

Transformer Substation Protection in Dubai with High Pressure Water Mist

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Water Mist for Transformer Fire Protection



- Water mist technology has been used as alternative to other water spray systems for transformer fire protection since 20 years
- Applications can be found in infrastructure projects, power generation and other industries
- Water mist can compensate missing constructional fire protection requirements and offers installation flexibility, particularly for retrofits in existing transformer sub-stations
- Systems are tested and certified e.g. by VdS
- Environmental conditions, particularly ventilation conditions, have to be taken into account



Large Scale Infrastructure Projects



- Infrastructure projects constantly increase in size
 - Due to the growth of the mega cities, power grid networks are under refurbishment or extension and require up to date fire protection measures
 - Water mist is identified as good solution in many of these refurbishment and extension projects to protect cable tunnels and transformer sub-stations
 - With growing power transmission networks, transformer sizes are growing as well and exceed the coverage of current water mist system certifications and approvals
- ➔ Specific fire tests have to be conducted to reflect the dimensions and fire scenarios of such transformers

Transformer Sub-Stations in Dubai



- Dubai Electricity & Water Authority (DEWA) operates Dubai's power and water supply network, ensuring supply to 670.000 customers with a power supply of around 10 MW
- With Dubai's rapid growth and related increase in power demand, DEWA extends its power network with additional transformer sub-stations
- It is DEWA's objective to further improve the availability and efficiency of the electric supply to reduce losses in power transmission and distribution networks
- High pressure water mist technology has been identified by DEWA as most suited to protect new large scale transformers in their 132 kV and 400 kV sub-stations

Transformer Sub-Stations in Dubai



- The fire protection concept has been developed in close co-operation with DEWA and the fire test laboratory IFAB based on the fire test protocol for transformer protection developed by VdS
- Since the VdS fire tests were conducted with a smaller transformer size than the ones at DEWA, additional full scale fire tests with a representative mock-up had to be conducted
- The water mist system performance had to be full scale fire tested following the requirements of NFPA 750 and CEN TS 14972 standards
- The fire tests have been conducted by IFAB as ISO 17025 accredited fire test laboratory in the fire test facilities of MPA Dresden
- The fire tests results have been assessed by MPA and TÜV

Fire Tests for Large Transformers



Fire Test Arrangement

- Transformer mock-up size (8,4 m x 5,7 m with 5,4 m height)
- Surrounding walls (10,4 m x 8,2 m with 7,5 m height) with open top
- Front wall with > 60% opening grade
- Realistic ventilation conditions by two fans to provide air velocity of 4 to 5 m/s around the transformer mock-up
- High pressure pump unit operating at 120 bar



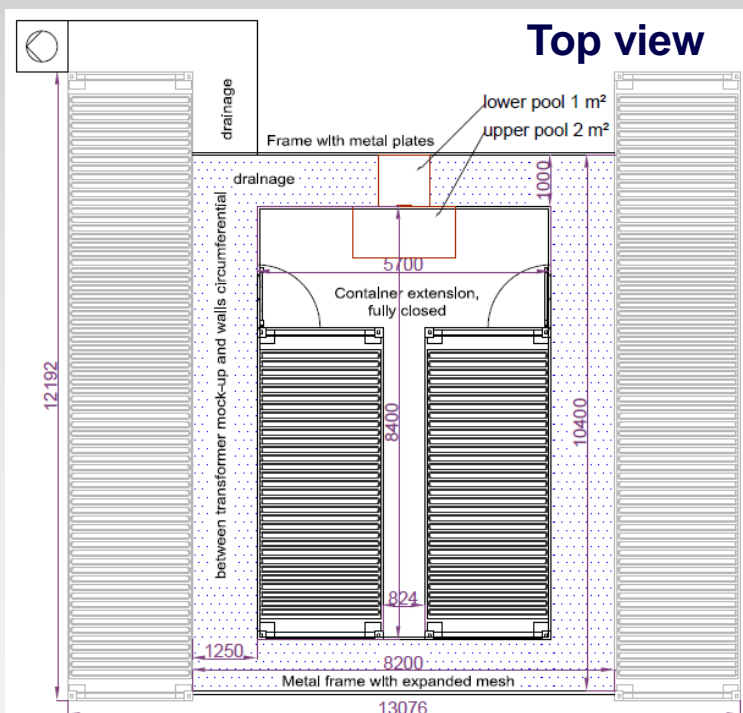
Fire Test Duration

- 30 minutes after activation of the water mist System (15 minutes water mist discharge)

