Mechanisms for successful water mist protection systems

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Project Overview

- Three year research programme
- Funded by
  - BRE Trust
  - Industry partners (insurance and system suppliers)

Selected Application

Commercial Offices

- Suitable fire hazard
- Primarily a property protection application
- Insurers concerned about open plan areas
- Sprinkler protection required over 30 m
- EN protocol

Project Tasks

1. Review
2. Survey
3. Experimental test programme
4. Generic framework

Review - Standards

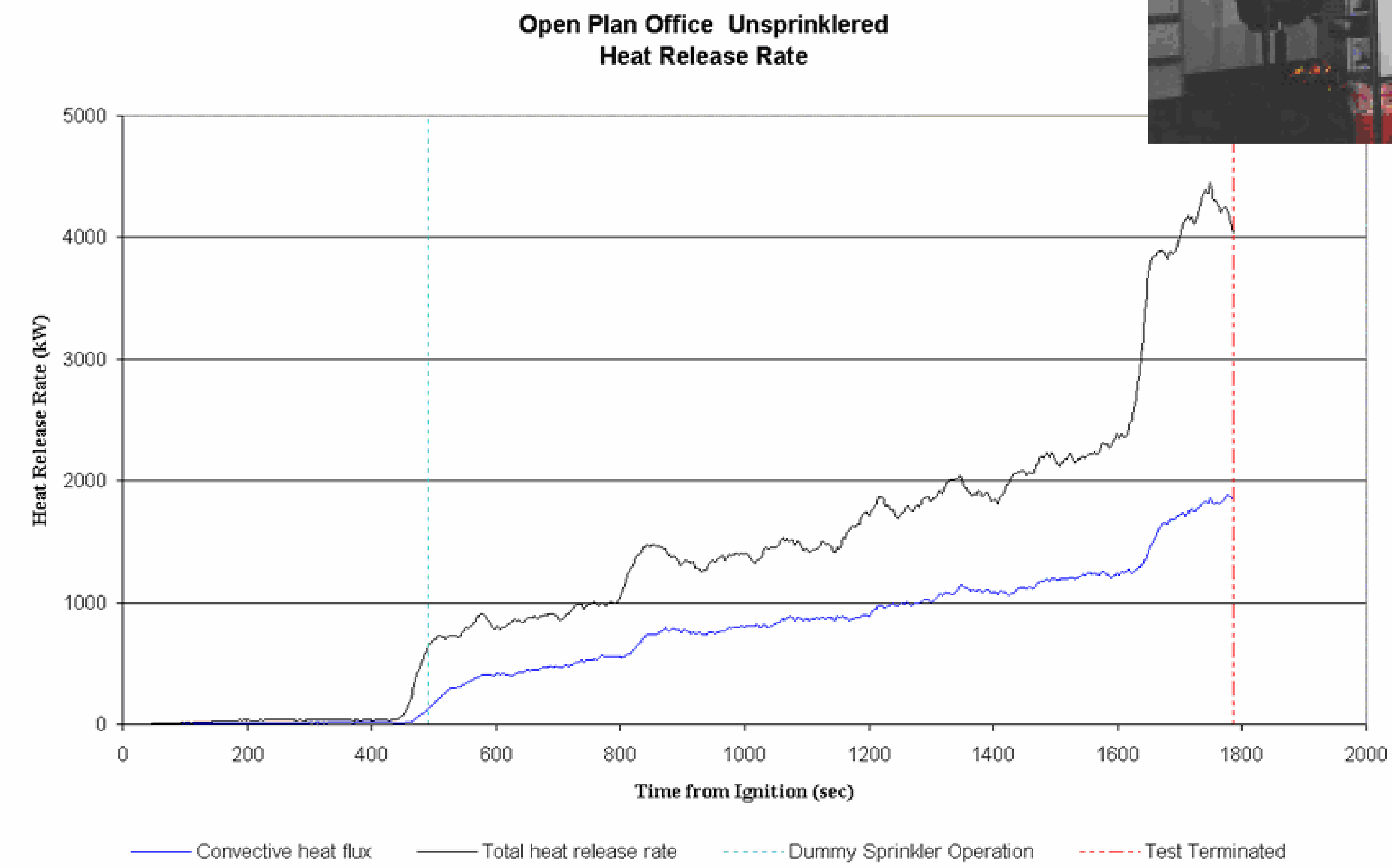
- CEN/TS 14972
  - Office occupancies of Ordinary Hazard Group 1
- FM Approval Standard 5560
  - Light hazard occupancies
- IMO A.800

