



## Fire suppression in buildings using water mist, fog or similar systems

*The authors of this report are employed by BRE. The work reported herein was carried out under a Contract placed by the ODPM. Any views expressed are not necessarily those of the ODPM.*

## Executive Summary

This is the project report of the study "Fire suppression in buildings using water mist, fog or similar systems", commissioned by the Buildings Division of the Office of the Deputy Prime Minister (ODPM) and carried out by BRE. Any views expressed in this report are not necessarily those of the ODPM.

Water mist systems are currently the subject of debate and information about the overall effectiveness of these systems for land-based life safety applications is not well established. The overall aim of this desk-based study is to determine what water mist, fog or similar innovative suppression systems are currently being installed in the UK. The BRE approach to this study was to collect and analyse information and data on these systems via a combination of specially designed-questionnaire(s), selected face to face interviews, a literature review and web search.

The summarised conclusions are as follows.

- Over 1000 water mist systems currently installed in the UK were reported. Most of the water mist systems installed in life safety applications had been provided in the last two or three years. These systems are spread across the UK with a high concentration in one or two areas in domestic and residential premises. These comprise various types of water mist systems installed in a range of local and total compartment applications. ('Total compartment' is where water mist is designed to protect all hazards in a predefined room; 'Local application' is where water mist is designed to discharge directly on an object or hazard). Water mist systems have been installed into all the Approved Document B (Fire safety) purpose groups.
- According to building control professionals and fire safety officers, the highest numbers of these systems are installed in dwellinghouses followed by flats and maisonettes. According to water mist companies, the highest numbers of these systems are installed in industrial premises or factories followed by dwellinghouses.
- Water mist systems have been accepted by the authorities having jurisdiction for a variety of reasons, the main being as compensatory features to Building Regulations requirements and on fire service recommendation. Water mist systems are being proved fit for purpose from the use of standards, fire demonstrations and performance tests.
- Currently, there is no British Standard on water mist systems or components. European and International Standards are in preparation but do not include a domestic element. Existing water mist standards are not directly applicable to UK land-based applications. There are a large number of standards referenced by respondents with varying degrees of relevance to water mist systems for land-based applications.
- The building control professionals and fire safety officers would like a British Standard or equivalent. There are many fire tests/reports for water mist systems but they find it hard to filter out relevant details and assess whether they apply to the particular land-based situation. The rigor of fire testing is not always checked or checkable. In some cases, the building control professional and fire safety officers seem to harbour a number of myths, misunderstandings and lack of knowledge about water mist systems.
- The water mist companies and trade associations are generally confident with the current status of standards and aware of European standards development. However, they acknowledge that the draft European standard does not include residential and domestic applications where performance requirements, development of suitable test protocols and performance criteria are needed.
- There is a concern about the use of water mist in life safety total compartment applications in residential, domestic and commercial premises. There is merit in dealing with residential and domestic premises as a special case.

Recommendations for further work that may be appropriate and/or necessary to provide full consideration of these systems for life safety and property protection for use in buildings are proposed.

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## 1 Description of the project

BRE has been commissioned by Buildings Division of the Office of the Deputy Prime Minister (ODPM) to carry out this desk-based study on fire suppression in buildings using water mist, fog or similar systems. Water mist systems are currently the subject of debate and information about the overall effectiveness of these systems for land-based life safety applications is not well established. The overall aim of this project is to determine what water mist, fog or similar innovative suppression systems are currently being installed in the UK. The specific objectives of the project are:

- a) to determine what, how many and where water mist, fog or similar innovative suppression systems are currently being installed in residential and other premises;
- b) to determine to what standards these systems are being installed;
- c) to determine how they are being proved as fit for purpose;
- d) to recommend what further work may be appropriate/necessary to provide full consideration of the effectiveness of these systems.

To achieve these objectives, the project is divided into a number of Tasks: Task 1 Collect data and information, Task 2 Analysis of results, Task 3 Dissemination of results.

This project report presents the findings of the study.

## 2 The BRE approach

The BRE approach to this study was to collect and analyse information and data on these systems via a combination of specially designed questionnaire(s), selected face-to-face interviews, a literature review and web search, analysis and provision of recommendations.

An initial survey was carried out using a specifically designed questionnaire. Two versions were produced and sent out, see Appendix A. The first, Questionnaire (1), was circulated to local authority building control, Approved Inspectors, fire authorities and other similar interested parties in the UK.

The available water mist companies and systems for the UK market were obtained using BRE experience and a web search. Table 1 shows the main water mist companies, their role, the system they use and brief description of system type. The actual names of the companies and their systems have been removed. The second, Questionnaire (2) was sent to water mist companies (specifiers, designers, manufacturers, suppliers, installers) in the UK.

Resulting from the questionnaire responses, a number of telephone calls and face-to-face interviews were conducted with selected water mist manufacturers, installers, other related companies, representatives of building control bodies and fire authorities in regions where these systems are being installed. These interviews allowed discussion, clarification and deeper investigation of the situation.

In parallel, a literature review and web searches have been carried out to obtain supplementary information. Salient information is included in this report.

**Table 1 Water mist companies for Questionnaire (2)**

Company	Company role	System	Water mist system type
1	Specifier, designer, manufacturer, supplier, installer	1	Low pressure (5 – 12 bar). Option of adding foam, using copper, plastic, stainless steel pipe.
1	Specifier, designer, manufacturer, supplier, installer	2	High pressure (120 – 200 bar). Pumped or cylinder
2	Installer	1	Low pressure (5 – 12 bar). Option of adding foam, using copper, plastic, stainless steel pipe
3	Designer, manufacturer, supplier, installer	3	Low pressure, using bank of cylinders, plastic pipe often used for residential applications. Also pumped systems available for larger risks
4	Specifier, designer, manufacturer, supplier, installer	4	High pressure, pumped or cylinder
5	Specifier, designer, supplier, installer	5 and 6	One high/medium pressure system, 6-20 bar and one high pressure system, 100 bar. Cylinders and pumped, single fluid
6	Designer, installer	Any	Company acts as an agent Previously used system 2
7	Designer and installer	7	Three office installations
8	Designer, supplier, installer	7	Single fluid – low pressure
9	Design and install	8	Low pressure, cylinder or pumped
10*		9	Low pressure (only marketed for use in bin rooms and internal waste areas)
11*		10	High pressure
12*		11	High pressure
13*		12	Low pressure, innovative nozzle design, cylinder or pumped

\*These companies did not return a completed questionnaire

### 3 Description of water mist or similar innovative systems

A water mist system is a fixed fire protection system. The system comprises components for detection and actuation, water supply, water delivery and water atomization. Water mist systems discharge a spray of small water droplets.

