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Watermist Systems for Building Fire Protection

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LPCB
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Part of the BRE Trust

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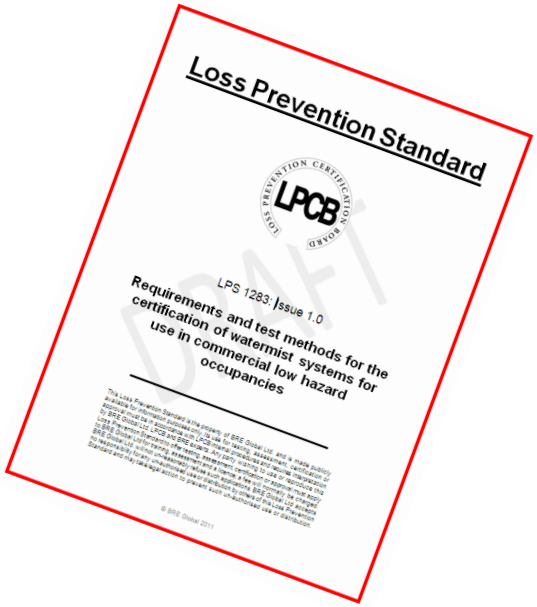
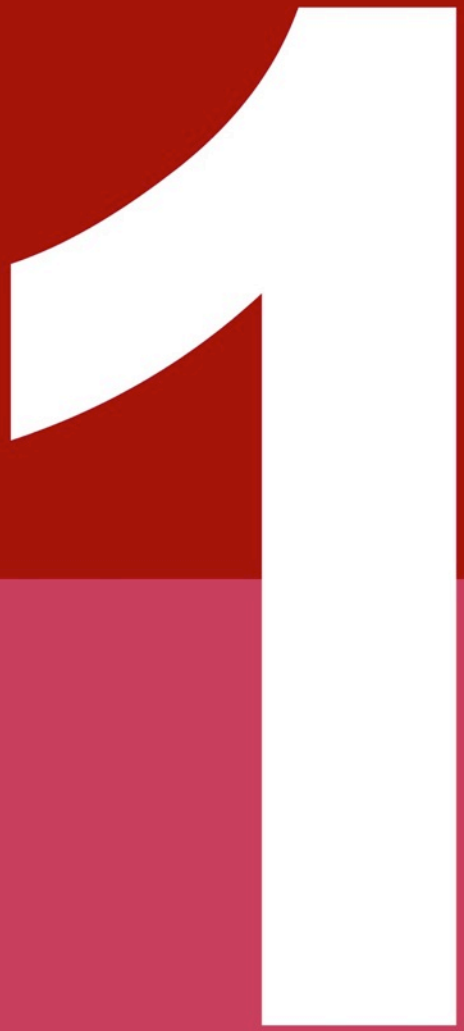
Introduction

1. Watermist properties
2. BRE Trust research project
   – Parameter testing
3. BRE Trust research project
   – Office testing
4. BSI Draft for Development standards
5. Summary



Watermist properties



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Watermist parameters

– One sprinkler droplet is equivalent to thousand(s) of smaller watermist droplets

– Increased heat transfer
  – Increased surface area = increased rate of heat removal

– Increased mass transfer
  – Increased surface area = increased rate of evaporation

