Using water mist systems in buildings and structures

A guide to compliant applications

British Automatic Fire Sprinkler Association

bafsa

TECHNICAL GUIDANCE

#3

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BAFSA expresses its appreciation to all those who participated in the drafting and completion of this document and in particular to the members of the BAFSA Watermist Working Group and the Joint FIA/BAFSA Watermist Working Group.

Notes:
In earlier drafts of this document, there were significant number of references and footnotes. The number of these references has been reduced to those which is felt are essential and others moved to the end of the guide. Notes on units. This document uses the scientific notation for units, examples are given below:

Flow	*Litres per minute*	*$l.min^{-1}$*
Density	*mm (per minute per m^2)*	*$mm.min^{-1}$ or $l.min^{-1}.m^{-2}$*
Size	*micron metre*	*µm*
Fire Load	*mega joules per m^2*	*$MJ.m^{-2}$*

Note also that although the pressure measurement 'Bar' is not an SI unit and is widely used in fire protection engineering.

1 Bar = 1000 kPa 1 Bar = 14.50377 1 Bar = 0.980665 kg/cm²

Scope

Water mist systems are based on proprietary products and designs; they are not harmonized to a common set of properties. The layout and spacing of nozzles, operating pressure and water capacity will differ between manufacturers and technology. It should be noted that nozzles and components are rarely interoperable (which means one cannot use a nozzle from one manufacturer on a system installed based on a different manufacturer).

This document has been written to provide facts about water mist as a firefighting technology. The general perception is that the application of water mist technology is similar or equivalent to sprinklers or gas extinguishing systems. This is not the case. The use of sprinklers and gas extinguishing systems is guided by prescriptive standards, developed from decades of fire-testing, research and knowledge base of their effectiveness and reliability in real-case fires. Water mist is a performance-based technology. That is, it that requires specific testing to each possible fire scenario. For a limited set of fire scenarios, a set of standardised fire test protocols have been developed. Each manufacturer has developed their own water mist product to 'pass' one or more of these fire test protocols. Thus, all water mist systems are based on proprietary manufacturers' technology and design. The correct use of the design standards for water mist are dependent on an assessment of the application hazard and determination of applicability with the relevant fire test protocol; proof of independent third-party fire testing to that protocol; proof of third-party component approval; and limits of applicability as determined through testing and documented in the manufacturer design manual. There is a requirement to ensure competence in design for water mist systems that is not currently verified through examination, or a LPCB third-party verification scheme, such as LPS1048 or LPS1204 respectively for sprinkler and gas extinguishing systems.

The aim of this document is not to replicate information that exists in standards but to explain the context in which they have been drafted, and to detail considerations and limitations of water mist systems, which are not clearly documented in all standards. It should be a useful document for those who may wish to specify fire suppression systems, have a role in approving these or simply want to increase their knowledge of water mist.

The annexes at the end of the document provide technical and supporting references.

1.0 Introduction

Over the past 30 years, water mist technology has increasingly been considered a viable method of protecting the occupants of buildings and some building equipment and contents. This document provides a guide to what mist systems can (and cannot) do and provides a guide to technology used and the standards that are presently available.

This document does not replicate or replace any specific standard but summarises the knowledge contained within. It aims to set the requirements in context so that they can be better understood by those who wish to procure, specify, or approve water mist systems.

The design of water mist systems is intended to achieve a fire performance objective. This maybe to achieve fire extinguishing, suppression, or control.[1] Manufacturers use differing technology to develop and maximise the efficiency and effectiveness of droplet deployment to achieve the performance objective. This will vary with both the manufacturer and with the application, both for the nozzle and means of water delivery. For each nozzle type there will be a change in nozzle appearance, minimum operating pressure, k-factor[2], spacing, height and activation type; and in different requirements for location, orientation and limitations (for example, use with ventilation).

As discussed in the introduction, water mist, unlike sprinkler or gas extinguishing systems, is wholly application and manufacturer specific. Each particular hazard or occupancy requires its own very specific design which is detailed in the manufacturer's DIOM (Design Installation Operation and Maintenance manual). This DIOM should include limits of applicability (such as fire hazard, temperature, height, ventilation, obstructions, etc). It is therefore not possible to design a mist system simply by reference to one of the standards available. This is unlike sprinkler systems where reference to BS EN 12845 or BS 9251 may suffice, or gas extinguishing systems where the BS EN 15004 series or BS 5306 Part 4 apply. For water mist, the DIOM is the fundamental guide to application and manufacturer specific design instructions whilst the standards *per se* list the performance requirements of water mist systems independent of manufacturer for the occupancies where fire test protocols exist.

1.1 DEFINITION OF WATER MIST

Definitions vary between standards in terms of the method of measurement, but a good working definition is:
"A water spray for which the cumulative volumetric distribution of 90% of water droplets is less than 1,000µm (microns)[3] at the nozzle minimum operating pressure".

1.2 DEFINITION OF A WATER MIST SYSTEM

A fire suppression distribution system connected to a water supply, that discharges water mist where required, that is fitted with one or more nozzles intended to extinguish, suppress or control the fire.

1.3 HISTORY OF DEVELOPMENT OF WATER MIST

Early maritime water mist applications were introduced following disastrous fires on two large passenger ferries in 1990. In 1993 a series of independent cabin and corridor fire tests were undertaken which led to revised International Maritime Organisation fire safety requirements for passenger ships and the development of installation guidelines and fire test procedures for alternatives to conventional sprinkler systems.

Early use of land-based water mist technology came at the beginning of the 1990 and was partly linked to the rapid expansion of food processing production plants that were being constructed to cope with the growing demand for ready-prepared meals and other convenience foods. The food industry and their insurers recognised the benefits of correctly installed and tested water mist systems in extinguishing potentially disastrous fires.

At about the same time, following the prohibition on the use of the Halon gases for firefighting in 1989, water mist joined the portfolio of alternative extinguishing media considered and developed by the fire industry.

Early applications were limited to very specific occupancies requiring full scale fire tests. Over the last 25 years however, much research has been carried out and as experience has grown with the subsequent development of fire test standards.
Water mist systems are a now an alternative for gas extinguishing systems for a wider range of hazards including engine rooms, electrical transformers, steam and combustion turbines, and oil

cookers. These types of applications were traditionally protected by carbon dioxide systems, but there is general acceptance by insurers and users that a suitably tested and approved water mist system is both safe and effective.