Water mist is (defined in Reference 1 as) a water spray for which the 90% of the flow-weighted cumulative volumetric distribution of water droplets,  $D_{v0.90}$ , is less than 1000 microns. This value is found at the minimum design operating pressure and is measured in a plane 1 m from the nozzle. Some systems additionally discharge other gases or additives.

The aim of the water mist system is to generate, distribute, and maintain an appropriate concentration of droplets sufficient for the protection of the risk.

In the event of a fire, the water droplets discharged from a water mist system remove heat and displace oxygen from the fire zone, resulting in fire control, suppression or extinguishment. In the zone where the fire and water mist interact, the intention is to lower the temperature, lessen the radiative heat and reduce the oxygen concentration, to such an extent that combustion can no longer be maintained.

These terms are defined as:

- Fire extinguishment: A sharp reduction in heat release rate leading to complete elimination of any flaming or smouldering fire;
- Fire suppression: A steady reduction in the heat release rate resulting in a lower controlled level of burning;
- Fire control: Limitation of fire growth and protection of structure (by cooling of the objects, fire gases and/or by pre-wetting adjacent combustibles).

Water fog protection, as far as BRE is aware, is not a separate category from water mist but is a particular type of water mist system, a commercial trade name that has come into common usage or sometimes used to describe the sub category of high pressure water mist systems.

BRE is not aware of any other similar innovative water-based system for use in buildings.

#### 3.1 System designs

There are two types of protection strategy, these are defined as:

- *Local-Application Water Mist System or Object Protection System.* This is a water mist system designed to discharge directly on an object or hazard. These systems have been installed to protect within enclosures, unenclosed objects within buildings and outdoor applications. A typical example would be a deep fat-fryer.
- *Total Compartment Application System or Volume Protection System.* This is a system designed to discharge water mist to protect all hazards in a predefined enclosure (volume), usually a room. A typical example would be an engine room.

The commercially available systems are all distinctly different. However, they can be categorised by reference to the following key components:

- *Fire fighting medium* - potable water, natural sea water, de-ionized water, water with antifreeze, water with additive, water with inert gas
- *Detection* – automatic nozzles, detectors, actuators, control panels
- *Atomisation* – nozzle and orifice, single fluid system, twin fluid system, low pressure ( $\leq 12.5$  bar); medium pressure ( $> 12.5$  bar and  $< 35$  bar), high pressure: ( $\geq 35$  bar)
- *Delivery* - wet pipe system, dry system, pre-action system, deluge system, pipe (stainless steel, plastic)
- *Supply* – storage vessel (e.g. tanks, cylinders), propellant (e.g. nitrogen), pumps.

The engineering of water mist systems requires calculation and design to determine the flow rates, nozzle pressures, pipe size, area, or volume protected by each nozzle, discharge density of water mist, the number and types of nozzles, and the nozzle placement in a specific system.

### 3.2 Alternative systems

There are established alternative systems to water mist, for example, automatic sprinkler systems, water spray and fixed gas extinguishing systems. These forms of fire protection are largely understood and there are historic performance records.

Sprinkler systems are usually designed to protect the whole building, delivering water to the fire location to control/suppress the fire, pre-wetting surrounding combustibles and structure and continue with this form of protection for in excess of 60 minutes (residential 30 minutes, domestic 10 minutes).

A fixed gas extinguishing system would be designed to protect the fire hazard and assets in a particular enclosure, extinguishing the fire and preventing re-ignition for a further 10 minutes.

Both automatic sprinkler and gas extinguishing systems have robust standards and approvals for the components and for the design and installation.

Oxygen reduction systems are another alternative to water mist (using inert gas, usually nitrogen) which is intended to reduce the probability of a growing fire should ignition of combustibles occur. It is a novel approach, which requires a permanently reduced oxygen atmosphere in the protected space; there is no historical record of performance and the protection method has not been standardised.

The essential performance objectives of a water mist system are not as well defined as those for sprinkler or gaseous extinguishing systems.



## **4 Current British, European, International and other standards**

The following summarises the current British, European, International and NFPA (USA) standards relevant to water mist systems. There are other standards which partly relate to water mist systems. These are not detailed here.

### **4.1 British Standards**

No British Standards have been published on the installation of water mist systems or components.

### **4.2 European Standards**

Committee CEN TC191 WG 5 has prepared a draft European standard for the design and installation of water mist systems, prEN 14972 Fixed fire fighting systems - Water mist systems – Design and installation, August 2004<sup>2</sup>. It has been circulated for comment and vote. There is a possibility that this draft will be published as a European Technical Specification in 2 to 3 years' time.

This draft standard covers the significant issues of water mist. It is based on a combination of prescriptive and performance based requirements, with reliance on supplier's instructions. The draft standard includes selected new fire test methods for evaluating systems, for flammable liquids, cable tunnels and for office occupancies of Ordinary Hazard Group 1. The intention is for fire test methods for particular applications to be added when available in the future.

### **4.3 ISO standards**

Committee ISO/TC21/SC5 has prepared a draft international standard ISO DIS 6182-9, Fire protection – automatic sprinkler system, Part 9: requirements and test methods for water mist nozzles, August 2003<sup>3</sup>. It has been circulated for comment and vote. This draft standard covers component testing. The emphasis of the draft standard is for shipboard applications. It is unclear if building applications are covered. The draft standard includes fire tests for shipboard applications.

### **4.4 USA standard**

NFPA 750 Standard on Water Mist Fire Protection Systems 2003 Edition<sup>1</sup> provides guidance on the installation of water mist systems. This is a generic, prescriptive installation standard and is the most comprehensive of all the available standards. However, in many cases it fails to address the needs of specific applications.

#### **4.5 International Maritime Organisation (IMO) standards**

The following International Maritime Organisation (IMO) water mist standards for shipboard protection have been produced<sup>4, 5, 6</sup>.

- IMO MSC/Circ. 913, Annex unified interpretations of the guidelines for the approval of fixed water-based local application fire-fighting systems, June 2003
- IMO MSC/Circ. 668, Alternative arrangements for halon fire-extinguishing systems in machinery spaces and pump-rooms, December 1994.
- IMO FSS Code, International code for fire safety systems, Resolution A.800 (19), Revised guidelines for approval of sprinkler systems equivalent to that referred to in SOLAS regulation 11-2/12, adopted 23 November 1995.

These give requirements for components/systems and detail system tests for particular shipboard fire hazards.

There is a large amount of available test data related to these IMO standards.

## 5 Findings of questionnaires

### 5.1 Questionnaire responses

There were 219 responses for Questionnaire (1) and 13 responses for Questionnaire (2). Tables 2 and 3 show a breakdown of the responses by category and whether they answered “yes” or “no” to the question of whether respondents encounter or have encountered the use of water mist, water fog or similar innovative fire suppression systems installed in buildings in the UK. This excluded automatic sprinkler systems to a published standard e.g. BS 5306 Part 2: 1990<sup>7</sup> or a medium or high velocity spray system.