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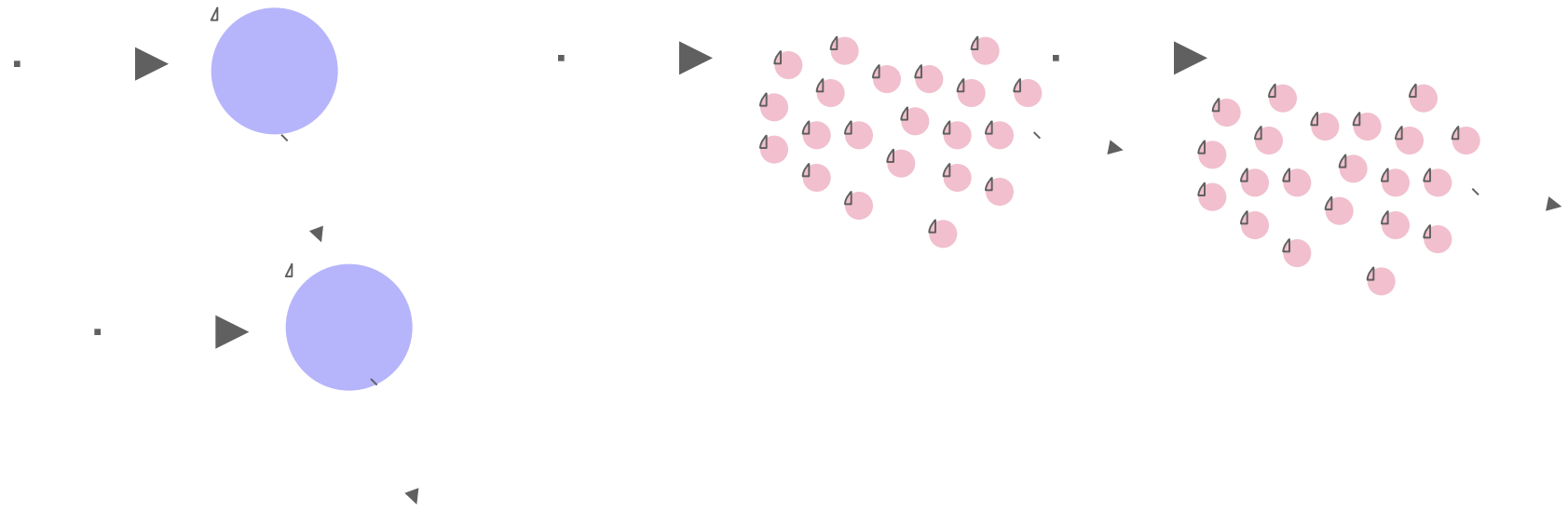
Watermist parameters

- Momentum
- Longer fall time for small droplets
  - large droplet = 4m per s, small droplet =1cm per s
- Increased transit time in fire/smoke/airflow for small droplets



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Water spray envelope

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Suppression mechanisms

– Droplets remove heat from fire and smoke (conduction, convection, radiation)

– Droplets spray/fall and wet fuel (inhibiting fire spread)

– Water vapour displaces oxygen (near flame)

- *In a compartment, droplets and water vapour filling, can inhibit fire spread*
- *In open/obstructed space, droplets and water vapour can be pushed away*

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Parameter testing

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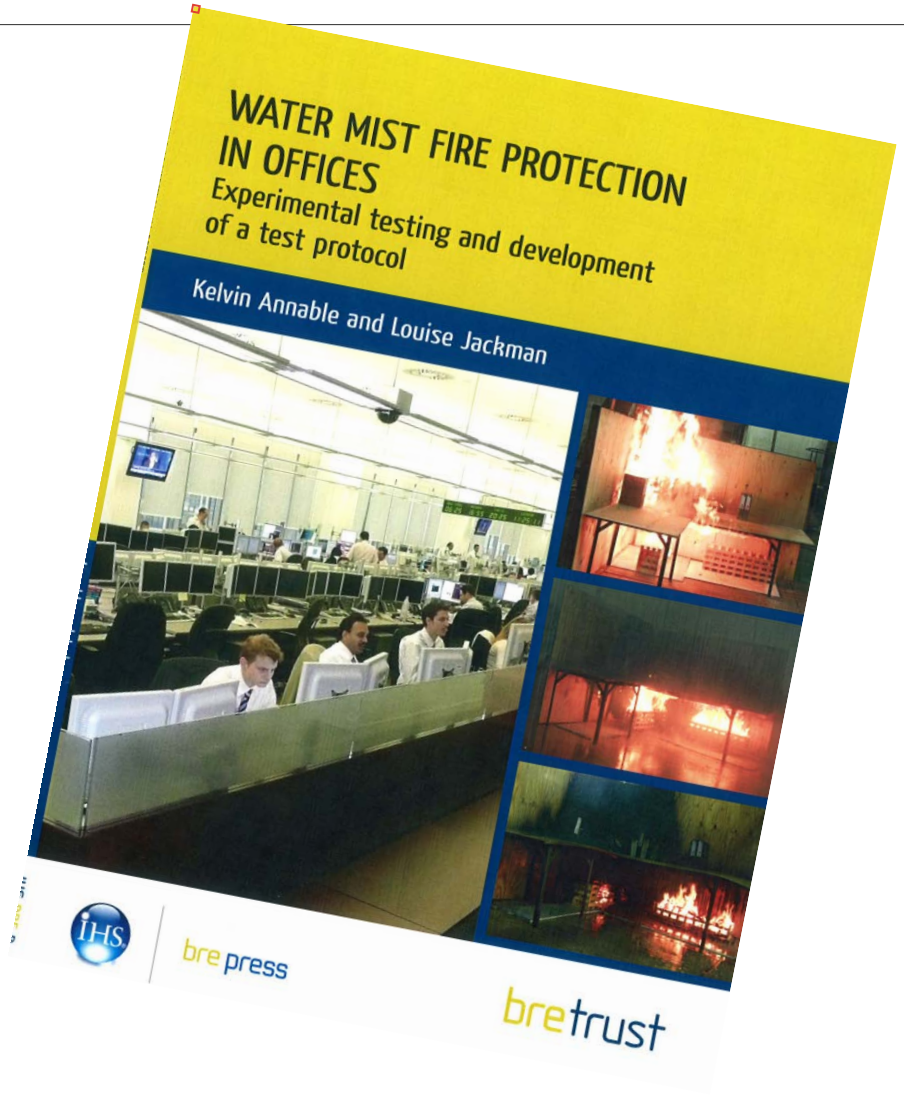
WATER MIST FIRE PROTECTION IN OFFICES
Experimental testing and development of a test protocol
Kelvin Annable and Louise Jackman
IHS
bre press
bretrust