Water mist has also been installed in homes, saunas, and heritage buildings. These types of applications (and others such as schools, offices, and data centres) require a much higher level of fire engineering to determine the suitability of water mist. This will be determined, amongst other factors, on the relevant fire test protocol and the limitations of the design to ensure the water mist system provides the fire protection objective. For an independent assessment of suitable applications, reference should be made to the standard BS 5306 Part 0.

The need for coherent guidance for performance-based water mist technology has led to the production of British, European, US and Maritime Standards for the design, installation, commissioning, and maintenance of water mist systems.

The detail of within each standard differs but the common theme is the water mist system must be performance tested for any given application to meet specific criteria (be that extinguishing, suppression, or control) as defined by a relevant fire test protocol. There are also detailed sections that cover salient matters such as component approval and design competence. At present in the UK there are both UK and European standards used in parallel, and it is an unfortunate fact that this has led to a 'pick and mix' approach from less competent designers.

1.4 HOW WATER MIST WORKS

For a fire to spread, it relies on the presence of the three elements: oxygen, heat and combustible material. This is known as the fire triangle. The removal of any one of these elements can suppress or extinguish a fire.

The fire triangle

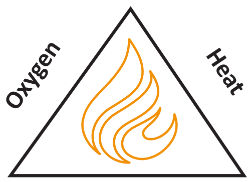


Figure 1: The fire triangle and water droplet size in relation to surface area

Water mist removes heat and displaces oxygen and provides a wetting interface between unignited combustibles and the flame front. The physical difference between water mist and sprinklers is simply the droplet size. As the droplet size decreases the following physical changes take place:

1. The mass decreases. This permits a more rapid evaporation of the water. It allows movement of the water within an air stream (entertainment). It lowers its momentum which can inhibit the water from penetrating the heat plume.
2. Per unit volume there are more droplets which increases the surface area available for contact with heat.

The production of small droplets can be achieved through a variety of technologies that include:

1. Using high pressure (typically greater than 60 bars) to force water through very small orifices. The pressure energy is transferred to breaking the water into small droplets that emit at high speed but small mass and pressure (droplet diameter in the range of 50 to 200 microns)
2. Using a deflector that breaks the water into droplets typically between pressures of 4 to 16 bars ('low' pressure). (Droplet diameter in the range of 150 to 350 microns)
3. Using a propellant gas (such as nitrogen or air) to atomize the water at a nozzle at pressures typically 6 to 8 bars (droplet diameter in the range of 10 to 50 microns). These are known as twin fluid systems. Note that they differ from water mist systems where the propellant is used simply to pressurize the water.

Note that pressure is not the defining property of water mist. The performance of the water mist system is all that is relevant. To avoid confusion neither the UK or European standards use the terms high- or low-pressure water mist. There are some performance and application differences between technologies.

Water has unique thermodynamic properties. The first is its specific heat capacity, that relative to other materials is very high. The specific heat capacity is the amount of energy required to heat one kilogram of substance by one degree kelvin[4]. The value for water is 4,200 $J.kg^{-1}K^{-1}$. This means that 4,200J (joules) of energy are required to heat 1kg of water by 1 degree Kelvin (1°C). Conversely cold water put onto a hot surface will extract the same amount of energy per unit mass/temperature drop.

The second important property is the latent heat of vaporisation. Once the water temperature reaches 100oC it changes phase to vapour (steam) without a change in temperature. The energy required for this phase change is known as the latent heat of vaporisation. For water this value is 2,257$kJ.kg^{-1}$. This means that 2,257kJ (kilojoules, or 2.257MJ (megajoules)) of energy is required to change liquid water to vapour. As for the example for specific heat capacity above, this property is used to extract heat.

The smaller the droplet size, the greater number of droplets per unit volume and a greater the surface area with which to absorb the heat. Therefore, smaller droplets equate to greater heat extraction and more rapid cooling.

Water as a droplet or vapour contributes to firefighting through two other mechanisms. The first is dilution of oxygen around the flame which removes a second element of the fire triangle. The second is the attenuation of radiation which

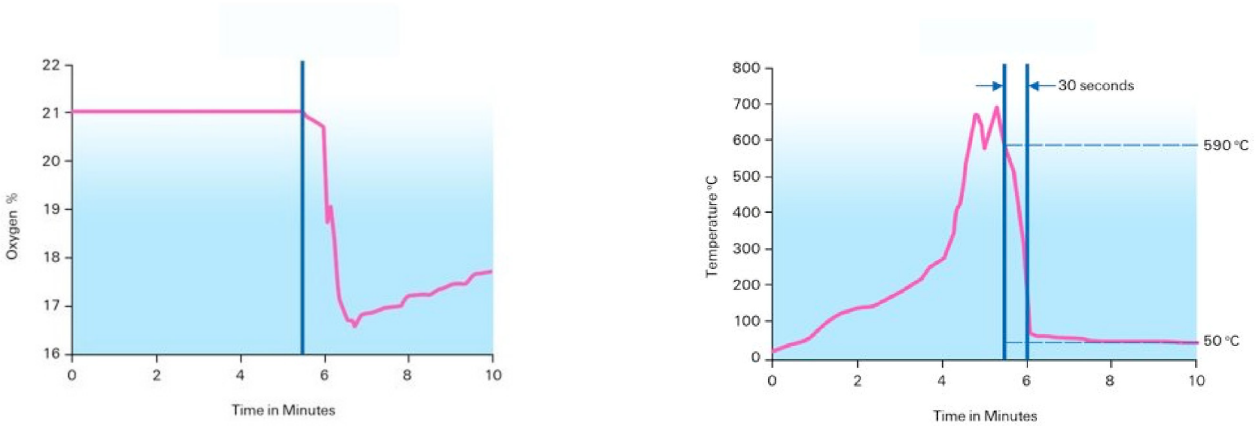


Figure 2: Oxygen reduction and temperature drop for water mist discharged on a Class B fire

prevents heat transferring to adjacent combustibles and structures, such as walls and ceilings.

Not all fires are 'hot' and therefore the effectiveness of water mist depends not only on its droplet size but also the fire class of the material and its burn temperature.

