Safeguarding Escape Routes within High-Rise Buildings

Ultra Fog Ltd.
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Overview

- Failures of compartmentation
- Subsequent justification against the use sprinkler systems
- Potential for water mist as a lower cost alternative
Retrofit sprinklers
Compartmentation

Existing buildings use compartmentation to prevent the spread of fire between dwellings.

- Dwelling should be able to contain a fire for at least 60 minutes
- Fire Brigade to bring the fire under control within this time.
- Neighbouring residents to stay put unless affected by heat or smoke.
Compartmentation failure


Shepherd’s Court, 2016.

Outcome of Lakanal House Inquest

1. Failure of compartmentation via inadequate fire stopping, an open window, and cross connection of ventilation ducts.

2. Fire spread rapidly - both vertically and horizontally.

3. 6 fatalities - all advised via phone to stay put to await rescue. Extensive smoke logging of the communal areas prevented rescue.

4. Coroner's Section 43 letter issued to the Council.
“Blocks of flats with a floor more than 30m above the ground level should be fitted with a sprinkler system […]”
Under current UK legislation, there is no requirement for retroactive installation of sprinklers, unless a building undergoes significant structural changes or change of use.
Lakanal House
Section 43 letter

Source: https://www.lambeth.gov.uk/elections-and-council/lakanal-house-coroner-inquest
Sprinkler feasibility study commissioned in response to the section 43 letter

Recommendations from the consultancy appointed by the Council:

<table>
<thead>
<tr>
<th>Type of accommodation</th>
<th>Installation of sprinkler systems into existing high-rise buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheltered housing</td>
<td>Recommended</td>
</tr>
<tr>
<td>Temporary housing</td>
<td>Recommended</td>
</tr>
<tr>
<td>General needs housing</td>
<td>Not recommended. Instead, as a minimum, LD3 fire detection is strongly recommended.</td>
</tr>
</tbody>
</table>

Justification?

Issues which were considered by the Council:

1. “Currently no legal requirement to install sprinklers in existing buildings [...]”

2. Council has “no right of access to leasehold properties” - retrofit within leasehold flats would require the owners’ consent and, normally, their funding.¹

3. “Effect on amenity” - pipe routing, accidental painting of sprinkler heads, aesthetics, coring/boring, disturbing the existing fire stopping, asbestos, etc.¹

4. Cost

“Sprinklers need only be provided within the individual flats. They are not required in the common areas such as stairs, corridors, or landings”
Indicative costs (2013)

Conventional Sprinkler Systems - lowered ceilings
- £97M

Conventional Sprinkler Systems - lowered ceilings
- £27M

Total cost for 76 high rise, general needs housing blocks

Conventional Sprinkler Systems - pipework boxed-in
- £15.7k

Conventional Sprinkler Systems - pipework boxed-in
- £3.7k

Average cost per flat

LD2 Fire Detectors
- £0.7k

Average cost per flat

Costs calculated in 2013. Excludes VAT, professional fees, inflation/deflation, and relocation costs.
Costs benefit analysis

Shortfalls

The analysis was...

...based on the costings provided by one sprinkler company. *Realistic reflection of competitive tendering?*

...based on conventional sprinkler systems and personal protection sprinklers. Watermist not considered.

...based on application of building regs (for new buildings) to existing buildings.
2018 cost estimates

London Assembly Planning Committee report: “Never again: Sprinklers as the next step towards safer homes”

Considered sprinkler systems, but not water mist systems.

<table>
<thead>
<tr>
<th>Source</th>
<th>Cost of retrofitting per flat</th>
<th>Retrofitting all buildings over 30 metres high in London*</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAFSA Callow Mount study*</td>
<td>£1150</td>
<td>£100.5 million</td>
</tr>
<tr>
<td>BAFSA</td>
<td>£1500 to £2500</td>
<td>£131.2m to £218.6m</td>
</tr>
<tr>
<td>Optivo® and Fire Protection Association</td>
<td>£2000 to £2500</td>
<td>£174.9m to £218.6m</td>
</tr>
<tr>
<td>Essex County Fire and Rescue Service</td>
<td>£2260 to £3500</td>
<td>£197.6m to £306m</td>
</tr>
<tr>
<td>London Borough of Croydon*</td>
<td>£4500 to £5500</td>
<td>£393.5m to £481m</td>
</tr>
</tbody>
</table>

Source: https://www.london.gov.uk/sites/default/files/final_afss_report.pdf
London Assembly Planning Committee 2018
“Other types of AFSS technologies are also available. These include water-misting and personal protection systems [...]. Water-misting can offer the ability to extinguish the fire, but typically require more individual sprinkler heads, higher water pressures and a more contained environment. Water mist systems are therefore generally more expensive than sprinklers.”

An inaccurate generalisation of watermist, based on a specific product, having 5m² coverage per head.
Water mist as a less expensive alternative to sprinklers?
Indirect fire suppression

Unlike sprinklers, water mist spray does not need to cover a fire to suppress the fire.

With a sufficient flux density, it is possible to suppress fires indirectly.