Review – Experimental Data

- Water mist research papers
- Fire load surveys
- Fire engineering design fires

IMO A800, SP REPORT 2003:01

Design Fire Database



Survey

Findings From Review and Survey

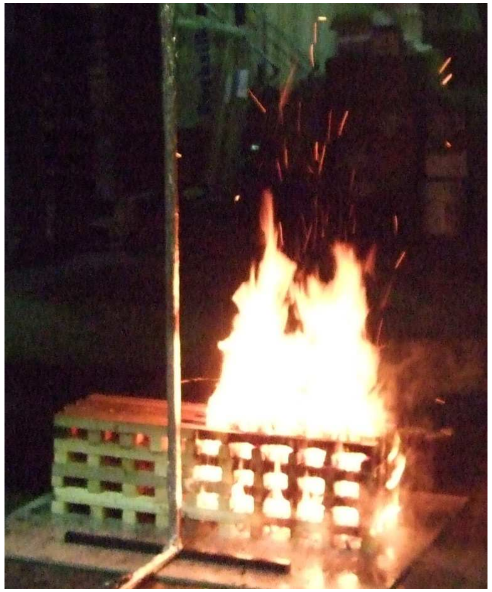
- Lack of public domain data available for solid combustible fires and open plan spaces
- Lack of public domain data available addressing the influence of key water mist parameters
- CEN office test protocol is a good approach but could be improved (fuel loading, ignition scenario, repeatability)

Single wood crib tests

- 21 simple 'demonstration' tests conducted
- Single wood crib
- Tests in open conditions
- 6 x 6 m ceiling at 2.8 metres height (unless stated otherwise)
- All tests with a single low pressure water mist nozzle
- Highly repeatable scenario to allow for direct comparison between a series of tests

Single wood crib tests

- Crib ignited at one end
- Allowed to burn until fire spread reached the middle of the crib
- Water mist manually activated
- 10 minute duration
- Any remaining fire manually extinguished – this provided comparative fire damage assessment



Findings – single wood crib tests

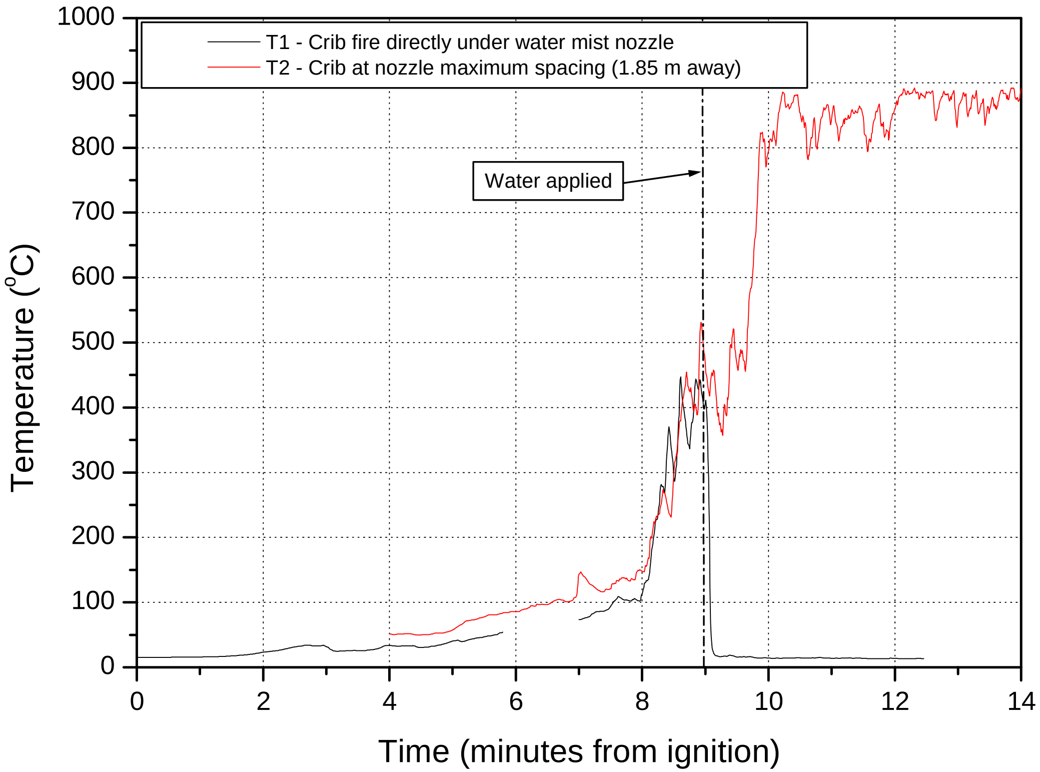
- The effect of nozzle spacing, that is, the position of the fire relative to the nozzle:

- The potential influence was clearly demonstrated:
  - With the crib directly beneath the nozzle the fire was effectively suppressed and extinguished (no residual smouldering) at the end of the 10 minute water discharge.
  - With the crib away from the nozzle at the 'maximum' spacing the fire was not suppressed and fire spread along the length of the crib.

Findings – single wood crib tests

Directly beneath nozzle

At ‘maximum’ spacing



Findings – single wood crib tests

- The effect of ‘reduced’ water flow (from 24 l/min down to 13 l/min):
- The reduction in water flow rate resulted in significantly reduced fire suppression effectiveness

24 l/min – suppression 2 minutes after water applied

13 l/min – less suppression 9 minutes after water applied

Findings – single wood crib tests

- The effect of shielding:

- Highly shielded fire; the water mist was prevented from achieving effective suppression and stopping fire spread.

- Partially shielded fire; effective at preventing spread to exposed fuel and a level of fire control within the shielded portion of the fire.

Highly shielded

Partially shielded

Findings – single wood crib tests

- The effect of ceiling height (4.3 m and 5.5 m):

- The fire suppression effectiveness was comparable with the same scenario at 2.8 m and the influence of ceiling height was considered to have had limited influence, for the tested scenarios.

Findings – single wood crib tests

- The effect of ventilation (at 'low' level affecting both the fire and water discharge profile):

- The crib fire initially struggled to take hold but then spread quickly. The fire was not effectively suppressed, particularly in comparison to testing in 'still air' conditions.

Findings – single wood crib tests

- The effect of ventilation (at 'mid' level affecting the water discharge profile only):

- The ventilation (of the order 2 – 3 m/s) was demonstrated to have a critical influence on the effectiveness of the water mist system. The water mist discharge pattern was severely affected by the ventilation.

Compartment tests

- Tests conducted in a compartment measuring 3.7 x 3.7 x 2.5 m high.

- This represented the maximum stated floor area protection size for a single nozzle in accordance with the low pressure water mist system providers design and installation manual (the system used in the singe wood crib fire tests).

Findings – compartment tests

- The effects of a 'sealed' compartment:

- The beneficial influence of a sealed compartment on the water mist system suppression effectiveness was clearly demonstrated.

- In open conditions the crib was not suppressed (with the crib fire at maximum spacing). For the equivalent scenario, but with a sealed compartment, the fire was effectively suppressed and fire spread along the crib prevented.

Findings – compartment tests

- The effect of a compartment and ventilation:

- The compartment, in combination with the ventilation arrangements tested, had a beneficial influence on the fire suppression effectiveness. Visual observations showed re-circulating air currents containing water mist droplets ‘drawn into’ or ‘blown into’ the fire location.

