



## REPORT

### Fire test at If Fire and Safety Center 2000-11-22

#### Fire tests in semi closed and open transformers using ULTRA FOG fire protection system (Water Mist)

The department of Fire safety center at the IF fire and safety center in Norway has on behalf of ULTRA FOG AB conducted a series of fire tests in two different transformers. The tests were conducted in Principle accordance with Fire safety center at the IF fire and safety center – method, Fire tests procedures for fire protection Transformers.

#### 1. Description of tests

##### 1.1 Principle

The tests we conducted on 10 MW Semi closed and 30 MW Open transformer filled with paraffin oil. The oil heated up to 90°C with gas burners turned to the cooling radiators on the transformer. When the oil reached 90°C a pump started and press out the oil from lots of hole on the top of the transformer and the oil start to fire.

##### 1.2 The 10 MW Semi closed transformer enclosures

The test were performed in a 3,6 m high enclosure having a equal side of 3,5 m (80,9 m<sup>3</sup>). One side was open and having a total area of 12.6 m<sup>2</sup> (3,6 by 3,5 m). The transformer was provided 0.7 m from the wall and 1.5 m in from the opening. The high is 2,1 m and having a bottom size of 1,9 by 1,1 m (4,4 m<sup>3</sup>) and the total envelope area was 14,7 m<sup>2</sup>.

##### 1.3 The 30 MW open transformer

The test were performed on a 2,6 m high transformer having a equal bottom of 3 m (26,1 m<sup>3</sup>) and the total envelope area was 31.2 m<sup>2</sup>.

The transformer was placed in a open position with free access to air.

##### 1.4 The fires

The test fires in table 1 were used in the test enclosures according to the test program. Kerosene oil was only used in all tests.



Table 1 Test fires

Fire Scenario	Description	Test fuel	Oil temperature	Pre-burn time	Approximate peak HRK
#1	Oil flow over Semi closed transformer	Kerosene oil	90°C	~30 seconds	10 MW
#2	Oil flow over Open transformer	Kerosene oil	90°C	~50 seconds	30 - 40 MW

This fire scenario was used in addition to the scenarios specified in Fire safety center at the If Fire and safety center – method, Fire tests procedures for fire protection Transformers.

## 1.5 Fire protection system

### 1.5.1 Fire protection system set-up fore The 10 MW Semi closed transformer enclosure

Total eight (open) nozzles ULTRA FOG model 931028-202, with model 940610-051 nozzle washer were used to protect the transformer. Four nozzle were symmetrically installed at each long side walls at the enclosure. The nominal K-factor of the nozzles was 0.8 L/min/bar<sup>1/2</sup>. The horizontal distance between the nozzle was 2 m and the vertical distance was 2 m. The distance between the nozzles and transformer was 1 m. The nozzles were connected via a stainless steel pipe-work to a high pressure pump. The pipe-work was fitted with a pressure manometer near the pump unit. The pressure was adjustment with a pressure regulator mounted no the pump unit.

### 1.5.2 Fire protection system set-up fore The 30 MW Open transformer

Twelve (open) nozzles ULTRA FOG model 931028-202, with model 940610-053 nozzle washer were used to protect the transformer. Four nozzle were symmetrically installed at the tow opposed side. And tow nozzle were symmetrically installed at adder sides. The nominal K-factor of the nozzles war 1.76 L/min/bar<sup>1/2</sup>. The first row of nozzles was mounted 1 m from the bottom of the transformer and the horizontal distance between the nozzle was 2 m and the vertical distance was 2 m. The distance between the nozzles and transformer was 1.5 m. The protected volume was 108 m<sup>3</sup>. The nozzles were connected via a stainless steel pipe-work to a high pressure pump. The pipe-work was fitted with a pressure manometer near the pump unit. The pressure was adjustment with a pressure regulator mounted no the pump unit.

## 1.6 Test procedure

Before the Fire test the Transformers was heated up to approx. 70-90 °C by Propane Fire. Measured by a separate system in the Control room. When the oil temperature reach the test temperature, the oil expand and start the overflow (over top) and ignite. Because of the increasing of the temperature over the transformers cooling system., also the expanding of inside oil increase in speed. These is one of the reasons the Fires in Transformers are difficult to extinguish.