Let us first consider Class B or Class F fuel types. Class B fuels are flammable hydrocarbon liquids or solids that include heptane, oil, paraffin wax, and alcohols. Class F fuels are vegetable or animal fats used in commercial or industrial cooking. Both Class B and Class F fires are characterised by a high temperature burn. The water removes heat energy first through the mechanism of specific heat capacity and then through latent heat of vaporisation. The production of large amounts of steam as the water changes phase depletes the oxygen around the flame front. The fire is extinguished when the oxygen level falls below 15% by volume. The cooling by water mist post extinguishment is equally as important as it will lower the fuel below the ignition temperature, preventing re-ignition.

Water Consumption 1MW Fire Extinguishment

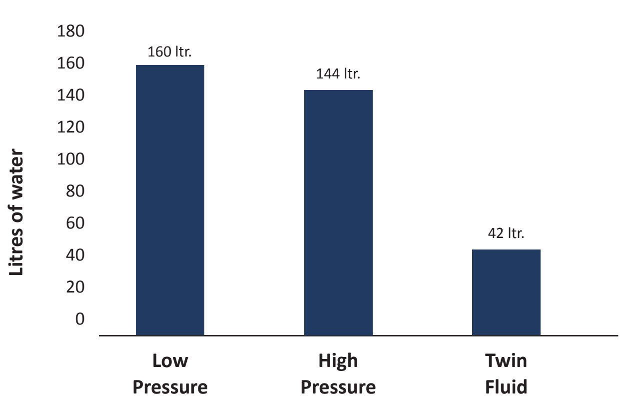


Figure 3: Relative water quantity required to extinguish a 1MW fire per water mist technology – decreasing droplet size reduces the water required

The application of water mist for Class B or Class F fires is by means of a deluge, or open nozzle system, whereby the water mist is discharged simultaneously through all nozzles. Actuation is via a detection system. The fire test protocols and approval procedures for this type of fire hazard have been long established and it is fair to say, that water mist is probably the de facto choice for these applications.

Test data proves that the smaller droplet sizes are more efficient in terms of water quantities, see is shown in Figure 3.

The design of water mist systems for Class B and Class F applications is of two forms – total flood or local application. In total flood the entire volume is filled with water mist (for example a generator enclosure). Water mist nozzles are required to be installed across uncloseable openings to prevent ingress of external air (oxygen) during the extinguishing process. For local applications water mist nozzles are directed on or around the object to be protected (for example industrial deep fat fryers).

Note that twin fluid systems rely on providing extinguishment to a greater degree through use of the atomising gas. The residual oxygen level is between 10-12% and the water mist provides additional cooling.

If we now consider Class A fuel types, the application of water mist now is more challenging. Class A fuels include combustibles such as wood, paper, and cloth, etc. Also within Class A fire class are plastics, which have unique burn characteristics. Class A fires are also deep-seated. This means that even if the surface temperature is cooled there is often sufficient thermal energy within the material to allow pyrolysis to continue (it is the pyrolyzed (material gas) products that ignite). Thus, whilst extinguishment is desirable it cannot be guaranteed and the objective of (all but one published) fire test protocol for Class A fires is that of suppression, defined by parameters within the protocol. Note that the defining parameters differ between fire test protocols, and it is important to ascertain the application requirement prior to deciding the suitability of a particular fire test protocol.

For Class A applications the water mist system is configured as an automatic system (as a sprinkler system). That is, each nozzle has a frangible heat sensitive element that acts as both detector and actuator. Water will only discharge from each nozzle that has reached activation temperature.

The suppression of Class A fires requires more water than for Class B or F fires, and the larger droplet sizes may produce more efficient systems in terms of water quantity used (as opposed to Class B and F fires). This is thought to be due to the importance of direct impingement and wetting of the material over indirect entrainment.

The effectiveness of water mist against sprinklers is often erroneously compared. As an example, a sprinkler water density is taken as 5mm (5 litres per minute per m^2) for a Class A fire ordinary hazard. This is then compared against a water mist water density of 0.5mm for a Class B fire hazard. Often accompanied by the statement "water mist is 10 x more efficient (or uses less water than) sprinklers".

As evidenced through fire testing, the water density to suppress Class A fires for water mist is not constant but increases with fire load density. As an example, for light hazard fire loads (< $150MJ.m^{-2}$), the lowest water density for a system approved to a light hazard fire test protocol (FM 5560 Appendix G) is 1.5mm and the average across all approvals is 2.5mm. This 50% of a sprinkler design density of 5mm.

For higher hazard fire loads, the water mist required density increases to between 3.5 to 4.2mm (based on the BS EN 14972-3 fire test protocol). Note for this hazard application the sprinkler design density is still 5mm. Note that the water mist values are at optimum (maximum) spacing and minimum pressures. In actual designs the water density will be more, which is explained below.

1. Definitions in BS 8489-1, see Annex 1 of this document
2. The k-factor is a nozzle constant that is used to calculate the flow rate at a given pressure
3. 1,000µm = 1mm
4. The Kelvin is an absolute unit of temperature whose unit value is the same as o Celsius. Zero kelvin is the lowest possible temperature equivalent to -273.16^{o}C, sometimes known as 'absolute zero'.

2.0 Water Mist Systems

Water mist systems are based on proprietary product; they are not harmonized to a common set of properties. The layout and spacing of nozzles, operating pressure and water capacity will differ between manufacturers and technology. It should be noted that nozzles and components are rarely interoperable (which means one cannot use a nozzle from manufacturer on a system installed based on different manufacturer). Nozzle and system designs are customised to the application, based on successful completion of fire testing which result in a variety of nozzle types, spacing and activation methods.

There are however generic water mist application categories.

2.1 TYPES OF SYSTEMS

2.1.1 OPEN NOZZLE OR DELUGE SYSTEMS

Open nozzle (or deluge) systems are dry pipe activated by a separate fire detection system.

Examples of open nozzles are shown in Figure 4.

2.1.2 AUTOMATIC NOZZLE SYSTEMS

Automatic nozzles contain a thermal element (normally a frangible thermal link or alcohol filled bulb) at a pre-set activation temperature (for most water mist nozzles tested and approved this is 57oC or 68oC). When the ambient temperature surpasses this value, the element fails (for example a thermal link will melt or the alcohol in the bulb expands breaking the glass). The water then flows from the nozzle. All other nozzles remain closed unless the ambient temperature exceeds their opening threshold value.