The collated responses to Questionnaires (1) and (2) are presented in the following sections.

**Table 2 Questionnaire (1) responses**

Respondent	Yes	No	Total
<b>Local authority – Building Control Officer</b>	26	140*	<b>166</b>
<b>Approved Inspector</b>	3	6	<b>9</b>
<b>Fire authority – Fire Prevention Officer</b>	13	28	<b>41</b>
<b>Other</b>	2	1	<b>3</b>
<b>Totals</b>	<b>44</b>	<b>175</b>	<b>219</b>

\*4 Anonymous

**Table 3 Questionnaire (2) responses**

Respondent	Yes	No	Total
<b>Water mist companies</b>	10**	1***	11
<b>Other</b>	0	2	2
<b>Totals</b>	<b>10</b>	<b>3</b>	<b>13</b>

\*\*2 responses were from one company, one for each of their systems

\*\*\*not in the UK

### 5.2 Geographical area in the UK

The Questionnaire (1) respondents reported that the buildings where water mist systems have been installed are randomly spread over England, Wales and Scotland. None were reported in Northern Ireland. The greatest numbers of systems reported were in Cheshire and Wiltshire, in dwellinghouses, and in Merseyside, in dwellinghouses, flats and maisonettes and other residential premises.

Three Questionnaire (2) respondents reported that the buildings with these systems installed were within the company's locality, one in London, one in South East England, and one said in the specific locations of East Sussex, London, Essex, Kent, Suffolk. The other seven said randomly spread across the UK.

### 5.3 Roughly how many buildings with water mist, fog or similar innovative systems (excluding automatic sprinkler systems) are installed in the UK?

The Questionnaire (1) respondents personally had had experience of approximately 247 proposed or actual water mist, fog or similar systems installed in 162 buildings.

The Questionnaire (2) respondents had had experience of approximately 1135 water mist, fog or similar systems in 1086 buildings.

It is likely that the largest figure is an underestimate of the number of water mist systems installed in buildings in the UK because not everyone replied and those who did may not have had knowledge of all the systems in their local area.

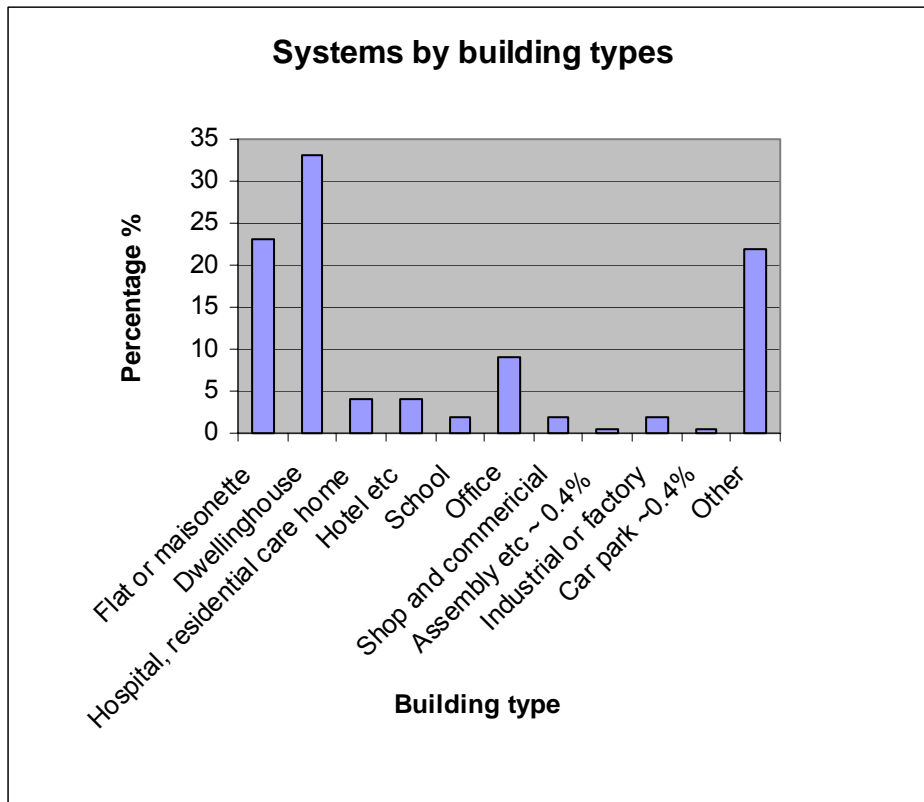
### 5.4 The building types and number of buildings per building type

According to Questionnaire (1) respondents, these systems were installed in building types in all the Approved Document B (Fire safety)<sup>8</sup> purpose groups, see Table 4.

**Table 4 Building types and Approved Document B purpose groups**

Building type	Purpose group category <sup>8</sup>
<ul style="list-style-type: none"> <li>Flats or maisonettes</li> </ul>	Residential (dwellings) group 1(a)
<ul style="list-style-type: none"> <li>Dwellinghouses</li> </ul>	Residential (dwellings) groups 1(b) and 1(c)
<ul style="list-style-type: none"> <li>Hospital, residential care home</li> <li>Hotel, boarding house, residential college, hall of residence, hostel</li> </ul>	Residential (other) group 2(b)
<ul style="list-style-type: none"> <li>School</li> </ul>	Part of Residential (Institutional) group 2(a)
<ul style="list-style-type: none"> <li>Office block</li> </ul>	Office group 3
<ul style="list-style-type: none"> <li>Shop and commercial</li> </ul>	Shop and commercial group 4
<ul style="list-style-type: none"> <li>Assembly, entertainment or recreation, museum/gallery</li> </ul>	Assembly and recreation group 5
<ul style="list-style-type: none"> <li>Industrial, factories</li> </ul>	Industrial group 6
<ul style="list-style-type: none"> <li>Car park</li> </ul>	Storage and other non residential group 7(b)
<ul style="list-style-type: none"> <li>Other                             <ul style="list-style-type: none"> <li>a fire station</li> <li>a historic building being converted to a hotel</li> <li>five gas turbines</li> <li>a transformer</li> <li>three diesel generators</li> <li>two engine test beds.</li> </ul> </li> </ul>	Storage and other non residential group 7(a)

The breakdown of the buildings by type is summarised in Figure 1.