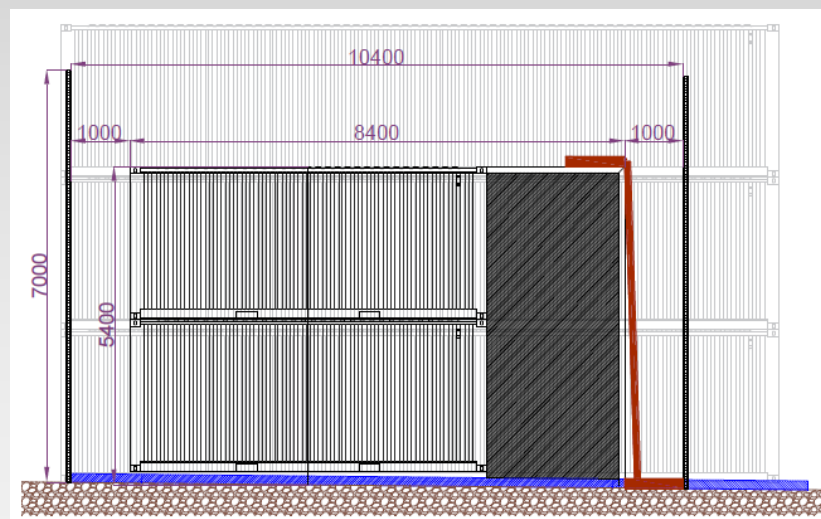
Fire Tests for Large Transformers

Water Mist System Arrangement

- Nozzle positioning as object protection system along the walls in different levels around the transformer mock-up to minimize interference for service and maintenance work on the transformer



Side view



Fire Tests for Large Transformers

Fire Test Scenarios

- Fire scenario 1** **Upper pool fire (pool 2 m²)**
Representing a spillage of transformer oil from the oil container to the top of the transformer
(HRR ~ 4 MW)
- Fire scenario 2** **Lower pool fire (pool 1 m²)**
Representing a spillage of transformer oil onto the grit soil underneath the transformer
(HRR ~ 2 MW)
- Fire scenario 3** **Flowing fire (upper + lower pool + trench)**
Representing a top transformer oil spillage spreading to grit soil underneath the transformer
(HRR ~ 10 MW)