Example of automatic water mist nozzles are shown in Figure 5.

Note that automatic nozzles do not currently exist for twin-fluid systems.

2.1.3 ELECTRONICALLY CONTROLLED NOZZLE

A type of nozzle in which the release of water is made by electronic means instead of by mechanical means. An electronic control allows for a predetermined number of nozzles to operate via alternative means, for example a smoke, heat, or flame detector.

Figure 4: High and low pressure nozzles

Figure 5: Automatic Nozzle Examples

Figure 6: Electronically Controlled Nozzle Example

Note that at present there are no UK test standards for this type of nozzle.

2.2 TYPES OF APPLICATION

2.2.1 LOCAL APPLICATION

A local application (or object protection) system is used to protect facilities and equipment only, such as individual diesel driven generator sets, transformers, switchgear and deep fat fryers, by discharging water directly onto the hazard and if required adjacent risks. Their use is advantageous when a specific risk is disproportionately higher than the risk in the rest of the space, or the object is small compared with the overall volume. The design requirements for local application are more stringent as the extinguishing method relies much more on cooling than oxygen reduction since the volume is not fully enclosed. (An exception is within the hood of an industrial deep fat fryer). Local application systems use open nozzle system design.

2.2.2 VOLUME PROTECTION

Volume protection systems are used to discharge water mist into an enclosed volume, compartment, or room. In open nozzle systems the water flows through all nozzles within the protected volume. In automatic systems one or more nozzles activate as required.

2.2.3 ZONED PROTECTION

In open deluge systems, each protected volume is controlled by a valve (known as a selector or directional valve). Water mist will only discharge into the volume with a fire. If there is sufficient water supply for the largest protected volume this can be an economical way of protecting more than one volume (assuming there will not be multiple fires at the same time where additional water quantities and/or larger piping will be required).

For automatic systems, zoning is a means for sectioning the building to identify where the fire occurs (for example, per floor). Each zone has a valve that will have a flow switch to indicate activation of a water mist nozzle within that zone of the system.

2.3 WATER SUPPLIES

Water mist can be delivered either through a pre-pressurised system (stored water and propellant gas in cylinders) or a flow generating device (a pump) through the system distribution pipework to the nozzles. In twin-fluid delivery systems there is an additional pipe for the atomizing gas.

2.3.1 SINGLE FLUID PUMPED

A single fluid system generates water mist by delivering water through the nozzle under pressure from a pump system. Pumps for pressures 16 bars and under are centrifugal type (as for sprinklers). Pumps for pressures above 50 bar are positive displacement (or piston) type. Both pump systems require a storage water tank of sufficient working capacity for the duration of discharge required for the size or design area of the hazard.

Centrifugal pumps are available for any flow likely to be required for a water mist system. The characteristic pump curve has a maximum pressure at zero flow (closed head) and the pressure decreases as flow increases.

Piston pumps have a maximum flow up to ~120 litres.min^{-1} and provide a constant pressure throughout the flow range. The head pressure is set by an unloader valve which also acts as a relief valve for unused flow. For example, if a pump provides 120 l.min^{-1} but the nozzle delivery only requires 50 l.min^{-1}, the balance (70 l.min^{-1}) returns to the storage tank or drain, via the unloader valve.

2.3.2 SINGLE FLUID PRESSURIZED

A single fluid pressurized system generates water mist by delivering water through the nozzle under pressure from a pressurised gas container. The gas (usually nitrogen) does not mix with the water being pressurised; it is only used for pressure/flow generating purposes.

2.3.3 TWIN FLUID PRESSURIZED

A twin fluid system generates water mist by mixing an inert gas or air fed from separate pipework to the water mist nozzle. Such systems are normally container based (as single fluid pressurized).

2.4 SYSTEM OPERATION TYPES

2.4.1 WET PIPE SYSTEM (AUTOMATIC NOZZLES)

This water mist system uses automatic, heat sensitive, nozzles fitted to distribution pipework that is permanently pressurised with water. Wet pipe systems are the most common automatic suppression configuration and are typically used to protect areas where temperatures are above 4oC and below 95oC and are unlikely to fall below freezing point.

2.4.2 DRY PIPE SYSTEM (AUTOMATIC NOZZLES)

This water mist system uses automatic nozzles fitted to distribution pipework that are permanently pressurised with air, nitrogen, or other inert gas. In the event of a fire, when a nozzle operates, the pressure drop in the distribution pipework activates the system's control valve to release water into the pipework where it is discharged through the nozzle.

These systems are typically used in the same applications as wet pipe systems where the key constraint is the need to prevent freezing of water in the pipes. There is a delay in flow of water because of the time it takes to fill the distribution network with water, which increases with the volume of pipe work to be filled. Because of this delay, such systems are not normally be considered for applications where there is a need for the protection of life.

Note fire test protocols do not test to include the delay in dry pipe systems. Proof will need to be provided in the certification of the maximum delay permitted and that the system will still perform as tested and prescribed.

2.4.3 DELUGE SYSTEM (OPEN NOZZLE)

A deluge system is designed so all open nozzles discharge simultaneously in the event of a fire. This is achieved when a separate fire detection system is actuated. This in turn operates the pump or container actuator and a valve in the pipe work to release the water through all the open water mist nozzles. Fire detection systems can be electrical, electronic, or pneumatic. The actuation should comply with BS 7273 Part 5. As the nozzles are open, the water distribution system is kept dry and unpressurised. The activation of the fire detection system is more sensitive than heat detectors or frangible bulbs. A deluge system may be zoned. This allows for several areas to be protected but permits a discharge in only one area (zone) at any given time (unless the water supply and pipe diameters are sized for simultaneous discharges).

2.4.4 PRE-ACTION SYSTEM

Such systems comprise an automatic water mist installation and a fire detection system. The water mist pipe work is dry, pressurised with air, and monitored for loss of pressure.
On receipt of a signal from two or more detectors, the main control panel sends a signal to open the pre-action control valve, allowing water to flow into the distribution pipework in readiness for the water mist nozzle(s) to operate. These systems are commonly used for the protection of high value areas such as data centres, server rooms or communications, or where sensitive electrical equipment and goods are stored. They provide warning of system discharge (through the operation of the fire alarm system) and prevent accidental discharge if a frangible bulb were inadvertently broken or the pipe work damaged. The actuation should comply with BS 7273 Part 3.