- However, the fire suppression was not as efficient as the test results demonstrated for still air conditions. A significant amount of water mist droplets were ‘blown out’ the open doorway

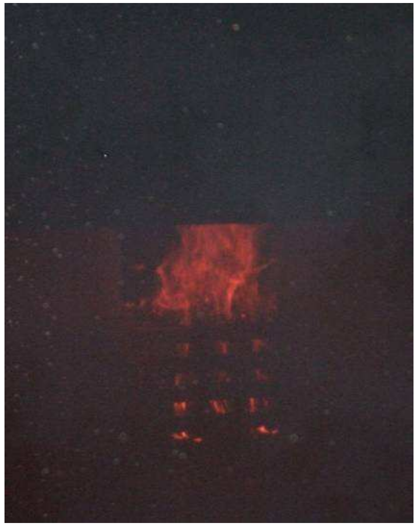
Findings – compartment tests

- The effect of a compartment and ventilation with a significant fuel loading:

- 'Baseline' test conducted with sealed low pressure water mist with no ventilation
- Second test conducted with a low pressure water mist with ventilation
- Third test conducted with a high pressure water mist with ventilation

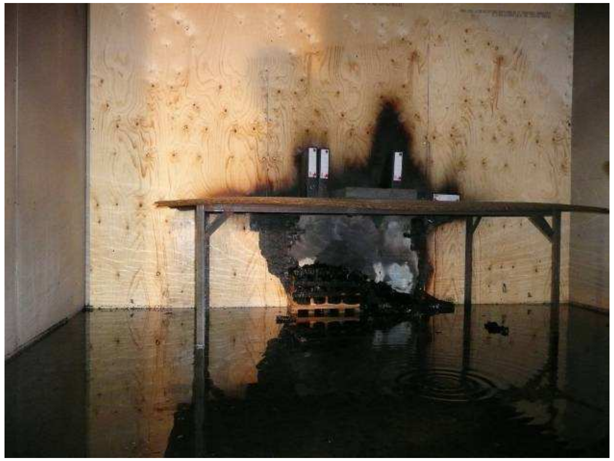
Findings – compartment tests

- ‘Baseline’ test, no ventilation, low pressure water mist system:



- Frangible glass bulb system operation after 2 minutes 48 seconds.

- System demonstrated effective fire suppression on exposed surfaces but highly shielded wood crib continued to burn freely. Overall, the water mist was effective at controlling the fire and limiting fire spread.



Findings – compartment tests

- Identical scenario but with ventilation:

Velocity readings (taken at various locations in the room) ranged from 0.7 – 4 m/s).

Findings – compartment tests

- Low pressure system - The development of the fire was severely affected (slowed) by the air flows. In combination, the temperature at which the frangible bulb actuated was much higher. There was a reduction in water above the chipboard table and water mist droplets ‘blown out’ the open door.
- However, the overall performance and effectiveness of the system was comparable to an equivalent test conducted in ‘still air’ conditions.

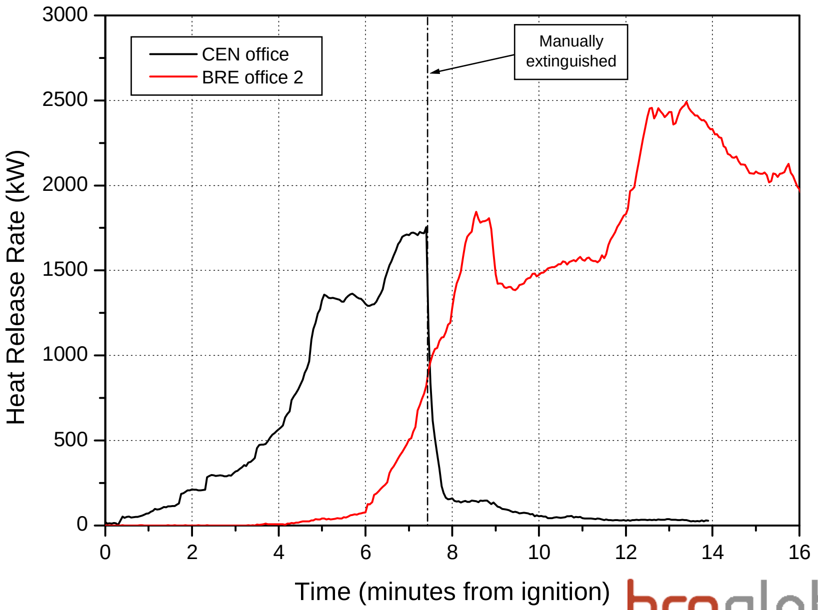
Findings – compartment tests

- High pressure system - The development of the fire was slowed. The activation temperature (and therefore time of operation) of the mist nozzle and distribution characteristics of the mist discharge were detrimentally influenced by the ventilation. The water mist system was not effective at preventing fire spread despite a level of fire control being demonstrated. The overall performance and effectiveness of the system was not clearly proven.

