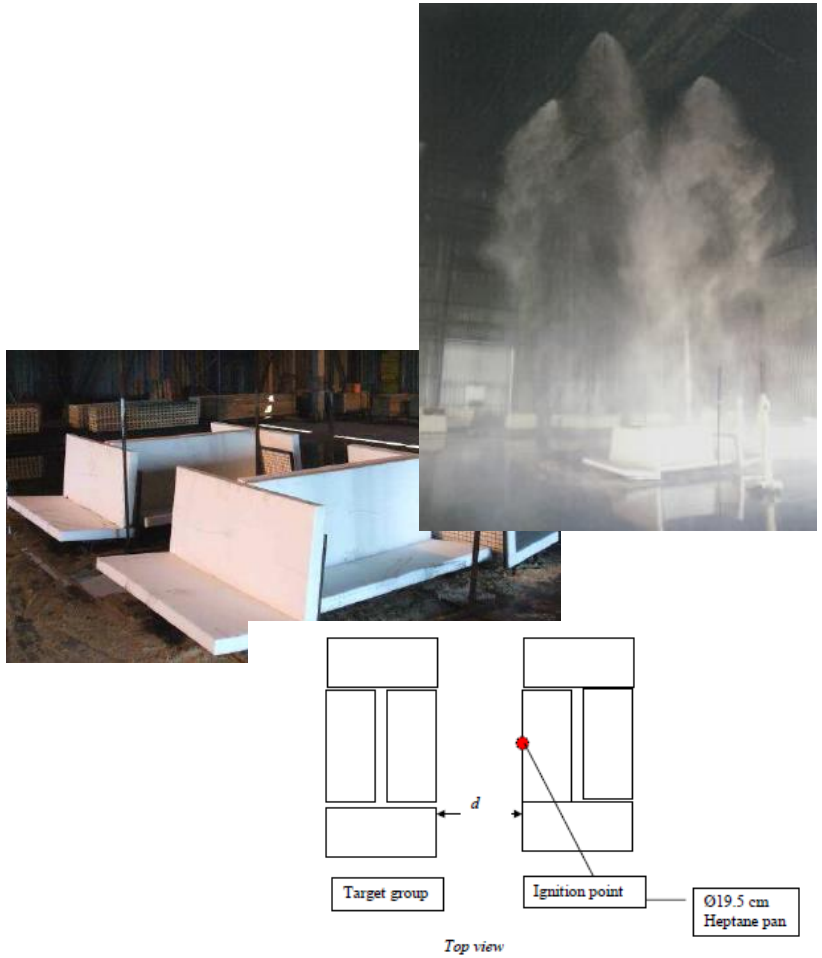
IFAB

DBI

Fire Test Validation

- Evaluation process conducted by accredited fire institutes and laboratories
- Full scale fire test scenarios developed in conjunction with independent fire test laboratories based on EN 14972 standards
- Fire tests were defined with standardized fire loads and ambient conditions reflecting the reality as close as possible regarding