**Figure 1**

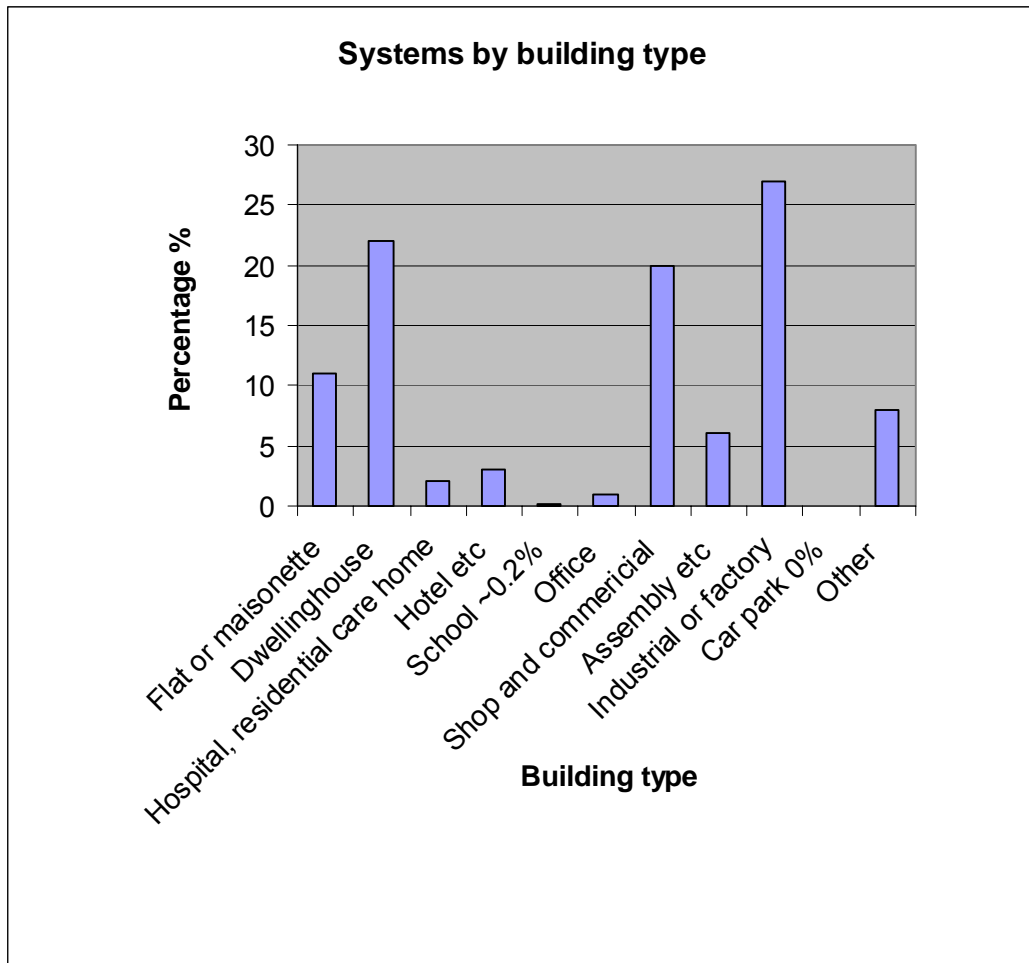
Therefore, most of these systems were found to be dwellinghouses then flats or maisonettes.

According to Questionnaire (2) respondents, these systems were installed in all the Approved Document B purpose groups except car parks. An assembly building was a new lawn tennis pavilion. The other category included

- Electronic data processing machines, archive, stores, control rooms.
- Lighthouses, mainly emergency power facilities
- Ovens
- Archive room
- Computer room
- Heritage buildings
- Unspecified.

The breakdown of the buildings by type is shown in Figure 2. Most of these systems were found to be industrial or factories followed by dwellinghouses then shops.

The differences between responses given for Questionnaires (1) and (2) could be because industrial systems are primarily for asset/property protection where the insurers rather than building control bodies/fire brigade have influence.



**Figure 2**

### 5.5 Type of systems

According to the Questionnaire (1) respondents, 91% of these systems were water mist, 7% were water fog, and 2% were other (similar) systems which included an oxygen depletion system and gas extinguishing systems.

According to the Questionnaire (2) respondents, 96% of these systems were water mist and 4% were water fog.

It is likely that water fog systems are water mist systems, see section 3.

### 5.6 The main reasons for the use of these systems

There were various main reasons for using these systems, according to Questionnaire (1) and (2) respondents, which are shown in Table 5.

**Table 5 Main reasons for using water mist systems**

<b>Reasons given</b>	<b>Questionnaire (1) (%)</b>	<b>Questionnaire (2) (%)</b>
Benefit additional to Building Regulations requirements	6	7
Compensatory feature to meet Building Regulations requirements	28	9
Fire Service recommendation	14	7
Property protection	9	16
Alternative to automatic sprinkler systems	17	12
Aesthetics	4	5
Water supplies	5	12
Performance	2	19
Cost benefit	5	7
Other reasons	9 <ul style="list-style-type: none"> <li>• Water damage reduction</li> <li>• Special risk</li> <li>• Listed/historic building</li> <li>• Halon replacement</li> <li>• High risk of arson</li> <li>• Database/computer protection</li> <li>• Compensatory feature to meet environmental health requirements</li> <li>• To meet Scottish benchmark standards.</li> </ul>	6 <ul style="list-style-type: none"> <li>• Special risk/risk specific</li> <li>• Power supplies to keep building going</li> <li>• Alternative to gas system.</li> </ul>

### **5.7 Number of systems considered fit for purpose and how many not**

The respondents to Questionnaire (1) considered that 92% of the systems they have been involved with were fit for purpose, 3% were not fit for purpose and 5% may or may not be fit for purpose.

All the Questionnaire (2) respondents were confident that the systems were fit for purpose.

### **5.8 Standards/specifications used for system design**

The Questionnaire (1) and (2) respondents who filled in this question thought that the standards/specifications that were used for system design were as collated in Table 6, see section 4 on current standards.

**Table 6 Standards/specifications used for system design**

<b>Standards/ specifications</b>	<b>Questionnaire (1) details</b>	<b>Questionnaire (2) details</b>
British, European or ISO building related standard	BS 7273 Part 1, 1990 for electrical actuation <sup>9</sup>  BS 5306 Part 2 <sup>8</sup> , EN 12845 <sup>10</sup> (where appropriate)  BS DD 240 and BS DD 251 <sup>11, Note1</sup>  Current BS	BS 7273 Part 1, 1990 for electrical actuation  BSI kitchen fire test  BS 5306 Part 2 (sprinklers)
USA standard	NFPA 750 NFPA 15 <sup>12</sup>	NFPA 750
USA building related standard	Not specified	Not specified
IMO ship protection standard	IMO FTP code resolute A.800 <sup>19</sup>  Offshore standard	IMO MSC Circ/728 IMO MSC 44/65 IMO a.800(19) IMO MSC Circ/668
Manufacturers' literature/data sheet	System 3 manufacturer's letter listing standards (IMO MSC 64/22/add.1, NFPA 750, NFPA 13R <sup>13, Note 1</sup> and 13D <sup>14, Note1</sup> , BS DD 2251: 2000 Note 1 except for maintaining water flow rates)  System tested in Norwegian fire research laboratory	Not specified
Approvals body standard	FM standard <sup>15</sup>  LP2000 (not a standard)	VdS design manual <sup>16</sup> SOLAS, VTT Bureau Veritas (BV), Det Norske Veritas (DNV), Lloyds register, American Bureau of Shipping (ABS) insurance test protocols.
Other	Draft proposal document - B1 trade off when using a domestic sprinkler installation (covers water mist) prepared by a county fire authority and district surveyors association	End user verification programme  LUL
Don't know or unsure	Only for Questionnaire (1)	Not applicable

Note 1. NFPA 13 R, NFPA 13 D and BS DD 251 are for residential sprinklers.