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Test set-up

- Watermist system
  - Low pressure
    (& high pressure)
  - Single nozzle
    (& four nozzle)
- Large laboratory
  - Open ceiling
  - Compartment
    (3.7m x3.7m x2.5m)

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Test set-up

- Wood crib (free burn)
  - Horizontal spread
    4 min, 12 min
    17 min, 19 min
  - 500 kW peak

  For watermist tests
  - Pre-burn
    (9 min)
  - Water delivery
    (10 min)

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Parameters studied

- **Nozzle spacing**
- Nozzle flow and pressure

- **Compartmentation**
- **Ventilation**
- Ceiling height

- Fire hazard (fuel, arrangement, **obstructions**)

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Nozzle spacing tests, no compartment

- Fire beneath nozzle
  - Good suppression
  - 20°C above crib @3min

- Fire 1.25 m offset from nozzle
  - Control, less suppression
  - 350°C above crib @3min

- Fire 1.85 m offset from nozzle
  - No control
  - 850°C above crib @3min

Nozzle in compartment, open door

- Fire 1.8m offset from nozzle
  - Control
  - 400°C above crib @9min
  - 120°C at ceiling

Nozzle in compartment, open door

- Obstructed fire beneath nozzle
  - No control
  - 850°C above crib @3min
  - 40°C at ceiling

Ventilation, in open

- Five tested ventilation scenarios
  - No control
  - 400 - 700°C above crib @3min

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Ventilation, in compartment 1.8m offset

- Open door
  - Control, 170°C above crib
  - 70°C at ceiling

- Wall vent, low pressure mist
  - Control, 200°C above crib
  - 60°C at ceiling

- Wall vent, high pressure mist
  - No control, 900°C above crib
  - 80°C at ceiling

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Critical parameters for fire testing of watermist

- Nozzle spacing
- Nozzle flow and pressure

- Ceiling height
- Compartmentation
- Ventilation

- Fire hazard (fuel, arrangement, obstructions)

