Case study DATA CENTER

Vienna, 2016-09-21
Data Centers in the course of time

- **Data Traffic worldwide** ...
  ... doubles every year

- **40 Zettabytes** ...
  Until 2020 the traffic will hit 40 Zettabytes a year
  \((40 \times 10^{21} \text{ Bytes} = \text{roughly equivalent to 57 times of sand grains on earth})\)

- **Investment of up to 90 Billion Euro** ...
  ... within 2020 in network infrastructure

- **Cloud computing** ...
  ... a fundamental part of our lifestyle

- **Data protection** ...
  97% of the generated data is encrypted and needs massive computer performance for organization
Growing needs of modern data centers

- **System availability and stability...**
  A shutdown of one center can cause a slow down of the entire grid

- **High safety level of fire protection...**
  fire hazard is a major risk for stable operation of center grids

- **Energy and space saving design...**
  realized by optimized temperature control of the cooling

- **Bigger and bigger server halls...**
  equipped with huge amount of server racks
Electronics and water

Does water mist work?
## System comparison

<table>
<thead>
<tr>
<th></th>
<th>Conventional Gas System</th>
<th>High Pressure Water Mist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk for humans and environment</td>
<td>( +/- ) depending on gas type</td>
<td>( + )</td>
</tr>
<tr>
<td>Ventilation system remains in operation during extinguishing</td>
<td>( - )</td>
<td>( + )</td>
</tr>
<tr>
<td>Immediate reaction</td>
<td>( + / - ) after evacuation time</td>
<td>( + )</td>
</tr>
<tr>
<td>Costs for return to operation after activation</td>
<td>( - )</td>
<td>( + )</td>
</tr>
<tr>
<td>Time for return to service after activation</td>
<td>( - )</td>
<td>( + )</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td>( - )</td>
<td>( + )</td>
</tr>
<tr>
<td>Economical for Server rooms</td>
<td>( + )</td>
<td>( - )</td>
</tr>
<tr>
<td>Economical for large Data Center</td>
<td>( - )</td>
<td>( + )</td>
</tr>
</tbody>
</table>
Server in operation during fire fighting

Ventilation system in operation during suppression

Immediate intervention of suppression system after detection

Completely harmless to humans and environment

Isolation of fire, no damage on surrounding server rack lines

Minimum risk for data center caused by the extinguishing system

Long life system design & low maintenance requirements

CFD Simulation of the system design, verified by fire tests, witnessed by notified body

Individual full scale fire test, witnessed by notified body

SPECIFICATION (SP)
AS SP-20104850 - Technical status from: 2016-09-20
Project name: HPWM Data Center Protection System
protection of: Vented Server Halls

1. APPLICATION
Full automatic high pressure water mist system for the protection of multiple server halls in any case of fire. Water mist generated by high pressure and specially designed nozzles removes energy from the fire, thereby cooling the fire source, and represses the oxygen feeding the fire. The system has been designed for stationary operation in an enclosed room and consists essentially of:
- High pressure pump unit incl. control panel
- Divertor valve
- High pressure and special atomizing spray nozzles
- VA3 stainless steel pipes and fittings

1.1 ADVANTAGES OF HIGH PRESSURE WATER MIST
- Extremely rapid fire suppression and minimal water consumption
- Harmless to human beings and environment
- Easy installation due to small pipe size (pre-fit)
- Additives (Anti Freeze, AFF) are applicable
- Very fast system response
- Protection against heat radiation
- Enabling safe and quick approach of the fire brigade
- Cooling of construction
- Small Water Supply Units
- Long life system due to high quality stainless steel parts
Facts about water and water mist

- **Short circuit** ...
  ... can occur when water is used in high quantities (e.g. like sprinkler amount)

- **Water damage** ...
  ... is often even more devastating than the fire itself

- **Other damages** ...
  ... of grid connected systems in case of short circuit

- **Pre-test in AQUASYSTest center** ...
  ... testing a personal computer without problems for 15min
Way to realize the project

CFD Simulation
- CFD Simulation Preparation
- Precise Fire Simulation
- Simulation Analysis

Full Scale Fire Test
- Fire Test Preparation
- Fire Test Execution
- Fire Test Analysis

System realization and setup on site, in close cooperation with the notified body

Final Inspection and Specific System Tests
- Used Simulation Tool: ANSYS FLUENT V14/V15

- Modelling of fire scenario:
  - geometrical configuration of data centre
  - modelling of ventilation system
  - positioning of nozzle heads
  - definition of fire load and heat release rate based on NFPA 92 and experience based on former fire tests

- Simulation inputs:
  - defined heat release rate
  - ventilation parameter
  - nozzle parameters (droplet sizes, velocities, activation temperature of glass bulb, ...)
Target: Evaluation of app. 30 different scenarios within reasonable time to determine most promising configurations including:

- nozzle types
- optimum nozzle positions
- optimum working pressure
- influence of ventilation
- activation strategy (for areas with open nozzles)

Simulation output: After evaluation of all simulation scenarios by notified body and fire marshal of customer, the most promising configurations were selected for real scale fire tests.
Fire test specification

- Test scenarios and room layout were chosen as a 99% mirror of situation at site
- Incl. ventilation system for simulation of cold and hot aisle
- Incl. heating and cooling system to ensure ambient temperature of the server hall
- Common definition of details of test scenarios and ignition source by server rack supplier, customer, AQUASYS and notified body
- Original server equipment was used including more than 30.000 m Cat 6 Ethernet cables
Fire test performance

- Fire test was monitored by cameras and precise measuring equipment
  - 20 thermocouples were used for data collecting
  - 9 air flow sensors
  - Several pressure and flow sensors

- Ignition source and material:
  - Original main boards, switches, hubs, ...
  - Cat 6 Ethernet cable
  - Packaging chips
  - Wood
  - Heptane
Test scenario 1 hot aisle

- Server rack arrangement
- Ventilation duct (airflow >2m/s)
- Closed nozzle for hot aisle protection
- Cable duct
Test scenario 1 hot aisle

- Fire load: 520 MJ/m² (appr. >500 KW)
- Activation after 0:52 / 0:65 min.
- Fire under control after 2:24 / 2:25 min.
- Temperature up to ~ 970°C
- Vent. Airflow: 2-3 m/s
- Test successfully passed
Test scenario 2 cold aisle

- Server rack arrangement
- Ventilation duct (airflow >2m/s)
- Open nozzle for cold aisle protection
- Cable duct
Test scenario 2 cold aisle

- Activated after 4:00 / 5:30 min.
- Fire under control after 4:46 / 6:30 min.
- Temperature up to ~ 740°C
- Vent. Airflow : 2 - 5 m/s
- Test successfully passed
Test scenario 3 cable duct

- Server supply tray
- Closed nozzle for cable duct protection
- Server rack arrangement
- Ventilation duct (airflow >2m/s)
Test scenario 3 cable duct

- Activated after 7:24 / 7:30 min.
- Fire under control after 9:21 / 10:06 min.
- Temperature up to ~725°C
- Vent. Airflow : 2-5 m/s
- Test passed
Conclusion

- High Pressure Water Mist and electrical components is not a big issue!

- Using CFD Simulation is a proper tool to evaluate basic configurations of a system.

- For new applications and complex environmental conditions CFD simulation can not compensate real scale fire tests.

- Ventilation in operation shows interesting influence to high pressure water mist: air flow of ventilation system affects / supports extinguishing efficiency.

- Using high pressure water mist enables fire fighting against hidden fire sources

- Water mist is an ideal solution for larger datacenter
Thank you for your kind attention!

...any questions?