## 5.9 Confidence that the systems installed are “fit for purpose”

The respondents who answered this question for Questionnaire (1) were confident that the systems installed are fit for purpose for the following reasons:

- System designed, installed and maintained to a standard (21)
- General fire demonstration (14)
- Installed by an approved installer (13)
- Product approved to a standard (11)
- Manufacturer’s literature (11)
- Fire performance test applicable to application/building (8)
- Independent laboratory test report (3)
- Don’t know (15)
- Other (4)
  - Product approval
  - Independent fire report
  - Fire service research demonstration
  - No involvement in choice of system
  - Not proven.

The number in brackets corresponds to the total number of ticks for each reason. A percentage is not meaningful in this case.

The respondents to Questionnaire (2) were all confident that the systems installed are fit for purpose for the following reasons:

- Fire performance test applicable to application/building (9)
- System designed, installed and maintained to a standard (7)
- Product approved to a standard (7)
- Installed by an approved installer (6)
- Independent laboratory test report (6)
- Manufacturer’s literature (5)
- General fire demonstration (4).

The number in brackets corresponds to the total number of ticks for each reason. A percentage is not meaningful in this case.

## 5.10 Whether installed systems checked for compliance to the appropriate standards

Twenty one of the respondents to Questionnaire (1) who had encountered water mist systems in buildings in the UK said that the systems were checked for compliance, 2 said they weren’t and 17 did not know whether they were checked for compliance. Four did not respond to this question.

Eight of the respondents to Questionnaire (2) who had encountered water mist systems in buildings in the UK said the installed systems were checked for compliance to the appropriate standards and 1 said they were not. One did not respond to this question.

### **5.11 Have designers or installers received specialist training for these types of system**

All of the respondents to Questionnaire (2) who had encountered water mist systems in buildings in the UK said yes, they had been on either another manufacturer's training course or their own training course.

### **5.12 Knowledge/experience of an activation of a water mist, water fog or similar innovative system in a real fire in a building application in the UK**

Five respondents in Questionnaire (1) had knowledge of 7 operations of a water mist, water fog or similar innovative system in a real fire in a building:

- Two fires in West Yorkshire (no details given but one may be the same as below)
- Four fires in warehouses (no details given)
- One in kitchen fire in a sheltered housing unit in Leeds, West Yorkshire at 7.40am on 3 October 2003.

"Wakefield Metropolitan District Council had a system 3 (see Table 1) low pressure residential water mist suppression system installed and commissioned in one of their sheltered housing units during July 2003. The system covers the apartments lounge, hall, bedrooms and kitchen and the buildings common areas except corridors. Either pendent ceiling nozzles with activation at 68<sup>o</sup>C or system 3 sidewall units with activation at 57<sup>o</sup>C are used. The pipe work and actuation heads are concealed from sight within the residential occupancies.

A fire broke out in the sheltered housing unit on Friday morning 7.40am on 3 October 2003 in apartment 15 occupied by a ninety year old man. The fire was in the kitchen where a toasters outer casing caught fire under the kitchen cupboards. A system 3 sidewall unit was located on the wall of the kitchen, it is estimated that the ceiling temperature would have reached 90–95<sup>o</sup>C, which activated the units nozzle extinguishing the fire in seconds. The system contained the fire to the kitchen, with no smoke damage to any other part of the flat. "(Taken from West Yorkshire Fire Prevention Panel AGM notes of 2 December 2003).

There was knowledge from the Questionnaire (2) respondents of an activation of a water mist system in 11 fires, as follows:

- One sauna and one fat fryer fire
- Kitchen fire where fire was extinguished and occupant saved
- Builder's rubbish fire external to new apartment spreading into the property
- Care facility occupant set fire to chair, system extinguished fire
- Greater than 6 fires in factory machinery all successfully extinguished

The systems were reported to be effective in all these cases.

### 5.13 General opinion on water mist, water fog or systems for protection of residential or other premises

77% of Questionnaire (1) respondents to this question favoured water mist, water fog or similar innovative systems for the protection of residential or other premises, 9% discouraged their use and 14% had no opinion. One person did not answer this question.

Therefore, Questionnaire (1) respondents generally favoured water mist, water fog or similar innovative systems. There were many comments following this question, as follows. Water mist systems were discouraged because:

- “Until a consensus design standard can be established and approved equipment is available
- Because no BS EN installation standard
- For protection of residential, systems require regular maintenance therefore not suitable for residential or similar, systems are only suitable where it can be guaranteed that regular maintenance will be available
- Currently discourage/would not support for compliance with fire/building regulations as no acceptable ‘dwelling’ standard, may consider for non fire/building regulations application where system can be proved to be more appropriate/cost effective than BS DD 251 system”.

Water mist systems were favoured by Questionnaire (1) respondents because they:

- “Use less water than sprinklers but need a pump so usually more expensive if sprinkler system does not need a pump. Main issue is quality control and adequacy of design in absence of standards.
- Can often provide better protection than sprinklers, because cabinets or furniture do not shield fire from the mist/fog operation also scrubs the smoke from the atmosphere
- Seem ideal but needs British Standards Institution approval
- Gives superior performance to residential sprinklers from test data, less water damage, not dependent for operation on mains water supply, hence good for remote areas.
- Viable alternative to sprinkler systems.
- Early suppression of any fire is to the advantage of occupants
- With a proper testing regime and the development of a standard in relation to buildings, am sure that water mist will be able to play a major part in fire safety design
- Fire service ‘downsizing’, would be relatively easy to install in new premises
- Suitable where water damages equipment or could cause explosion (boiler rooms, generators, etc).
- No life risk as the system is for an automated car stacking system – ideal where water supplies are poor, British Standard or other required for installation in the UK
- Test evidence witnessed
- Impressed with demonstration which attended at the Fire Service Station in Liverpool
- Cost effective against sprinklers
- Improved means of escape in a listed building
- Self contained system not reliant on water mains, system puts fires out, reducing potential harmful combustion products, technology widely used and tested in vessels, system tamper proof, installed by approved contractors, complements passive protection and provides more design flexibility without prejudicing safety, more effective than sprinklers