Fire Tests for Large Transformers

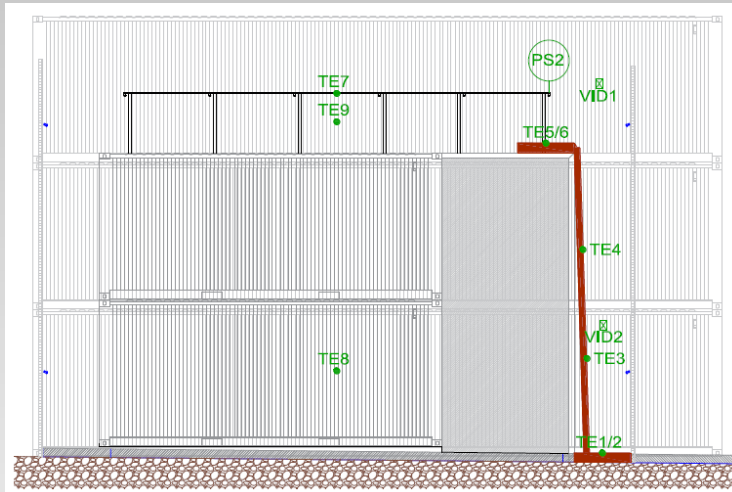


Fire Load Specifications

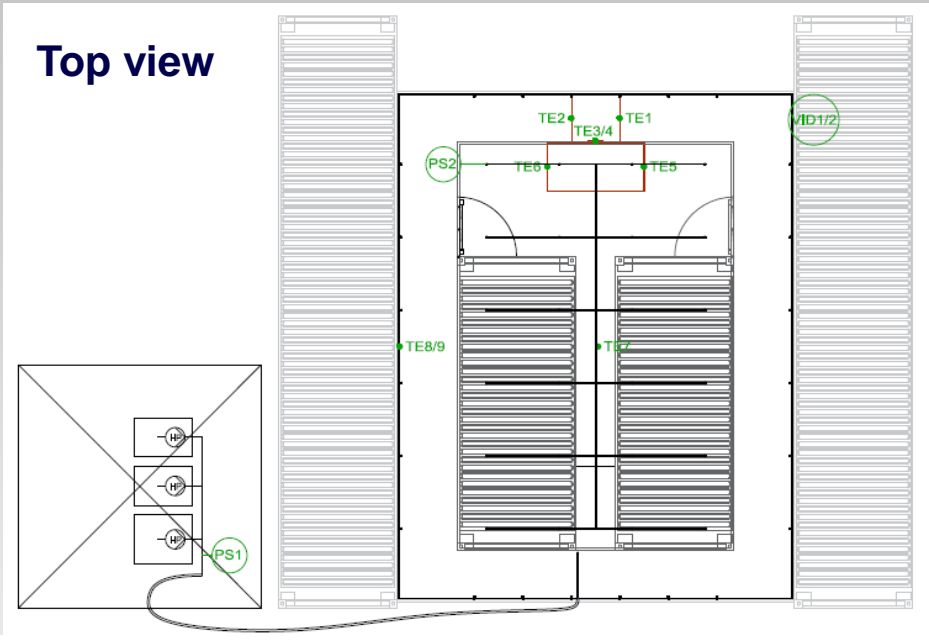
- Diesel oil (Flash point >55 °C; Ignition point >250 °C; Heat value 37 MJ/l; Density 0,86 kg/l)
- Ignition by 1 l of n-Heptane (Flash point - 7 °C; Ignition point - 215 °C; Heat value 32 MJ/l; Density 0,71 kg/l)
- Lower pool 1 m² placed on the ground beside the mock-up (1,0 m x 1,0 m with 0,15 m height)
- Upper pool 2 m² placed on top of the mock-up at the transformer edge (2,0 m x 1,0 m with 0,15 m height)
- Trench mounted at the upper pool and leading to the lower pool (5,5 m x 0,4 m width with a rim of 0,1 m)

Fire Tests for Large Transformers

Side view



Top view



#	Position
TC1	In lower pool, right
TC2	In lower pool, left
TC3	In trench, 2.0 m height
TC4	In trench, 3.5 m height
TC5	In lower pool, right
TC6	In lower pool, left
TC7	Above transformer (middle), same level as nozzle grid
TC8	Sidewall (left), 1m height
TC9	Sidewall (left), 5.5m height
PS1	HP pump system
PS2	Most remote nozzle of the system

Recorded Data

- Temperatures around the transformer mock-up and above the pools
- Pressure at the pump and at the most remote point in the pipework
- Video of both pools and the trench