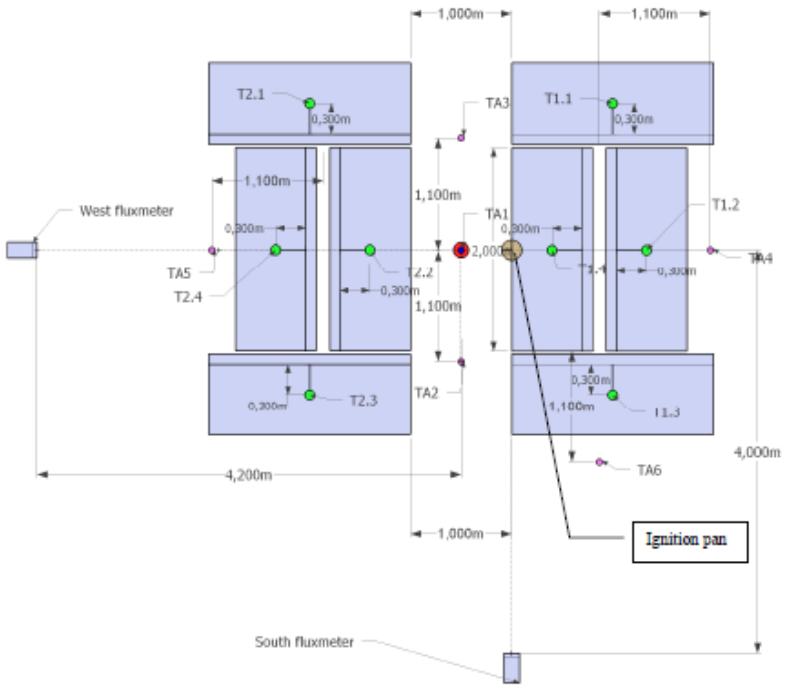
Fire Tests for Greater Heights



Fire Test Scenario

- Test hall of 30 m x 20 m floor area with open perimeter ceiling at 12 m height
- Natural ventilation conditions / No enclosure effect
- Fuel package adapted from IMO A800, respectively EN 14972-3, with 2 groups of 4 sofas each made of polyether foam
- 50 cl Heptane as igniter, being placed under the centre sofa
- Fire tests under one and between four nozzles
- Automatic glass bulb water mist nozzles
- Fire test duration 30 minutes

Fire Tests for Greater Heights



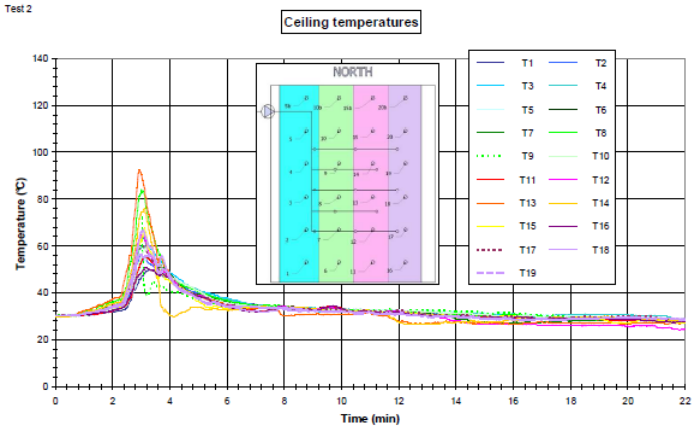
Measurements

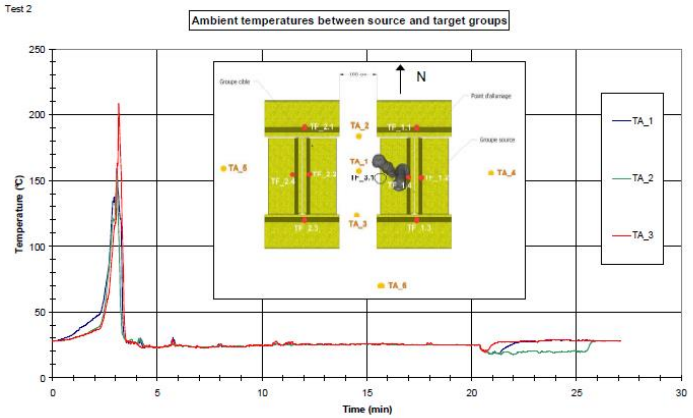
- Temperature at sofas (T1.1 to T1.4 and T2.1 to T2.4)
- Ambient temperature at 1,5 m height above floor (TA1 to TA6)
- Ceiling temperatures
- Heat flux

Evaluation Criteria

- Temperature reduction at ceiling and in the vicinity of the fire
- Reduction of heat radiation
- Fire control and suppression to avoid fire propagation to the target sofas