- Seen demonstrations and am convinced that systems are capable of rapid fire extinguishment, do not rely on a water supply from the mains so will not be subject to pressure variations.
- Favoured subject to compliance with suitable standards
- Support the active application of water mist to fire at the earliest opportunity, traditional fire sprinklers and residential sprinkler technology is often over specified, believe that water mist systems have a real role to play in community safety
- Less water required with booster pump, water mist knocks down smoke and causes less smoke damage, very quick extinguishment, alleged to give better conditions for means of escape
- Due to poor water supplies and lack of space/structural strength for storage tanks, 'traditional' systems may not be viable, these innovative systems may provide an alternative
- Based on evidence of demonstrations and lower cost of installation
- Any system providing it conforms to a given standard that we consider acceptable, is considered beneficial in preventing loss of life/serious injury and reduces fire spread/damage
- Reduces risk but cost has to be measured against other types of system i.e. BS DD 251.
- Believe water mist is extremely effective, cost beneficial and would be a welcome alternative which would particularly suit some specialist applications. However, need appropriate standard, guidance/approval for enforcing authorities in order for them to specify/recommend. Do not believe NFPA 750 and IMO standards to be appropriate for domestic/residential application".

Questionnaire (1) respondents had no opinion because:

- "It is not a building control function to have an opinion but measure if the system meets standards. It either does or does not. We cannot favour any product.
- Not enough understanding of the system yet
- They are difficult to apply to residential buildings as maintenance cannot be required or expected. The type of premises where they would be of most use are high risk residential e.g. HMOs".

75% of Questionnaire (2) respondents favoured the use of these systems but 25% discouraged the use of these systems. Water mist systems were favoured by Questionnaire (2) respondents because they:

- "Have unique benefits in certain situations
- Ease of installation on residential premises – type installed are commercial - high specification works – stainless steel pipe and control systems to BS 7273
- Low pressure water mist, fast 'knock down', greater fume scrubbing, greater cooling than conventional systems, reduced water requirements
- Less water damage, self contained, no power requirements
- Water mist performance is more effective than sprinklers".

Water mist systems were discouraged by Questionnaire (2) respondents because they are:

- "Expensive, with no independent design standards to follow and their performance is based on manufacturer's test not on third party thorough testing procedures
- Expensive, difficult to achieve desired operating water pressure. Sprinklers are more cost effective than water mist
- Requirement for continuous water supply for Class A risks".

## 6 Collated findings

The following information and discussion is based on the findings from the answers to the questionnaire and also information gathered from interviews and the literature.

### 6.1 General findings

Water mist systems are currently the subject of debate and information about the overall effectiveness of these systems for land-based life safety applications is not established.

The subject of the performance of water mist systems is a complex one.

Fixed water mist fire suppression systems are an emerging technology and were originally demonstrated by a large amount of fire testing to be suitable and effective as halon alternatives for the protection of spaces on board ships, e.g. in machinery spaces.

The advantages of water mist systems are that they are environmentally friendly, and there is the perception that they use less water than other traditional water-based systems and may be more cost effective, particularly where system weight incurs a penalty.

The fire control mechanisms of water mist systems are different to those of sprinklers and fixed inert gas systems. The performance of water mist systems can be detrimentally affected by large compartment volumes, openings in the compartment, small heat output fires, some fire types and where shielding may occur.

Water mist systems have also been applied to land-based applications, e.g. local application asset protection of electronic equipment, deep fat fryers, machinery spaces, gas turbines, etc. These are applications where there is supporting third party validation test data. They are now being actively marketed in the UK as total compartment systems in offices, hotels, schools, historic buildings and residential and domestic premises for life safety and property protection reasons.

Currently, there is no British Standard on water mist systems or components. European and International Standards are in preparation. Existing water mist standards are not directly applicable to UK or European land-based applications. The lack of standards is in part because water mist systems are difficult to generalise. Sprinkler systems may only be required to control or suppress fires whilst it may be necessary for water mist systems to extinguish fires to ensure an acceptable outcome. This design objective in combination with the design variables, which may influence fire extinguishing performance, result in the need for bespoke water mist systems i.e. project specific designs.

## 6.2 Survey findings

1. A sixth of local authority building control officers, a third of Approved Inspectors and a third of fire safety officers who responded had had experience of water mist systems.
2. These systems are spread throughout the UK with a few 'high concentration' areas in residential and domestic dwellings.
3. The water mist companies reported approximately 1135 systems in 1086 buildings, in the UK. The building control and fire authority respondents reported one fifth of these systems. It may be that these authorities do not see all systems if they are outside their jurisdiction. The reported figures are probably an underestimate because not everyone replied and those who did may not have had knowledge of all the systems in their local area.
4. These water mist systems have been installed into all the Approved Document B (Fire safety) purpose groups in commercial, industrial, residential and domestic premises. The highest number reported by building control professional and fire safety officers is in dwellinghouses followed by flats and maisonettes. However, the water mist companies also reported a high number in dwellinghouses but a higher number in industrial premises or factories. This could be because industrial systems are for asset/property protection where the insurers rather than building control/fire brigade have influence.
5. There appears to be some confusion by some local authorities and fire brigades about which protection systems are water mist. For example sprinkler systems, gas systems, oxygen reduction systems.
6. Water mist systems have been accepted by authorities having jurisdiction, for a variety of reasons, the main being as compensatory features to the Building Regulations requirements, on fire service recommendation. By contrast, the water mist companies state their main reasons as performance and property protection closely followed by other reasons.
7. There is a high confidence from all respondents about fitness for purpose of water mist systems.
8. There are a large number of standards referenced with varying degrees of relevance to water mist systems in UK land-based applications.

The approving authority needs to satisfy itself that these systems are 'fit for purpose'/appropriate for their intended use, in particular whether there are adequate published standards for design, installation and maintenance, adequate published standards for products, and/or whether there is appropriate technical evidence of their effectiveness in the particular application.

The building control professionals and fire safety officers would like a British Standard or equivalent.

There is lots of test work and reports on fire tests using water mist systems but they find it hard to filter out relevant details and assess whether this is applicable

to a particular land-based situation. The rigor of fire testing is not always checked or checkable.

In some cases, they seem to harbour a number of myths, misunderstandings and lack of knowledge about water mist systems which means that in some cases, systems seem to be accepted on the wrong basis e.g. from a general demonstration, from evidence of non applicable data, thinking it is a sprinkler system, thinking "something is better than nothing", confusion between different types of suppression systems.

The water mist companies and trade associations are generally confident with the current status of standards and aware of European standards development. However, they acknowledge that the draft European standard does not include residential and domestic applications where performance requirements, development of suitable test protocols and performance criteria are needed.