Fire Tests for Large Transformers

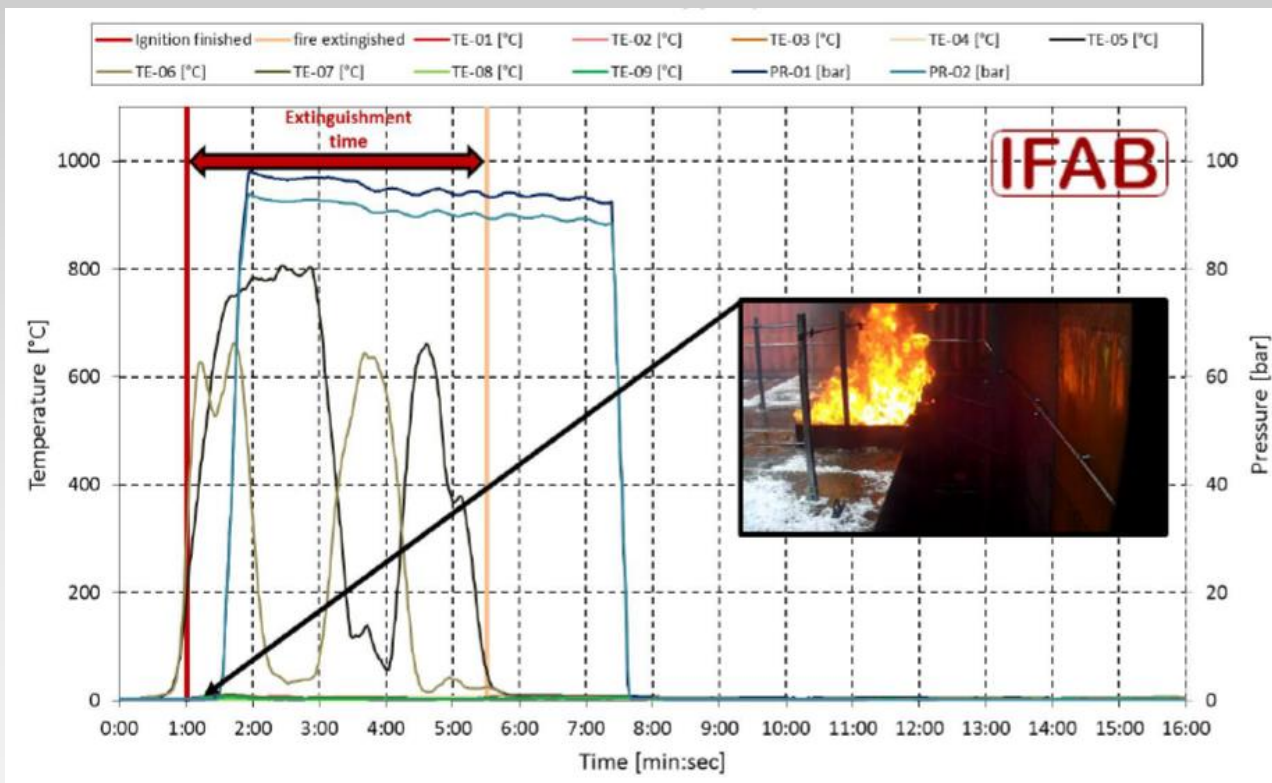
System Performance Criteria

Pass / Fail Criteria Water Mist System

- Fire shall be extinguished within 15 min after activation of the water mist system
- The fire shall not (self-)reignite within 15 min after shut-off of the water mist system

Fire Tests for Large Transformers

Scenario 1 2 m² upper pool fire (~ 4 MW)