2.4.5 ELECTRONICALLY CONTROLLED SYSTEM

Electronically controlled systems consist of nozzles which incorporate a valve that is operated by a 'controller', actuated by fire sensors to either allow water to discharge or to shut off flow. This permits for a pre-determined number of nozzles to operate. Which nozzles operate will depend on the location of fire identified by the controller. This may be via the use of a detection system or other sensing method. There are also stand-alone, modular domestic systems that use this principle. Such self-contained applications are known as Personal Protection Systems and are designed specifically to protect vulnerable people such as the bed-ridden or immobile. System requirements are detailed in the Loss Prevention Standard LPS 1655.

2.5 SYSTEM DESIGN TYPE

2.5.1 ENGINEERED

Engineered systems require hydraulic flow calculations to determine the requirements of pump pressure and flow and the amount of water storage. The core information will be determined from the type and number of nozzles within the design area. Calculations will be undertaken for the hydraulically most favourable areas (to determine the maximum water quantity and flow required) and the hydraulically most unfavourable areas (to determine pump source pressure and pipe sizes such that the most remote nozzles operate above the minimum design pressure).

2.5.2 PRE-ENGINEERED

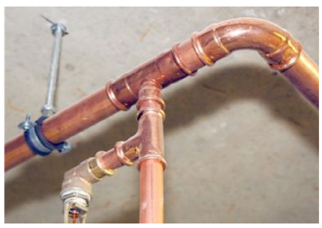
These systems have pre-determined flow rates and water quantities. This results in very little work to be done by the designer as the pipe diameters can be derived from look-up tables verified by testing and included in the DIOM. These systems generally are limited to simple deluge systems, for example the protection of small enclosures for the protection of Class B fuel hazards.

2.6 WATER MIST PIPEWORK AND FITTINGS

The material used for the pipework and fittings of a water mist system should be governed by the operating pressure and other requirements of the water mist system (such as water purity) and the environment surrounding the installed pipe. This may include resistance to heat, or chemical corrosion.

All water mist systems require the use of non-corrosive materials such as stainless steel, copper, or brass. Twin fluid systems can use galvanized or steel pipe for the atomising agent as there is no direct contact with water.

Further details of pipe types can be found in the FIA-BAFSA Piping Document.

Examples of pipe and fittings stainless (L) and copper (R)

3.0 Using Water Mist

Given the performance-based design of water mist systems and their proprietary nature, the design of water mist systems **does not** follow the prescriptive approach as detailed for other fire suppression systems (i.e. sprinklers, gas extinguishing systems, etc). As a result, system component manufacturers have much more involvement and responsibility in demonstrating the suitability and performance of their water mist system and must show necessary competence in assessing suitable applicability and design.

3.1 LEGISLATION

The primary legislation for life safety fire protection is contained in the Building Act 1984, and the building relevant regulation is the Building Regulations 2010, Schedule 1. The applicable fire safety guidance is given in Approved Document B (ADB) Volumes 1 and 2 including the latest date amendments. Codes of practice for fire safety in the design, management and use of buildings are detailed in BS 9991 (residential) and BS 9999 (commercial and industrial). Note that the current requirements of the building regulations of 2018 have superseded certain sections of BS 9991 (a 2024 revision is in preparation). ADB does not include reference to water mist, but BS 9991 (2015 edition) and BS 9999 do. In Wales, the design and installation of water mist systems, where installed as an alternative to sprinkler systems must comply with Regulation 37A of Building Regulations and the Domestic Fire Safety (Wales) Measure 2011.

3.2 WATER MIST STANDARDS

At the time of publication (November 2023), there are two British Standards and one suite of European Standards covering the design and installation of water mist systems in the UK (see Annex 2).

As new products and test protocols for applications are in continuing development, there may not necessarily be a standard to guide manufacturers and buyers to the suitability of every solution. This may have to be done on a case-by-case basis with the creation of a bespoke fire test protocol and by referring, if relevant, to a similar real-life application. The water mist standards BS EN 14972 Part 1 Annex A details the methodology to develop a fire protocol where one does not yet exist. An example of a well-established application which only recently has had a standard for it is that of data centres. ‘Prisons’ do not yet have such a protocol although water mist was proven by testing commissioned by Scottish and English Prisons some years back.

Clause 8 Method B of BS 5306-0:2020 provides guidance on the how deviations from standards and out of scope systems can be assessed for the intended application. Application of due diligence by examining the proposed installation of a non-standard solution is essential. As is the by assurance that a proposed standardised system does indeed comply to the standard in the manner it states it does. This is the key reason for the value of third-party certification and the disclosure of the manufacturer’s DIOM manual to all stakeholders involved. Method B warns that: *“Innovative, engineered or otherwise non-standard solutions can be significantly higher risk in many respects. However, they can offer overall benefit where there is a genuine need for such a solution. At least equivalent performance (to the closest applicable standardised technology) should be sought”*. It is often the case that the contracting parties are unaware of the size and type of fire load. Thus, it is not always possible to determine if the water mist system is suitable. As an example, BS 8489 Part 1 Table 1 lists two fire test protocols for light hazards. The first is FM 5560 Appendix G (most commonly available from water mist manufacturers) which has a maximum fire test load of 150 MJ.m-2. The second is BS 8489 Part 7 that tests for fire loads up to 500 $MJ.m^{-2}$ (less available from manufacturers). Thus, if the FM protocol were used for a fire load of 250 MJ.m-2 (instead of a BS 8489 Part 7 tested system) the performance of the system will be at best unknown, and at worse ineffective.

At the time of writing, the published British Standards for water mist include for limited application in residential and domestic occupancies (BS 8458) and industrial and commercial occupancies (BS 8489). The European standards are covered in the BS EN 14972 series.

BS 8489 Part 1 and BS EN 14972 Part 1 set out the design and installation requirements of water mist systems and subsequent parts of these standards detail fire test protocols for certain applications. BS 8458 is a stand-alone document that includes design, installation, and the requirements of fire testing.