As cost represents a significant barrier to the retrofit installation of active fire suppression systems, is it feasible to protect a dwelling with a single watermist nozzle, to deliver economically viable, life-saving systems?
Example of indirect fire suppression: 48m² cabin fire test

- Fire tested in accordance with IMO RESOLUTION MSC.265(84)
- Size of test room: 8m x 6m (48m²)
- Flow rate: 32.1 litres per minute at 100 bar
- Flux density: 0.27 litres per minute, per m³
- Potential heat absorption approx.: 83 MJ
Example of indirect fire suppression: 48m² cabin fire test

Method - test scenario #4: “disabled nozzle test”.
“The nozzle(s) in the cabin should be disabled. Fire arranged in one lower bunk bed and ignited with the igniter located at the front (towards door) centreline of the pillow…”

Acceptance criteria:
- The fire is not allowed to propagate along the corridor beyond the nozzles closest to the door opening
- Max 30s average ceiling surface temp within the corridor shall not exceed 400°C
Paradigm shift:

A single nozzle to actively protect the escape route within each dwelling, and to actively prevent the spread of smoke and flame from a dwelling into the communal escape route.
One nozzle per dwelling?

- Convention dictates that the sprinklers should be installed at the locations where a fire is most likely to start - to tackle the seat of the fire.
- This rationale is based on conventional sprinkler systems - whereby the water droplets quickly fall to the floor, thereby necessitating the use of large volumes of water to be delivered via nozzles located within reach of the fire.
- Water mist behaves differently. As demonstrated during fire tests to internationally recognised standards, water mist
  - Remains suspended in the air for longer;
  - Inhibits the transmission of radiant heat;
  - Suppresses fires even when the seat of the fire is obstructed or located in an adjacent room (via expansion and convection).
Examples of dwelling layouts

- Tissington Court, London
- Total floor area: 42m²
- Suggested location of single water mist nozzle
- Location of water mist nozzle proposed to stop the spread of fire towards the front door (leading the block’s communal stairwell)
Examples of dwelling layouts

- Lupin Point, London
- Total floor area: 59m²
- Suggested location of single water mist nozzle
- Location of water mist nozzle proposed to stop the spread of fire towards the front door (leading the block’s communal stairwell), and to protect the escape route from both bedrooms.
- Minimal protection of kitchen and reception room - focus is on the protection of life rather than property.
Examples of dwelling layouts

- Castle Mead, London
- Interlocking “scissor section” flats, similar to Lakanal House
- Total floor area: 65m²
- Suggested location of single water mist nozzle
- Location of water mist nozzle proposed to stop the spread of fire towards the front door (leading the block’s communal stairwell), and to prevent the spread of a fire from the kitchen or reception room to protect the escape route from the bedrooms.
“It is unlikely that retrofitting sprinklers or water mist systems would be reasonably practicable for existing blocks. Nevertheless, this does not preclude their use where there is clear justification and appropriate consideration of the practicalities of their installation and subsequent maintenance.”
“Consideration of the practicalities”

- Access rights
- Funding
- Drilling/coring
- Fire stopping
- Asbestos
- Theft and vandalism
- Maintenance
- Water supply (pressure and flow)
- Space

Virtues of watermist in the context of high rise retrofit.

- High pressure
- Low water consumption
- Small diameter pipework
- Fewer nozzles
- Actively reinforces the building’s passive fire protection, by inhibiting the transmission if radiant heat.
**"Consideration of the practicalities"**

**Sprinklers vs Water Mist**

<table>
<thead>
<tr>
<th></th>
<th>Sprinklers</th>
<th>Water Mist</th>
<th>Comparative effect of water mist</th>
<th>Benefits of water mist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Droplet size (diameter)</td>
<td>1mm</td>
<td>0.05mm</td>
<td>-</td>
<td>More efficient use of water. Fewer nozzles. Lower water consumption. Smaller diameter pipework, less impact on the building during installation.</td>
</tr>
<tr>
<td>1 litre =</td>
<td>2 million droplets</td>
<td>15 million droplets</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Surface area per litre</td>
<td>6 m²</td>
<td>120 m²</td>
<td>Faster heat transfer, faster cooling of the fire.</td>
<td></td>
</tr>
<tr>
<td>Terminal speed</td>
<td>1.4 m/s</td>
<td>0.3 m/s</td>
<td>Increased exposure time within the fire, smoke, and airflow.</td>
<td></td>
</tr>
</tbody>
</table>
Further research

- Feasibility study
  - Indicative costs of retrofit single nozzle systems within high rise blocks
  - Fire testing
    - Define the test parameters:
      - Representative fire load
      - Representative layout
    - Define the quantifiable objectives, e.g., cooling rate, maximum allowable temperatures; etc.
Summary

- Cost remains a significant barrier to the retrofit installation of sprinkler systems in high rise residential buildings.
- There is an assumption that water mist systems are generally more expensive than sprinkler systems.
- Opportunity exists to safeguard life by simplifying the scope of protection via water mist.
- Evidence demonstrates that water mist is effective at inhibiting the transmission of radiant heat.
- There is scope to apply water mist to actively enhance the compartmentation of high rise buildings, however, more research is required to establish the feasibility of this.
Thank you.

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