At the same time the Water Mist was released, we measured a temperature drop of 30\* C.

## 2 Summary of the test resultants

### The result for Semi closed transformer enclosure

The result tables summarizes the results from the tests with 2 m spacing. All the times are given from the time of ignition.

Table 2 Results from the tests with 2 m spacing and 90 bar water pressure at the nozzles.

Date of test	2000-09-28
Pre-burn time (sec)	25
Numbers of nozzles	8
Nominal K-factor (L/min/bar <sup>1/2</sup> )	0,8
Nozzle spacing (m)	2,0
Distance from nozzle to transformer (m)	1
Water pressure (bar)	90
Area water density (L/ m <sup>2</sup> min)	0,75
Area water density (L/ m <sup>2</sup> min)	4,1
Oil temperature at the ignition (C)	90
Fire size	10 MW
Result/ extinction time (sec)	70

Table 3 Results from the tests with 2 m spacing and 45 bar water pressure at the nozzles.

Date of test	2000-09-28
Pre-burn time (sec)	31
Numbers of nozzles	8
Nominal K-factor (L/min/bar <sup>1/2</sup> )	0,8
Nozzle spacing (m)	2,0
Distance from nozzle to transformer (m)	1
Water pressure (bar)	45
Volume water density (L/ m <sup>3</sup> min)	0,55
Area water density (L/ m <sup>2</sup> min)	2,9
Oil temperature at the ignition (C)	90
Fire size	10 MW
Result/ extinction time (sec)	72

### The result for Open transformer

The result tables summarizes the results from the tests with 2 m spacing. All the times are given from the time of ignition.

Table 4 Results from the tests with 2 m spacing and 80 bar water pressure at the nozzles.

Date of test	2000-09-29
Pre-burn time (sec)	56
Numbers of nozzles	12
Nominal K-factor (L/min/bar <sup>1/2</sup> )	1,76
Nozzle spacing (m)	2,0
Distance from nozzle to transformer (m)	1,5
Water pressure (bar)	80
Volume water density (L/ m <sup>3</sup> min)	1,74
Area water density (L/ m <sup>2</sup> min)	6
Oil temperature at the ignition (C)	90



Fire size	30 MW
Result/ extinction time (sec)	105

Table 5 Results from the tests with 2 m spacing and 80 bar water pressure at the nozzles.

Date of test	2000-09-29
Pre-burn time (sec)	45
Numbers of nozzles	12
Nominal K-factor (L/min/bar <sup>1/2</sup> )	1,76
Nozzle spacing (m)	2,0
Distance from nozzle to transformer (m)	1,5
Water pressure (bar)	80
Volume water density (L/ m <sup>3</sup> min)	1,74
Area water density (L/ m <sup>2</sup> min)	6
Oil temperature at the ignition (C)	90
Fire size	40 MW
Result/ extinction time (sec)	123

### 3 Conclusion

The tests shows that the described Ultra Fog system met all requirements in at the If Fire and safety center – method, Fire tests procedures for fire protection Transformers for Semi closed transformer enclosure and Open transformers.

The system cooling the transformer and the oil very fast and the extinction time is short and the system works very impressive.

#### Semi closed transformer enclosure

- With nozzle model 931028-202, with model 940610-051 nozzle washer and a nozzle spacing of 2 m between the nozzles and maximum mounted 1.5 m from the fire source (transformer). The nozzles can be installed on wall or the roof on the enclosure. The volume water density must minimum be 0.5 L/ m<sup>3</sup> min and minimum water pressure 45 bar at the nozzles.

#### Open transformer

- With nozzle model 931028-202, with model 940610-053 nozzle washer and a nozzle spacing of 2 m between the nozzles and maximum mounted 1.5 m from the fire source (transformer). The system should be designed and installed that the water spray hit the sides on the transformer and the maximum vertical distance from the transformers bottom to the first row is 1m. The volume water density must minimum be 1.7 L/ m<sup>3</sup> min and minimum water pressure 80 bar at the nozzles.

#### If Fire and Safety Center in Norway

  
 Ole Eckholdt  
 Head of section.

## Watermist-test ved If Sikkerhetssenter