Note that the UK were active contributors to EN 14972 Part 1. However, there were certain important technical and fire safety aspects that were not agreed with CEN prior to publication. The UK concerns, with additional guidance, are detailed in the National Forward and National Annexes of BS EN 14972 Part 1. It is important that these are fully considered and documented prior to any use of this standard.

See Annex 2 for full details of published BS EN standards relating to water mist systems and components.

The International Water Mist Association (IWMA) also holds up to date information covering international published standards for water mist.

3.3 FIRE TEST PROTOCOLS

The design and installation methods of water mist systems are based on proprietary information, so systems will vary between manufacturer and with each application, so their effectiveness in fighting fires must be verified by standardised tests. This standardised test is known as a fire test protocol which has a set of parameters that define the system performance objectives. Fire test protocols have only been published for a selected range of fire hazards and occupancies. Note that the type and size of fire loads used for the fire test may not represent those of the application hazard. In addition, each test protocol will have limiting parameters which will limit the system performance and validation of certification. Such parameters include, but are not limited to, height, ventilation, ceiling slope, activation temperature, obstructions, etc. It is these aspects that requires suitable competence in fire engineering to determine whether water mist is appropriate for any given hazard/occupancy.

The introduction of BS 8489 Part 1 states *"The water mist system is to be…tested in accordance with a recognised test protocol"*. This means that the system specified for an occupancy not covered in the standard requires the designer and installer to produce evidence that the proposed system is fit for purpose for the proposed application. This must include one or more of each of the following:

- Fire testing undertaken in an approved fire laboratory with BS EN ISO/IEC 17025 accreditation
- Reference to third-party verified fire tests already undertaken elsewhere for such an application

Care should be taken by manufacturers and installers to avoid claims appearing to fulfil these criteria but which on closer inspection do not.

3.4 COMPONENT STANDARDS

There is a significant amount of accumulated knowledge of the ways in which fire suppression system components can fail over time depending on the material with which they are made, method of construction and operation, and the environment that they are exposed to. Some of the tests and best practices embedded in these standards may include ageing tests, over-pressure tests, and material choices. The only UK national water mist component standard is for nozzles - BS 8663 Part 1.

A CEN standard for nozzles, EN 17450 Part 2 is awaiting publication. However, this does not include a high-temperature ageing test that BRE have verified is critical for proving the reliability of automatic nozzles that use dynamic polymeric O-rings. It is likely that this test will be an optional (normative) test, that would be required for the UK market. This will be confusing to many end users resulting in a two-tier standard. Some experts believe that the EN standard is technically inferior to BS 8663-1.

Note: The problem of dynamic O-rings is well-documented with sprinklers and has been observed with water mist nozzles. The O-ring can harden that can cause leaks and/or fail to actuate when required.

3.5 THIRD-PARTY VERIFICATION

Third-party testing and verification of the performance and composition of the system must be proven by certification, often publicly listed (for example LPCB Red Book Live). Although not mandated by law in the UK, certification provides one element of surety to stakeholders. This is because certification is an assessment by an independent competent body, and evidence that the manufacturer is willing to have their manufacturing processes and systems' performance thoroughly scrutinised. Robust certification also performs important functions such checking that the supplier has not changed their materials, or design, without obtaining full revalidation. Certification also provides additional routes to problem and dispute resolution.

Certification laboratories have, for many years, undertaken work in testing products to national standards but also (usually in the absence of such standards) to their own standards. For example, as there is no UK standard for personal protection water mist systems, the LPCB developed LPS 1655. LPCB have also been published approval documents for fire suppression systems in kitchens - including water mist. Such documents are invariably developed by test laboratories in conjunction with stakeholders who are expected to fund the work. Certification laboratories also have the autonomy to extend their testing and assessment program to promote confidence of the systems tested beyond the consensus found in national standards.

Certification laboratories which have experience with water mist components internationally are FM, LPCB, UL and VdS.

3.6 TYPES OF CERTIFICATIONS

3.6.1 FIRE TEST PROTOCOL

A certificate detailing the performance to a specific fire test protocol. The certificate will detail factors including as a minimum nozzle spacing, height, operating pressure and k-factor and limitations.

3.6.2 SYSTEM CERTIFICATION

This is certification of the fire performance for the specific application and is closely linked to the requirements of the standard in addition to specific test laboratory criteria. The test laboratories will certify systems which have successfully been tested either to specific fire test protocols (above) as listed in BS 8489 (parts 4 to 7), BS 8458 or BS EN 14972. Other fire test protocols in standards exist in the standards FM5560, UL2167 and VdS 3188.

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- Examination and tests on production samples performed to evaluate:
  - o The suitability of the product.
  - o The performance of the product as specified by the manufacturer and required by the testing organization; and, as far as practical,
  - o The durability and reliability of the product.
- A thorough review of the proposed water mist DIOM manual.

There are occasions where a variation of a standardised product or a completely different product (which is out of scope of existing standards) is proposed. Invariably, there will not be a certification scheme for such systems which will rely on a certifier who is willing to adapt or create a test protocol for that product. The certifier may adapt existing test protocols for system and components but might also need to develop custom fire test protocols following the guidance in Annex A of BS EN 14972-1. This can be a lengthy process, but it is the typical path for a product category to then become standardised. Conversely, a system which is within the scope of a standard implies that certification schemes are readily available and there is therefore no reason for these systems not to be able to be fully certified.

3.6.3 CERTIFICATION OF EQUIPMENT

As with other fire protection equipment, certification of the components should be the norm. A certified component provides evidence the component has been third party scrutinised and therefore is reliable, but it is not a guarantee on its own and should not be confused with the system performance validation. There should also be a link (through a reference in the DIOM) on what components and what certifications have been achieved for which applications.

Therefore, specifiers of water mist systems must ensure that the components that make up a water mist system are listed as approved by a recognised approval body. It is essential that specifiers are supplied with copies of the relevant listing or certificates, which should normally be included in the tender submission or specification document.

Components which typically undergo certification are:

- Control valves, water pumps, water, and gas pressure containers.
- Distribution pipework, couplings, and fittings.
- Water mist nozzles.
- Fire detection and alarm control panels, fire detection sensors, alarm sounders, indicators, and actuators.
- Non-electrical equipment such as pneumatic, hydraulic, or mechanic control valves and equipment.
- Manual actuation equipment.