Fire Tests for Greater Heights

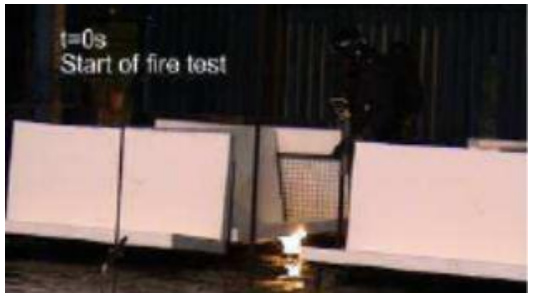


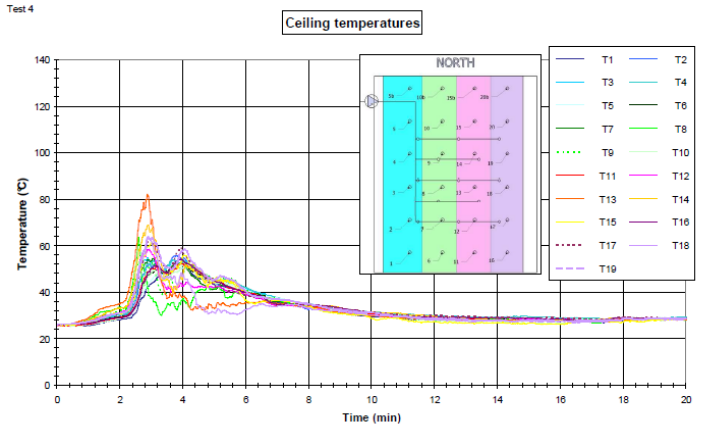


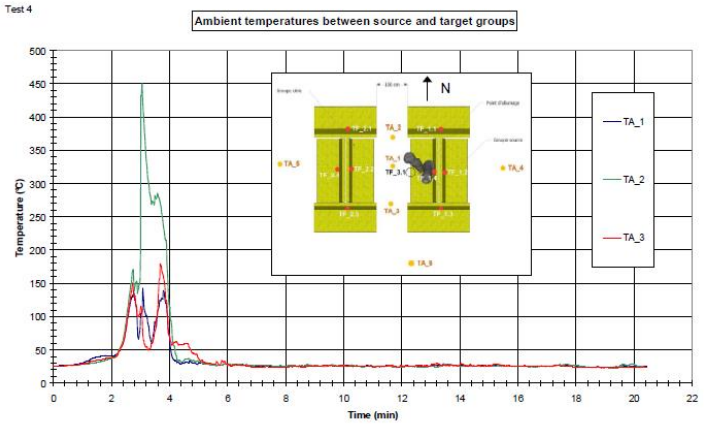
Fire Test Under 4 Nozzles

- Activation of 4 nozzles within 2 min 50 sec
- Rapid temperature and heat radiation reduction
- Fire is controlled / No propagation to target sofas

Fire Tests for Greater Heights







Fire Test Under 1 Nozzle

- Activation of 3 nozzles within 2 min 50 sec
- Rapid temperature and heat radiation reduction
- Fire is controlled / No propagation to target sofas

Fire Tests for Flammable Liquid Stores

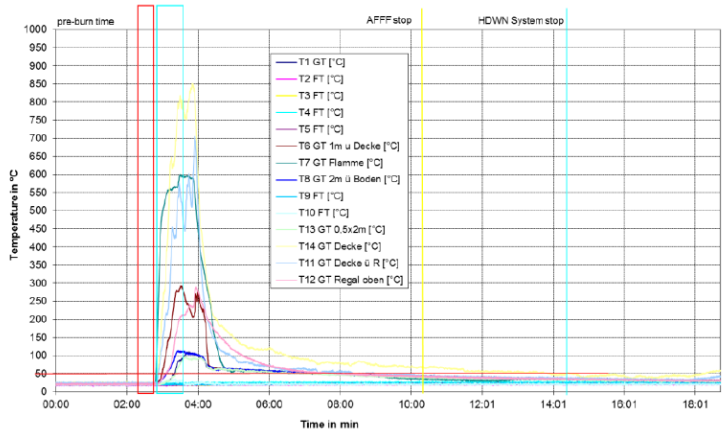
Fire Test Scenario

- Test hall of 15 m x 10 m floor area with ceiling at 5,5 m height
- Natural ventilation conditions / No enclosure effect
- 2 m^2 and 4 m^2 open and hidden n-Heptane pools fires and flowing fire as combination of both pools
- Open water mist nozzles

Evaluation Criteria

- Temperature reduction in the vicinity of the fire below 100°C within 3 minutes of water mist discharge
- Extinguishment within 15 minutes

Fire Tests for Flammable Liquid Stores



Fire Tests

- 2 m^2 and 4 m^2 open n-Heptane pools fires extinguishes within 3 minutes
- 2 m^2 covered n-Heptane pools fire extinguishes within 4 minutes
- Flowing fire extinguished within 5 minutes and 30 seconds
- Rapid temperature control