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Office testing

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Typical office

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Base information

– Fire load surveys

– Fire engineering design fires

– Standard test fires

IMO A800, SP REPORT 2003:01

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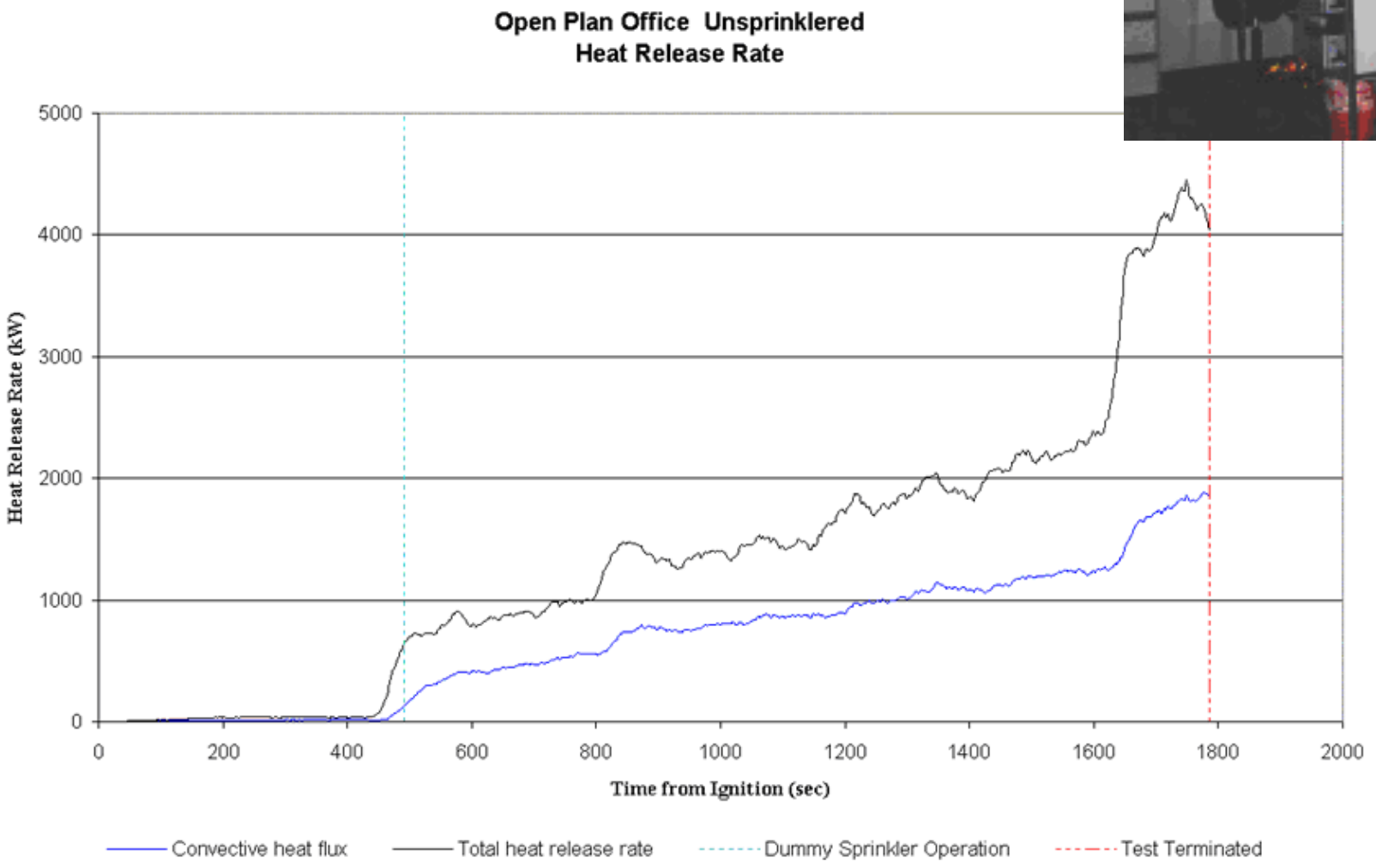
Design Fire Database



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Office fire test protocol

- Stylised, repeatable fire
- Progressive spread
- Medium growth
- 2500 kW peak

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Findings – sprinkler (SP1)

- K80 pendent sprinklers
- 10.5 m^2 spacing (5 mm/min)
- Ignition centre of 4 nozzles
- Suppression
- 5 mins after activation
  - 40°C at 2.5m
  - 40°C at 5m (ceiling)
- Damage
  - no spread to edge
  - plywood in tact

Findings – watermist (SP3)