In addition to compliance with the minimum test requirements for individual components according to the relevant standards, it is essential that the assembly of components is tested together as a system and as such, the system also carries a system approval. To ensure the efficacy of a system, an independent third-party certification body must examine and test that system to establish its firefighting performance and the compatibility of all components.

3.6.4 CERTIFICATION OF INSTALLERS

The third essential element of quality requirements for installations is an assurance that the designer/installer of the system is fully competent to undertake this work. It is the only certain way to ensure that the requirements in BS 8458, BS 8489 and BS EN 14872-1 to design and install the system are 'entrusted to appropriately qualified and experienced people'. This is typically done using a certification standard which is based on a national standard as specified above.

Third-party certification is key because it is an external assessment of competence. However, given the proprietary nature of water mist, it will not necessarily capture the specific requirements from different manufacturers. Therefore, just as important, is evidence that the installers' workforce have been trained by the manufacturer and can demonstrate competence for that specific product. This evidence should be available from manufacturers, so stakeholders should ask for sight of references and training certificates from system or component manufacturers.

Note that designer competence requires skills and experience in fire engineering; determining applicability and suitability of a fire test protocol to the fire hazard and occupancy; the ability to determine design areas; and undertake hydraulic flow calculations. It will also require an understanding of pump curves; actuation; system interfacing; electrical loads and system resiliency. These are just some of the examples. Such an engineer is likely to be qualified to at least degree level, have many years' experience in the fire suppression industry, be registered with the IFE and be either an Incorporated or Chartered fire engineer or scientific equivalent.

As stated, a key part of the regime which ensures that water mist systems will be effective and reliable is the correct installation of the water mist system, which depends on the attestation of the competence of the designer and installing company.

It is important to note the distinction between accreditation and conformity assessment. Accreditation ensures that those who carry out testing, certification and inspection are competent to do so, it therefore applied only to approval and testing bodies accredited by the United Kingdom Accreditation Service. (https://www.gov.uk/guidance/conformity-assessment-and-accreditation) 'Approvals' by organisations who are not so accredited should be viewed with care.

Conformity assessment is a service provided by an accredited body such as an UKAS accredited (or European Notified Body) to providers of products or services. As a result, installers, products, and components can only be certified (or conformity assessed), they cannot be accredited.

Given the changes necessitated by the withdrawal of the UK from the EU, the government intends to introduce legislation to extend recognition of goods that meet EU requirements, including the CE marking, indefinitely, beyond 31 December 2024 for many products. This will mean that certain goods that meet EU requirements can be placed on theGB market. These updates apply to the 18 regulations that fall under the Department for Business and Trade (DBT). Manufacturers will have the choice to use either theCE marking or other recognised EU markings (where permitted), or the UKCA marking to supply products to Great Britain.[5]

UKAS accredited certification bodies which are presently providing third party certification for water mist installers are LPCB, IFCC and FIRAS.

Note that at present there is no equivalent LPCB third-party installer scheme in the UK to LPS 1048 for sprinklers. FIRAS and IFCC operate third-party schemes for residential and domestic systems, but these are essentially verifications of tests undertaken against selected annexes in BS 8458. TPC is not based on a common, harmonized standard.

3.7 DIOM – DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL

The DIOM is the document that contains all the key information from the manufacturer of the water mist system. These will vary between manufacturers and with different applications even with the same manufacturer. These documents should be available to the specifier, and AHJ to review suitability of the proposed water mist system and compliance with the design objectives.

The DIOM should not be used in isolation and must reference the standard to which the system has been designed. If the system is stated to comply with a specific standard, documented evidence of compliance to all clauses, or justifications for variations to clauses, must be provided. Details of the fire test protocols against which the system has been tested should be provided with full details of the results obtained and the details of the laboratory which undertook testing. National Annex B to BS EN 14972-1 provides the critical list of items to be included in the DIOM, such as:

- General Information regarding the type of system.
- Limits of application, for example height, ventilation, obstructions, etc.
- Description of components and the standards to which they are designed.
- Testing of the specific system/s and details of the fire test protocols against which they have been tested and the results of such tests.
- Approvals and certifications gained in respect of systems and components.
- Declaration of conformity to applicable product safety directives.
- Planning, Design and any specific qualifications or approvals needed by the designer.
- Nozzle maximum and minimum spacings, height, working and standby pressure.
- Minimum design area (AMAO), minimum number of nozzles in design area.
- Discharge duration per application.
- Water supply requirements including details of acceptable water quality.
- Installation process.
- Testing and placing in service (commissioning).
- Inspection and audit.
- Maintenance.
- Typical hazards applicable to the fire testing (including fire type and maximum fire loads).
- Hazard description.
- Types and sizes of fire loads tested.
- Nozzle k-factor.
- Interaction with other fire systems (detection, alarm, smoke control).

5. https://www.gov.uk/guidance/placing-manufactured-goods-on-the-market-in-great-britain

4.0 Choosing a Water Mist System

4.1 INTRODUCTION

Before any fire protection system is specified the methodology as detailed in BS 5306 Part 0 clause 4 should be followed. BS 5306-0 contains tables that explain the suitability of different fire protection systems for different applications.

Standards detail best practice and are for the guidance of the wise, not an avenue to 'pick and choose'. It is not whether a system simply 'complies' to a standard but rather how it conforms to each of the clauses within. This highlights the importance of the DIOM in detailing the design constraints and performance limitations of the proposed water mist system with respect to the referenced standard, supported by the evidence of fire testing and third-party certification. Equally, this is the reason that the system manufacturer must make the full text of the DIOM available to specifiers and regulators.