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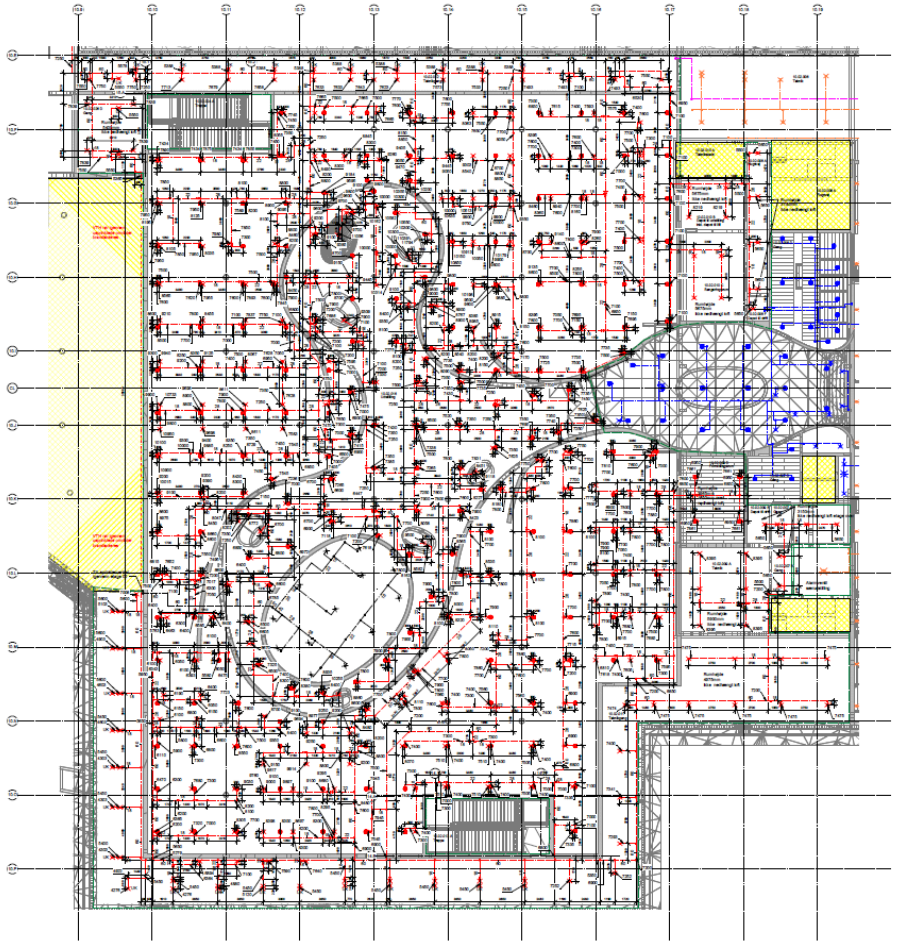
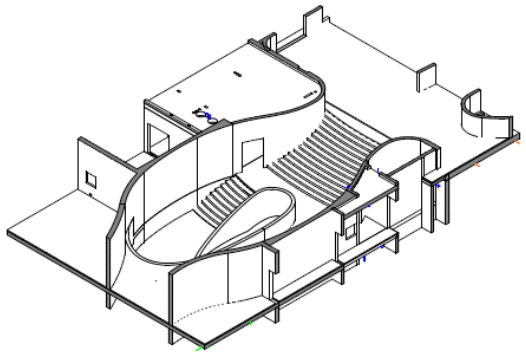


Transfer of Fire Test Results - Exhibition Areas

- Fire risk assessment determined the need of protection of all exhibition areas
- Building structure connects several floors without fire partitions
- An automatic system with glass bulb activated nozzles has been applied
- Pre-action system to avoid water being present in the exhibition areas
- Final inspection by the Danish fire institute DBI



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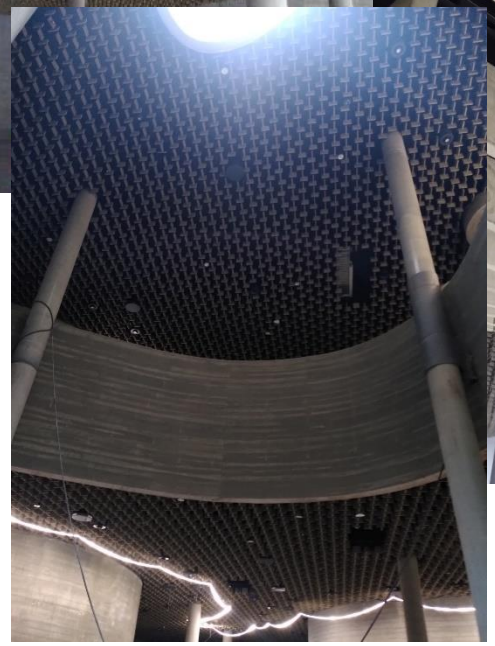
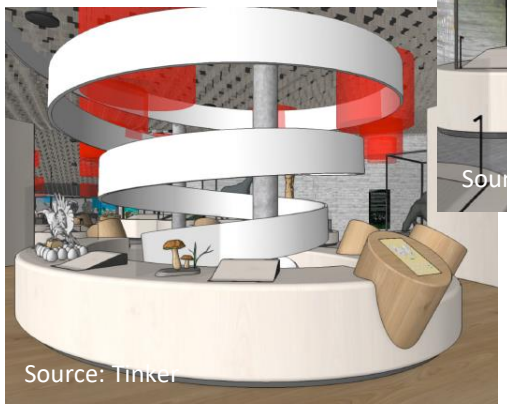
Transfer of Fire Test Results - Exhibition Areas