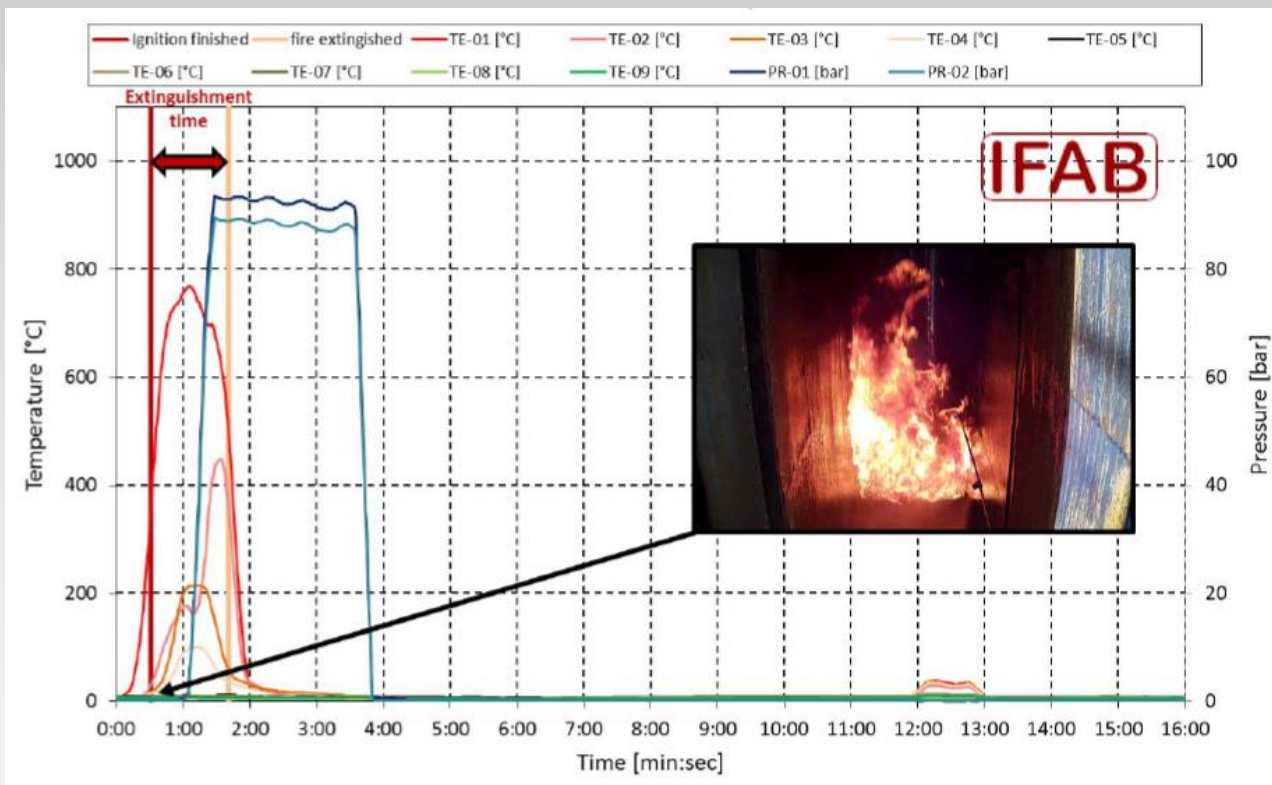


Achieved Results

- 4 min extinguishing time
- No re-ignition
- All system performance criteria were met

Fire Tests for Large Transformers

Scenario 2 1 m² lower pool fire (~ 2 MW)