- Low pressure
- 6.25 m^2 spacing (5 mm/min)
- Ignition centre of 4 nozzles
- Suppression
- 5 mins after activation
  - 20°C at 2.5m
  - 20°C at 5m (ceiling)
- Damage
  - no spread to edge
  - plywood in tact

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Findings – watermist (SP2)

- Low pressure
- 9 m^2 spacing (3.5 mm/min)
- Ignition centre of 4 nozzles
- Control(?) not suppression
- 5 mins after activation
  - 300°C at 2.5m
  - 100°C at 5m (ceiling)
- Damage
  - spread to edge
  - plywood not in tact

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Findings – watermist (SP6)

- High pressure
- 9 m^2 spacing (2.8 mm/min)
- Ignition centre of 4 nozzles
  - 30 s delay
- No control
- 5 mins after activation
  - 300°C at 2.5m
  - 90°C at 5m (ceiling)
- Damage
  - spread to edge
  - plywood not in tact

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@ 5 mins

@ 10 mins

@ 15 mins

@ 20 mins

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Summary

For an office fire load (OH1)
- large open space in a building
- 5 m ceiling

- Of the tested arrangements
  - only one watermist system resulted in suppression
  - with sprinkler equivalent delivered density (5 mm/min)
  - Other tested arrangements failed to suppress the fire
- Nozzles spacing and flow rate are critical

- Other arrangements may perform better
  - lower ceilings
  - lower fire loads
  - in a compartments

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BSI Draft for Development standards

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DD 8489-7 low hazard occupancies

Category 1

- *Small compartment, bunk beds*
- *Large compartment, furniture*

Category 2

- *Large compartment, furniture*
- *Open space sofas*

Category 3

- *Simulated work station*

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Background

- Fire test protocol based on
  - FM 5560
  - IMO A.800
  - BRE Trust research, FB34
- With additional consideration for:
  - Fire load, material & arrangments

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DD 8489-7 low hazard occupancies

Small compartment

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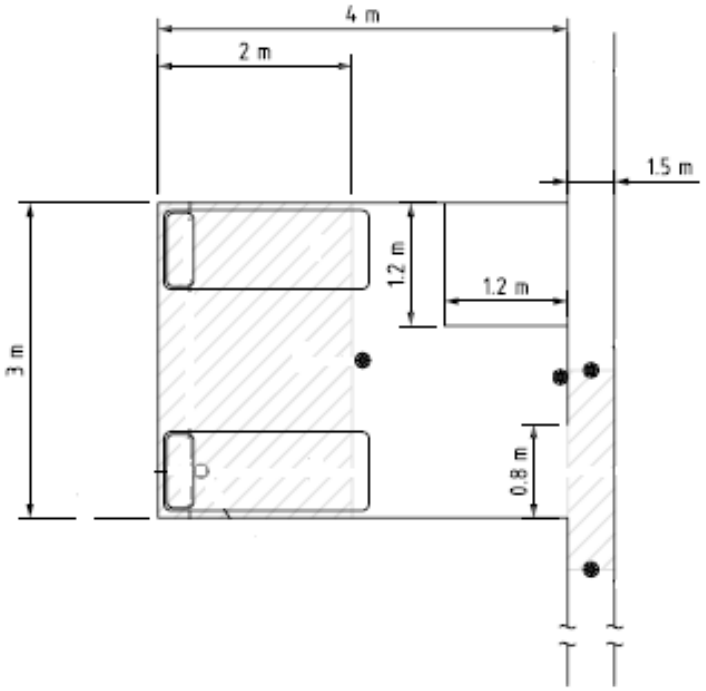
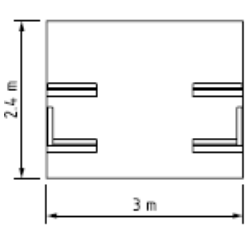
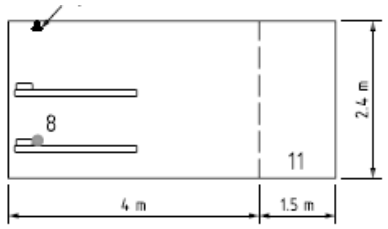
DD 8489-7 Small compartment, bunk beds
Test arrangements