- Nozzle spray obstructions by ceiling panels and exhibits have to be taken care of / Adjustment of nozzle positioning





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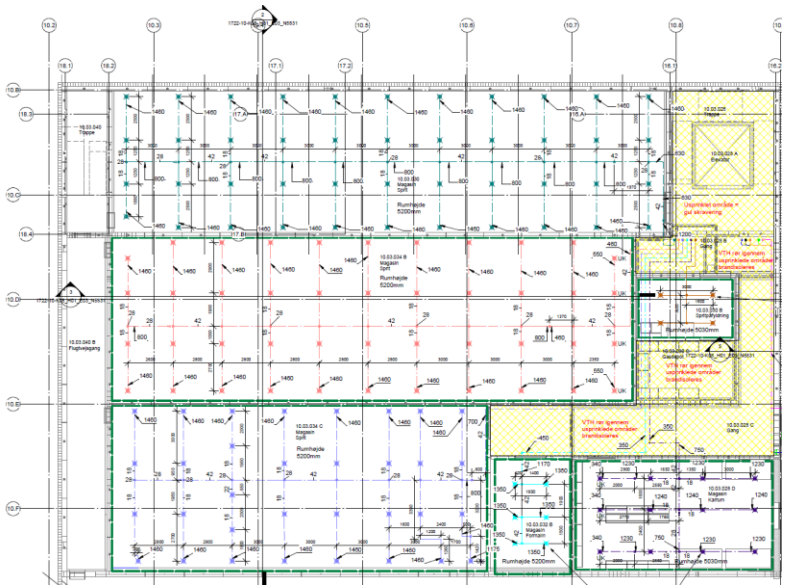
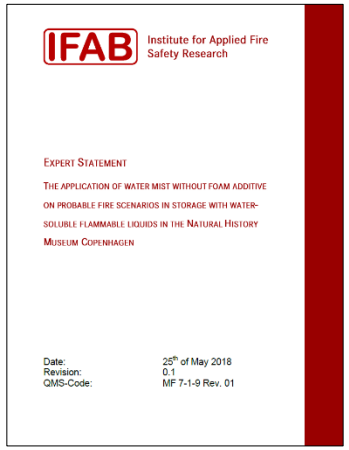


Transfer of Fire Test Results - Exhibits Storage Magazines

- Fire risk assessment determined the need of protection of all underground storage areas containing exhibits in alcohol and formalin
- A deluge system with open nozzles has been applied to account for a rapid system activation in the entire enclosure by the smoke detection system
- System design evaluated by a fire test laboratory based on full scale fire test results
- Final inspection by the Danish fire institute DBI


IFAB Institute for Applied Fire Safety Research

EXPERT STATEMENT

THE APPLICATION OF WATER MIST WITHOUT FOAM ADDITIVE ON PROBABLE FIRE SCENARIOS IN STORAGE WITH WATER-SOLUBLE FLAMMABLE LIQUIDS IN THE NATURAL HISTORY MUSEUM COPENHAGEN