9. The respondents' confidence in the fitness for purpose comes from the use of standards, fire demonstrations and performance tests.

In the absence of detailed guidance, adhoc fire tests have been carried out in attempt to represent the realistic fire scenario to demonstrate the performance of the system.

Insurers seem to be taking the lead in requiring ad hoc testing of water mist applications in specific risks where they are being used for asset/property protection purposes.

10. 50% of local authorities and 90% of water mist companies stated that installed systems are checked for compliance to standards.
11. All designers and installers who responded have received specialist training.
12. There appear to have been very few reported fire events in the field in the UK. In all the reported fire events the water mist systems have performed successfully.

It seems to be accepted both by the building control professionals, fire safety officers and the representatives of the water mist companies that water mist has the potential to be extended to new land-based applications.

13. Local authorities and some water mist companies perceive water mist systems to be better than sprinkler systems because speed of extinguishment, less water required, less water damage, no requirement for mains connection, ease of installation and cost. Other disagreed with these points.

Many expressed concerns regarding the lack of an appropriate British Standard for buildings water mist protection and systems being marketed without suitable prior testing, witnessing or third party verification by some of the smaller companies/ manufacturers.

Some suppression systems are better than/more suitable than others for certain applications; water mist may not always be the best or an appropriate solution to a fire protection problem. There is a concern from part of the suppression trade about some companies who deal only with water mist and for commercial

expediency always offer water mist rather than selecting another more appropriate suppression product. In these cases there may be inappropriate application e.g. where sprinkler would do better, poor designs e.g. insufficient nozzles, 'risk taking' e.g. when there is no data to confirm system will perform effectively and poor selection of design parameters e.g. inadequate duration of operation.

There is concern about some companies where there is poor installation practice.

There is currently no installers' certification scheme for water mist systems.

There is less confidence and a concern about the use of water mist in life safety total compartment applications in residential, domestic and commercial premises as an alternative to sprinklers. There is a need for experimental validation of systems before they are used in these premises for appropriate room sizes, ventilation conditions and fuel load arrangements. There is merit in dealing with residential and domestic premises as a special case. There is a need for classifications of area of coverage, hazards, and duration of water supplies.

There is concern about the extrapolation of verification data, e.g. for large heights with total compartment systems.

Method of detection and time of activation is critical for water mist systems.



## 7 Conclusions

The conclusions of the study are as follows:

1. Over 1000 water mist systems currently installed in the UK were reported. Most of the water mist system installed in life safety applications had been installed in the last two or three years.
2. These systems are spread across the UK with a high concentration in one or two areas in domestic and residential premises.
3. These comprise various types of water mist systems installed in a range of local and total compartment applications. ? They have been installed into all the Approved Document B purpose groups.
4. The highest numbers of these water mist systems are installed in
  - a) dwellinghouses followed by flats and maisonettes, according to building control professionals and;
  - b) fire safety officers and industrial premises or factories followed by dwellinghouses, according to water mist companies.
5. Water mist systems have been accepted by the authorities having jurisdiction for a variety of reasons, the main being as compensatory features to Building Regulations requirements and on fire service recommendation.
6. Currently, there is no British Standard on water mist systems or components. European and International Standards are in preparation. Existing water mist standards are not directly applicable to UK or European land-based applications.
7. There are a large number of standards referenced by respondents with varying degrees of relevance to water mist systems for UK land-based applications.
8. Water mist systems are being proved fit for purpose from the use of standards, fire demonstrations and performance tests.
9. The building control professionals and fire safety officers would like a British Standard or equivalent.
10. There are lots of fire test work/reports using water mist systems but building control professionals and fire safety officers find it hard to filter out relevant details and assess whether they apply to the particular land-based situation. The rigor of fire testing is not always checked or checkable.
11. In some cases, the building control professional and fire safety officers seem to harbour a number of myths, misunderstandings and lack of knowledge about water mist systems.
12. The water mist companies and trade associations are generally confident with the current status of standards and are aware of European standards

development. However, they acknowledge that the draft European standard does not include residential and domestic applications where performance requirements, the development of suitable test protocols and performance criteria are needed.

13. There is a general concern about the use of water mist in life safety total compartment applications in residential, domestic and commercial premises. There is merit in dealing with residential and domestic premises as a special case.

## 8 Recommendations

Recommendations for further work that may be appropriate and/or necessary to provide full consideration of these systems for life safety and property protection for use in buildings are as follows:

- i) An independent simple guide on water mist. Consideration should be given to producing a guide for use by approving authorities (building control professionals and fire safety officers) to detail current knowledge, improve education about systems, to dispel myths/misunderstandings, etc. This guide could include an assessment schedule/checklist.

Such a guide could be published by the relevant Government departments, BRE, insurance industry, standards arena or trade association or perhaps a combination of these.

- ii) Specification on water mist for domestic and residential occupancies. This has been identified as a special case for consideration.
  - a. Write fire test procedure with performance criteria based on and similar to DD252 but for water mist.
  - b. Select water mist system and carry out preliminary fires to assess feasibility of using water mist. Following success, proceed with ii) c.
  - c. Carry out independent detailed generic experimental research to evaluate the effectiveness of water mist systems for domestic and residential applications. This would investigate the effect of key parameters, e.g. ventilation, room size, fire type.

Fire test procedure could be published via standards arena as a British Standards Specification or Method document for submission to be included in the European draft standard.

- iii) Specification on water mist validation fire tests.
  - a. Design of application specific validation fire tests for acceptance of systems for real scenarios. This would include setting performance criteria for water mist systems.
  - b. Carry out independent generic experimental research to evaluate the effectiveness of water mist systems for realistic land-based applications. This would investigate the effect of key parameters.

Fire test procedures could be published via the standards arena as a British Standards Specification or Method document for submission to be included in the European draft standard.

Note on generic experimental research. Because of the bespoke nature of water mist systems, system suppliers would need to be involved in designing, setting up and running systems for any experimental work, without compromising independence.

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**Appendix A – Questionnaires**

**QUESTIONNAIRE (1)**

**FIRE SUPPRESSION USING WATER MIST, FOG OR SIMILAR  
INNOVATIVE SYSTEMS IN BUILDINGS IN THE UK**

1. Please select one of following categories, which best describes your primary role?

- Local Authority Building Control Officer
  - Approved Inspector
  - Fire Authority – Fire Prevention Officer
  - Other-say what \_\_\_\_\_
- 

2. Do you or have you encountered in your work the use of water mist, water fog or similar innovative fire suppression systems installed in buildings in the UK (excluding automatic sprinkler systems to a published standard e.g. BS 5306 Part 2: 1990 or a medium velocity or high velocity spray system)?

- Yes
- No

If the answer to question 2 is 'No', the questionnaire is finished. If Yes, please proceed to the next question.