- 4 m by 3 m by 2.4 m high
- One open doorway
- One nozzle (centre or sidewall)
- Two ‘dummy’ nozzles near open doorway outside room
- Untreated plywood wall lining (3/4 mm)
- Three polyether non FR-treated foam sheets + pillow (cotton cover)
- Insulated fibreboard soaked in heptane







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DD 8489-7 low hazard occupancies

Large compartment

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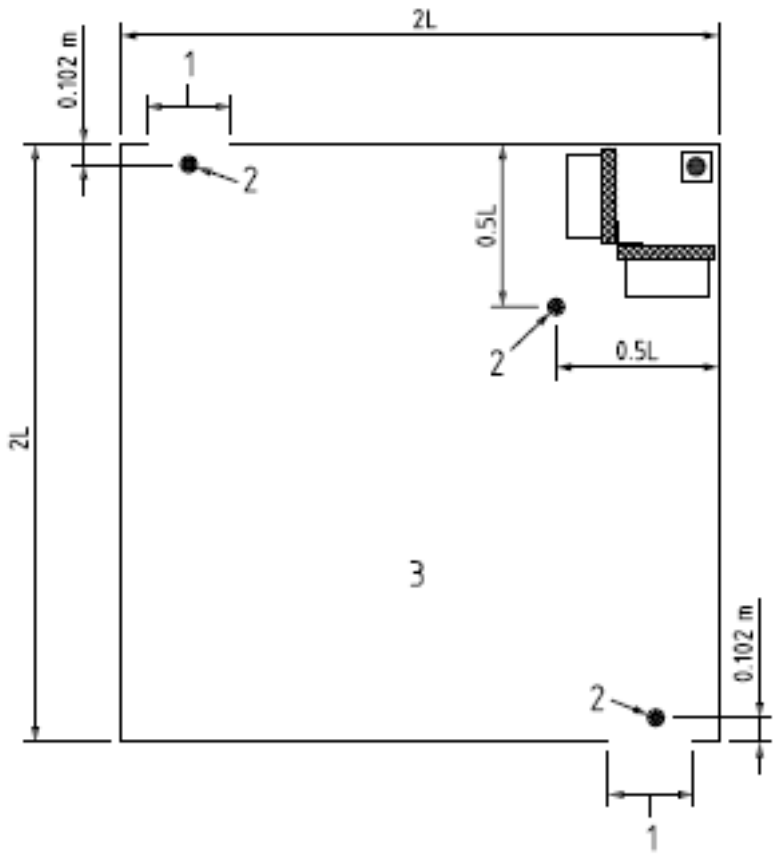
DD 8489-7 large compartment, furniture
Test arrangements

- 2L m by 2L m by 2.4 m high
- L = nozzle spacing (e.g. 3 m)
- Two open doorways
- Four nozzles
- Two ‘dummy’ nozzles near open doorway inside room
- Untreated plywood wall lining (6mm)
- Two polyether non FR-treated foam
- A wood crib, eight layers of wood sticks on top of a heptane tray
- Cotton wicks soaked in heptane



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DD 8489-7 low hazard occupancies

Open space sofas

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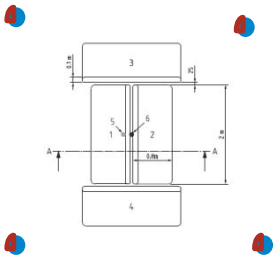
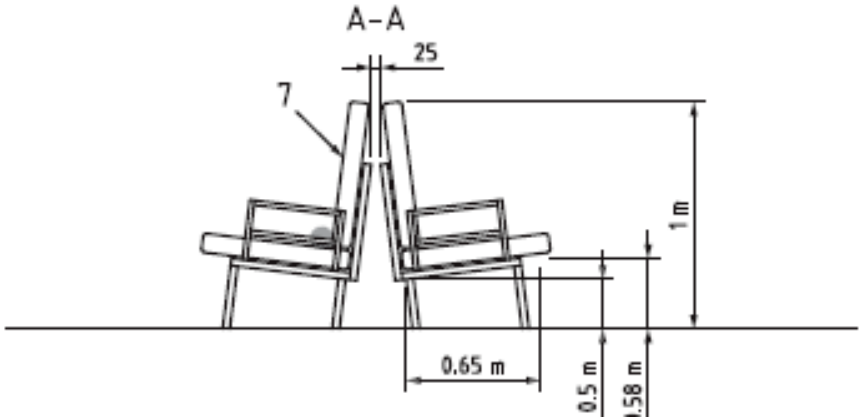
DD 8489-7 open space sofas
Test arrangements