Date: 25th of May 2018
Revision: 0.1
QMS-Code: MF 7-1-9 Rev. 01

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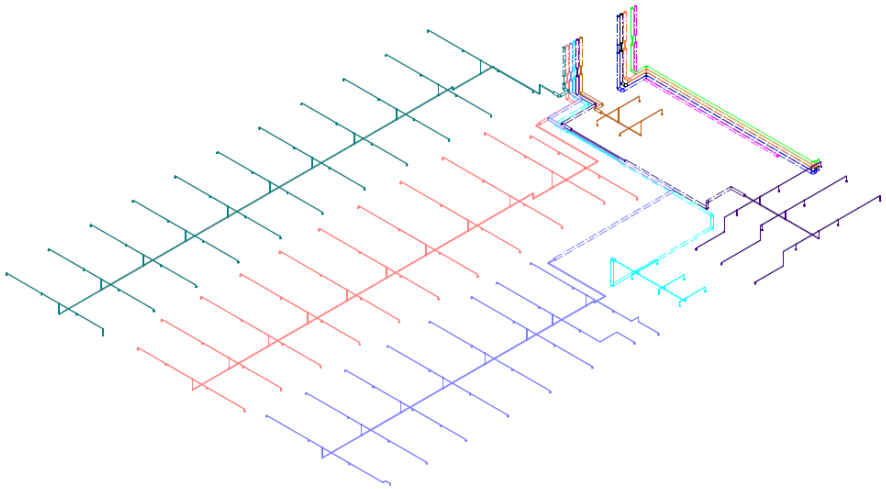

Design and Installation

- Entire project planned in 3D
- Small bore pipework for installation
- Press fittings assure quick installation and highest reliability
- Operational area for all automatic nozzle areas 216 m^2
- Exhibition area subdivided in several pre-action zones with separate pre-action section valves
- Complete activation of each storage magazine via deluge section valves

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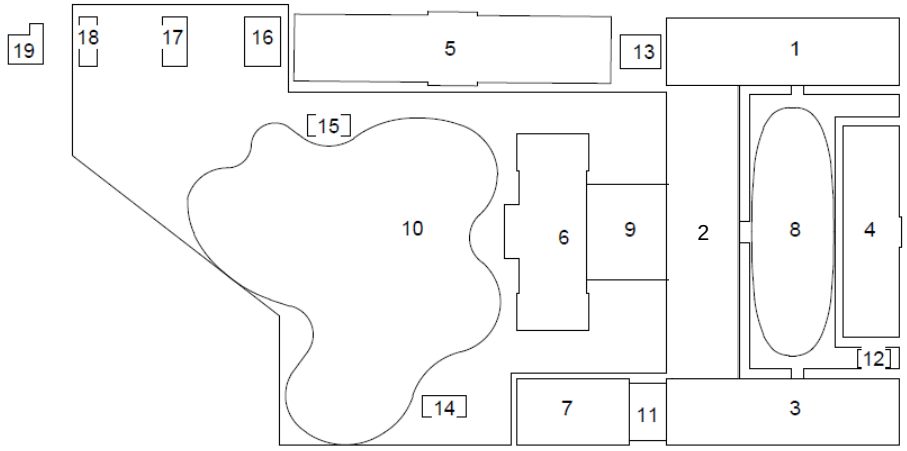

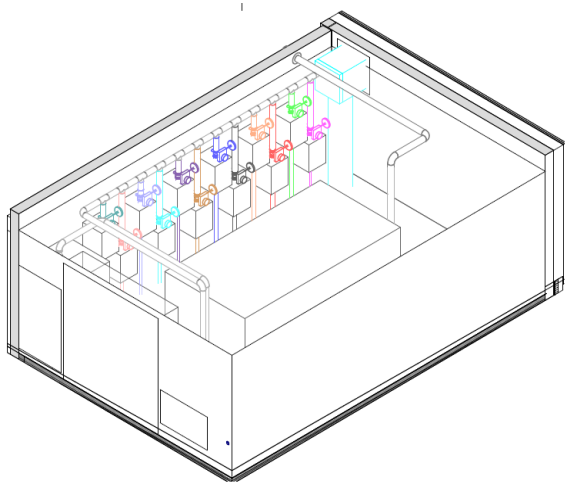

Pump Room

- Small pump room (16) with only 30 m^2
- All section valves centralized in the pump room for easy maintenance
- Pump unit with 6+1 x 120 l/min flow rate at 120 bar incl. redundant pump
- Water tank (19) with 44 m^3 volume secures minimum 60 minutes operating time of the water mist system
- Water supply from the tank to the high pressure pump unit via redundant booster pumps and filtration units

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Conclusion

- Water mist has been identified as the best suited agent for fire protection in the museum due to
  - Enhanced cooling eases evacuation by providing safe escape routes and creates safer conditions for fire services
  - Minimized water usage reduces consequential damages and museum operation interruptions in case of system activation
  - Small bore pipework, compact system components and small water storage requirements ease water mist system integration

Thank You for Your Attention

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