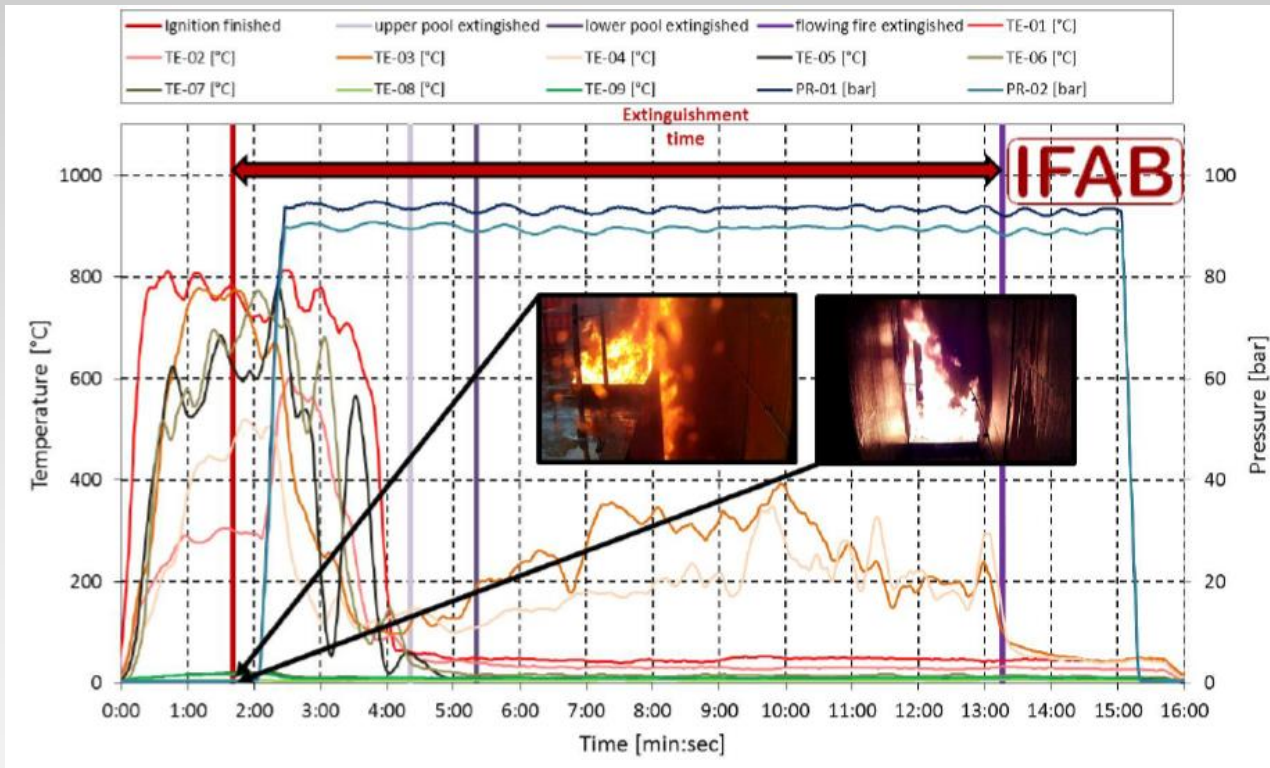


Achieved Results

- 40 sec extinguishing time
- No re-ignition
- All system performance criteria were met

Fire Tests for Large Transformers

Scenario 3 Upper + lower pool + trench fire (~ 10 MW)



Achieved Results

- Pools extinguished in 3 min 20 sec
- 11 min 15 sec extinguishing time
- No re-ignition
- All system performance criteria were met

Transformer Sub-Stations in Dubai



DEWA Sub-Stations

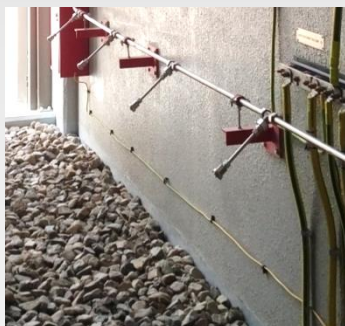
- DEWA's fire safety concept foresees the protection of new large scale transformers in their 132 kV and 400 kV sub-stations with high pressure water mist
- The transformers with overall sizes of up to 5,7 m by 8,4 m and 5,4 m height are located in enclosures with more than 60% front wall and roof opening
- The expected ventilation conditions within the enclosures can be up to 4 m/s
- System to be tested and certified by a fire test laboratory and certification body accredited by Dubai Civil Defense
- System acceptance based on VdS, MPA and TÜV certification
- First part of the project includes protection of 42 transformers in 6 sub-stations



Transformer Sub-Stations in Dubai

Protection Concept

- Grit soil underneath transformers to limit transformer oil spread in case of leakage
- Deluge local protection system surrounding the transformers with open nozzles designed based on full scale fire test results
- Transformers are equipped with flame detectors for identification of fires at the fire alarm panel
- Each transformer equipped with a section valve being either opened by a thermally activated glass bulb via a hydraulic sensor line or by the signal of the fire alarm panel via a push button
- All section valves are fitted with a manual override
- Safety concept foresees activation of one transformer in case of fire



Transformer Sub-Stations in Dubai

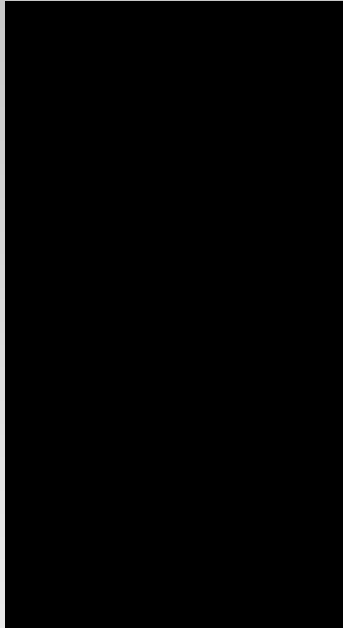


Protection Concept

- Small bore stainless steel pipework installed at the perimeters of the transformer walls to minimize interference with service and maintenance
- Jockey pump to prefill main pipe from pump unit to decentralized section valves, assuring shortest delays between system activation and water mist discharge
- High pressure water supply via 6 pump stations located in the sub-station sprinkler pump room / 4 x 120 l/min (120 bar) pump units with 100% diesel unit redundancy
- Water mist system supplied by fresh water from 120 m³ tanks at each pump station (15 m³ thereof assuring 30 minutes system autonomy)



Transformer Sub-Stations in Dubai



System Commissioning Spray Test

- Rapid filling of the transformer surroundings under ventilation conditions

Conclusion

High pressure water mist offers a proven and certified fire protection solution to ventilated large scale transformers

Water mist is providing effective and safe fire protection for transformers to assure business continuity to power network operators and businesses depending on energy supply



**Thank You for Your
Attention**