- 3L m by 3L m by up to 5 m high
  - L = nozzle spacing (e.g. 3 m)
- Open on all sides, no wall lining
- Four nozzles
- Three polyether non FR-treated foam sheets + pillow (cotton cover)
- Insulated fibreboard soaked in heptane





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DD 8489-7 low hazard occupancies

Simulated work station

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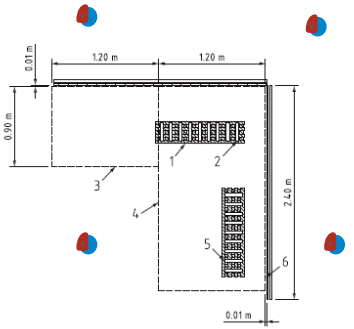
DD 8489-7 simulated work station Test arrangements

- 6 m by 6 m by up to 5 m high
- Open on all sides, no wall lining
- Four nozzles
- Untreated plywood wall lining (6mm)
- Two wood cribs
- Chipboard table + indicatives

DD 8489-7 simulated work station
Three tests

- Under one nozzle
- Between two nozzles
- Between four nozzles



DD 8489-7 simulated work station
Acceptance criteria

– Control test fire for 30 min

– Acceptance criteria are:

Plywood damage	Not extended to wall ends No areas burnt through or fallen away
Box and foam damage	Limited, some unburnt
Ceiling gas temperature , in centre of ceiling	≤ 80°C

– Mean temperatures remain steady or decreasing after 5 mins

Summary

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Key facts

- Watermist is a complex technology
  - Increased efficiency
  - Increased vulnerability
- No generic system design methodology, all systems are bespoke
- There are critical watermist parameters, e.g. Nozzle spacing and flow
- There are critical fire / room parameters
  - Fire (spread, duration, obstructions)
  - Compartmentation
  - Ventilation

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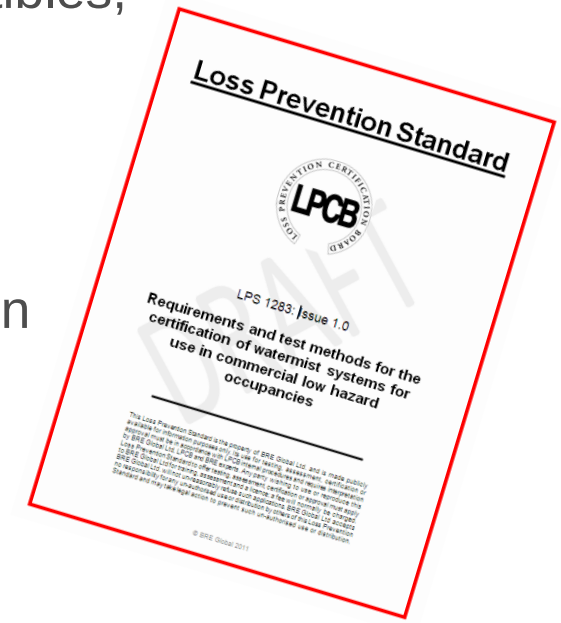
Watermist for building fire protection

- Watermist systems can be used to protect low hazard occupancies
- Watermist systems have limits
  - Application fire load
    - Fire load, fire growth rate, height of combustibles, obstructed fire load
  - Application arrangements
    - Floor area, ceiling height
    - Ventilation
  - Watermist systems require precise specification
    - Components
    - Design parameters



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Testing watermist systems against standards is essential

- To obtain fire performance test results for
  - Specified system design
  - Particular hazard type
  - Against an agreed standard
- To provide benchmarking
- To provide confidence in a system for:
  - Customers
  - Specifiers
  - Enforcers
  - Approval bodies

Thank you

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Watermist office test demo
http://www.youtube.com/user/BREVideoUK#p/u/11/kq8N-9TaoZc