3. Roughly, how many buildings with water mist, fog or similar innovative systems (excluding automatic sprinkler systems) in the UK have you had contact with?

Number of buildings \_\_\_\_\_

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4. What were the building types, tick all the boxes that apply and indicate number?

- Flat or maisonette, number \_\_\_\_
- Dwelling house, number \_\_\_\_
- Hospital, residential care home, number \_\_\_\_
- Hotel, boarding house, residential college, hall of residence, hostel, number \_\_\_\_
- School, number \_\_\_\_
- Office block, number \_\_\_\_
- Shop and commercial, number \_\_\_\_
- Assembly, entertainment or recreation, details and number  
\_\_\_\_\_
- Industrial/factories, number \_\_\_\_
- Car park, number \_\_\_\_
- Other, please specify, number \_\_\_\_

Please provide further details \_\_\_\_\_

\_\_\_\_\_

5. What type of systems were these?

- Water mist, number \_\_\_\_
- Water fog, number \_\_\_\_
- Other similar, say what and number \_\_\_\_\_

6. What was the main reason (s) for the use of these systems, tick all that apply

- Benefit additional to the Building Regulations requirements
- Compensatory feature to meet Building Regulations requirements
- Fire Service recommendation
- Property protection
- Alternative to automatic sprinkler system
- Aesthetics
- Water supplies
- Performance
- Maintenance
- Cost beneficial
- Unsure
- Other, please specify \_\_\_\_\_

7. Of the systems you have been involved in, how many do you consider are fit for purpose and how many are not?

- Yes, fit for purpose, number \_\_\_\_
- No, not fit for purpose, number \_\_\_\_
- Uncertain, number \_\_\_\_

Reason \_\_\_\_\_

8. What standards/specifications were used for system design?

- British, European or ISO building related Standard
- USA building related standard
- IMO, ship protection standard
- Manufacturer's literature/datasheet
- US standard
- Approvals body standard
- Other, please specify \_\_\_\_\_

Please fill in details of standard(s)/specification(s) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

9. Why do you have confidence that the systems installed are "fit for purpose"?

- System designed, installed and maintained to a standard
- Product approved to a standard
- Fire performance tests applicable to application/building
- Approved installer
- General fire demonstration
- Independent laboratory test report
- Manufacturer's literature
- Other, please specify \_\_\_\_\_

10. Are installed systems checked for compliance to the appropriate standards?

- Yes
- No
- Don't know

11. Do you have any knowledge/experience of any of an activation of a water mist, water fog or similar innovative system in a real fire in a building application in the UK?

Yes, number \_\_\_\_

No, number \_\_\_\_

Please provide any details \_\_\_\_\_

12. What is your general opinion on water mist, water fog or systems for protection of residential or other premises?

Favoured

Discouraged

No opinion

Please provide reason(s) \_\_\_\_\_

Signed \_\_\_\_\_

Date \_\_\_\_\_

## QUESTIONNAIRE (2)

### Fire suppression using water mist, fog or similar innovative systems in buildings in the UK

1. Does your company specify, design, manufacture, supply or install water mist, water fog or similar innovative fire suppression systems in buildings in the UK (excluding automatic sprinkler systems to a published standard e.g. BS 5306 Part 2: 1990 or a medium velocity or high velocity spray system)?

Yes

No

If the answer to question 1 is 'No', the questionnaire is finished. If Yes, please proceed to the next question.

2. Please select one of following categories, which best describes your primary role?

System specifier

System designer

System manufacturer

System supplier

System installer

Other-say what \_\_\_\_\_

3. Roughly, how many buildings with water mist, fog or similar innovative systems (excluding automatic sprinkler systems) in the UK has your company dealt with?

Number of buildings \_\_\_\_\_

4. Whereabouts in the UK are these?

- Mainly in general locality of business, where \_\_\_\_\_
- Mainly in specific location (s), where \_\_\_\_\_
- Randomly spread across the UK
- Other – please specify \_\_\_\_\_

5. What were the building types, tick all the boxes that apply and indicate number?

- Flat or maisonette, number \_\_\_\_
- Dwelling house, number \_\_\_\_
- Hospital, residential care home, number \_\_\_\_
- Hotel, boarding house, residential college, hall of residence, hostel, number \_\_\_\_
- School, number \_\_\_\_
- Office block, number \_\_\_\_
- Shop and commercial, number \_\_\_\_
- Assembly, entertainment or recreation, details and number \_\_\_\_\_
- Industrial/factories, number \_\_\_\_
- Car park, number \_\_\_\_
- Other, please specify, number \_\_\_\_

Please provide further details \_\_\_\_\_

\_\_\_\_\_

6. What type of systems were these?

- Water mist, number \_\_\_\_
- Water fog, number \_\_\_\_
- Other similar, say what and number \_\_\_\_\_

7. What was the main reason (s) for the use of these systems, tick all that apply

- Benefit additional to the Building Regulations requirements
- Compensatory feature to meet Building Regulations requirements
- Fire Service recommendation
- Property protection
- Alternative to automatic sprinkler system
- Aesthetics
- Water supplies
- Performance
- Maintenance
- Cost beneficial
- Unsure
- Other, please specify \_\_\_\_\_

8. Of the systems you have been involved in, are you confident that they are fit for purpose?

- Yes, fit for purpose
- No, not fit for purpose
- Uncertain, number \_\_\_\_

Reason \_\_\_\_\_

9. What standards/specifications were used for system design?

- British, European or ISO building related Standard
- USA building related standard
- IMO, ship protection standard
- Manufacturer's literature/datasheet
- US standard
- Approvals body standard
- Other, please specify \_\_\_\_\_

Please fill in details of standard(s)/specification(s) \_\_\_\_\_

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10. Why do you have confidence that the systems installed are "fit for purpose"?

- System designed, installed and maintained to a standard
- Product approved to a standard
- Fire performance tests applicable to application/building
- Approved installer
- General fire demonstration
- Independent laboratory test report
- Manufacturer's literature
- Other, please specify \_\_\_\_\_



11. Are installed systems checked for compliance to the appropriate standards?

- Yes
- No
- Don't know

12. If you are a designer or installer, have you received specialist training for these types of systems?

- Yes
- No
- Not applicable

Please provide any details \_\_\_\_\_

13. Do you have any knowledge/experience of any of an activation of a water mist, water fog or similar innovative system in a real fire in a building application in the UK?

- Yes, number \_\_\_\_
- No, number \_\_\_\_

Please provide any details \_\_\_\_\_

14. What is your general opinion on water mist, water fog or systems for protection of residential or other premises?

- Favoured
- Discouraged
- No opinion

Please provide reason(s) \_\_\_\_\_

Signed \_\_\_\_\_

Date \_\_\_\_\_