Findings – office scenario fire tests

- BRE developed and characterised office scenario:

- Stylised fuel, highly repeatable, easily obtained, cost effective.
- Fuel loading representative of OH1, medium fire growth rate, with target items.
- Tests under an open 6 x 6 m ceiling at 5 m height



Findings – office scenario fire tests

- Sprinkler test; LPCB approved K80 pendent sprinklers used.

- Scenario in the centre of 4 heads on a 12 m^2 spacing (5 mm/min).
- The sprinkler system was successful at extinguishing flaming above the table and preventing any further burning in the plywood walls. Only a low level of burning in the two shielded wood cribs persisted. The fire was effectively suppressed.

Findings – office scenario fire tests

- Low pressure water mist test

- Scenario in the centre of 4 heads on a 6.25 m^2 spacing (5 mm/min) at ~13 bar
- Flaming above the table was effectively suppressed but the wood cribs under the table burnt freely for the duration. The water mist system demonstrated effective fire suppression for the tested scenario

Findings – office scenario fire tests

- High pressure water mist test

- Scenario in the centre of 4 heads on a 9 m^2 spacing (2.8 mm/min) at ~100 bar
- The system significantly reduced temperatures within the office scenario fire set-up compared to the unsuppressed test and although a level of fire control was demonstrated the fire was not effectively suppressed.

Conclusions

- Nozzle spacing has been demonstrated to have a critical influence on the fire suppressing effectiveness of a water mist system (in certain tested conditions);

- Nozzle water flow rate (and associated coverage) has also been demonstrated to have a critical influence on the fire suppressing effectiveness of a water mist system (in certain tested conditions);

- Shielding (the prevention of direct water spray onto a fire location) has clearly been demonstrated to prevent effective fire suppression (in certain tested open conditions);

Conclusions

- Ceiling height has been demonstrated to be highly significant with respect to automatic heat activated water mist system response times;
- The possible effects of ventilation have been clearly demonstrated:
  - Ventilation can severely affect the fire growth rate (either significantly slow or speed up);
  - Ventilation can severely detrimentally affect the water distribution profile of water based suppression systems (high pressure systems most, low pressure systems and to a lesser extent sprinkler system discharges);
  - Ventilation has been demonstrated to have a critical influence on the fire suppressing effectiveness of water mist systems (in certain tested conditions);

Conclusions

- Some possible benefits of a compartment on the fire suppressing effectiveness of a water mist system have been clearly demonstrated (in certain tested conditions);

- Tests were conducted with industry provided low and high pressure water mist systems against the BRE developed office scenario. The results, with one exception, were of some concern as effective fire suppression was not demonstrated. Results indicate that the water mist systems, as installed for testing, were not able to provide the intended level of fire protection. Or, in terms of the design of the tested systems, the spacing between nozzles was too great and the quantity of water discharged too low, to provide effective fire suppression.

Conclusions

- One test with an industry provided low pressure water mist system effectively suppressed the BRE developed office fire scenario. This test was conducted at approximately 5 mm/min, an equivalent water coverage to that required by a sprinkler system in accordance with the specifications of BS EN 12845.

Conclusions

- A fire test protocol for office occupancies of Ordinary Hazard Group 1 has been developed and experimentally tested. This protocol will be submitted to the relevant technical British Standards committee for potential inclusion into British Standard Draft for Development 8489 – Commercial and industrial water mist systems.

- Overall, the work has provided valuable new information on a number of the parameters influencing successful water mist systems

Thank You

- Any questions?

- Louise Jackman & Kelvin Annable
- Fire Safety Group
- BRE Global