One of the principal perceived benefits of water mist is its ability to solve a water supply or storage constraint. This subject it is important to clarify. As an example, for light hazard systems for Class A fires the design is not based on achieving a water density, as with sprinklers. It is based on the layout of the nozzles in accordance with the DIOM, the number of nozzles within the design area, and the respective pressure and k-factor at those nozzles. Often, contractors quote the minimum water density of the water mist system, which is only achieved at maximum spacing and minimum operating pressure. This is rarely possible as room layouts are rarely dimensioned to fit an exact number of nozzles and there will always be obstructions that require additional nozzles. In addition, the operating pressure will always be above minimum. As an example, a manufacturer claims a water mist density of 2mm based on 16m^2 maximum spacing a minimum tested operating pressure. The layout of the room and obstructions mean that the spacing is reduced to 12m^2 per nozzle, the water density increases by 2.66mm. If the pressure at that nozzle is % above minimum, then the flow will increase by square root of the increase. The water supply is based on most favourable hydraulic calculation that could be defined by either the most nozzles within the design area and/or the maximum pressure at which they are subjected. A frequent observation during third-party audit of water mist designs is that contractor either does not determine the design area (and number of nozzles within) correctly or understand the effect of hydraulic gradient. The same applies to the working tank capacity required, with often gross tank capacities being used instead.

Water mist has to date been used mostly used for asset and business continuity purposes.

Consultation with the **relevant stakeholders** should first take place to seek approval where any protection system is being considered, regardless of whether the system is an elective install (providing addition protection to an otherwise compliant building), to meet Building Regulations, or for property protection or for business continuity purposes:

- The building control authority or approved inspector.
- The fire authority.
- The water supply undertaker (*This is usually essential to comply with* Water Regulations).
- The insurer(s) of the premises and premises' contents.
- The owners and property managers.
- Residents' associations.

Note that the use of water mist is presently not permitted under Building Regulations. A suitable automatic fire suppression system detailed in Regulation B3(3) is defined in Approved Document B as a sprinkler system designed to BS 9251 or BS EN 12845.

The DIOM should be comprehensive enough to provide answers to all questions from any of these stakeholders. So that project approvals can been given, whether from building control or the insurer, it is essential that the specifier is provided with a full, written technical specification from the installer, authorised by the manufacturer, on how the system will be designed, installed, commissioned, tested, and maintained in accordance with the DIOM.

4.2 EFFECTIVENESS AND RELIABILITY

As for any fire protection installation, the system must be able to perform as designed and intended. For that, it needs to be demonstrated that the system will be effective for the intended application. Effectiveness depends on the suitability of the proposed system for the application and that it has been designed and installed correctly so that it works as intended. It must also be available to operate, without delay, whenever required.

Once a decision has been made that a water mist system is appropriate, three conditions must be satisfied:

a) the system chosen must be suitable for the proposed fire hazard and fire load (the application).
b) the system must be designed, installed, and commissioned correctly by a competent contractor using approved equipment.
c) the system must be maintained so that it is ready to operate (available).

Only when there is evidence that this has been done can the system be expected to perform reliably once installed.

Note that there is little data on either reliability or effectiveness for water mist systems. There is extensive international data for sprinklers, harmonized standards, and rigorous component certification. One of the fire engineering decisions in risk analysis and design is that of reliability and effectiveness. PD 7974 gives detailed quantitative guidance for sprinklers that does not currently exist for water mist.

4.3 SUITABILITY

There are several factors that need to be considered before a water mist system is considered suitable for the building, asset or occupant being protected. Ignoring any of these could be deemed to evidence of negligence and in the case of life safety systems in the UK, a breach of fire regulations. Adequate specification and due diligence should take the following into consideration.

4.3.1 FIRE TEST PROTOCOL APPLICABILITY

The proposed installation must refer to the fire test protocol which has been used to validate the performance of the proposed system. This test must be relevant to the application being considered and carried out with the same components and systems being specified in the installation.

4.3.2 THIRD PARTY EVIDENCE

A declaration of compliance is a first-party declaration but verification such as certification is a key demonstrator of long-term reliability and compliant performance. This should be sought for systems and components where such schemes are available.

4.3.3 TENABILITY

Tenability is governed by exposure to heat (convective, conductive and radiation all have difference threshold values) and the Fractional Effective Dose (FED). FED is normally determined by CO_2 and CO levels but can also be measured by levels of by-products of combustion such HCN and HCl.

Water mist has been shown to provide tenability within protected spaces, but dependent on the fire test protocol this may be limited to temperature only. Further evidence may be required if tenability is a core criterium.

4.3.4 PROTECTION OF GLAZING

Water mist system may possibly be used for the protection of glazing but there are no published fire tests protocols for verification. Any data presented by the manufacturer must be third-party verified against as set of performance criteria acceptable to the AHJ and user.

4.3.5 SMOKE SCRUBBING

Smoke is made up of mostly solid substances entrained with toxic gases. While water mist may not be able to fully ‘scrub out’ all the particulates in smoke it has been shown to be capable of capturing some water-soluble gases. Specific fire testing is required for verification of applicability and limitations as this is not detailed in the published fire test protocols.

4.3.6 REDUCTION IN VISIBILITY

Water mist effect visibility that must be considered relevant to the evacuation of normally occupied areas. These are:

- Reduction of visibility through the mist (akin to walking in mist or fog).
- Light diffraction in various directions and a loss of visual contrast that could lead to people within the area becoming disoriented.
- Cooling and mixing with the smoke layer that reduces the buoyancy and causes the smoke layer to fall.

With these facts in mind, the system designer should specify measures to safeguard occupants. Guidance in BS 9991 and BS 9999 must be followed.

4.4 WATER SUPPLIES

It is critical for the operation of the water mist system that the installation can provide the flow and pressure that the system needs to operate in all scenarios.

The amount of water (and pressure) required is governed by the fire hazard, design area, manufacturer details (DIOM), and most favourable (and unfavourable) hydraulic calculations.

If an enhanced availability system is required there must be resilience in water supplies. Guidance is given in the standards albeit conflicts between the published UK and EN standards remain unresolved.

4.4.1 WATER DISCHARGE TIMES

The minimum duration for water discharge is prescribed in the relevant standards and is a factor of the type of hazard and occupancy. For domestic dwellings this will be a minimum of 10 minutes; and residential at least 30 minutes. For commercial and industrial light hazard occupancies it will be a minimum of 60 minutes.

The water quantity required assumes that all the nozzles in hydraulically most favourable design areas are operating.

For extinguishing systems which are required for local and total flood applications involving flammable liquid fires, up to and including 260m3, and for industrial oil cookers, the duration discharge should be at least twice the time taken to extinguish the fire and to prevent reignition, and a minimum of 10 minutes. For larger volumes (>260m3) this discharge time may need to increase to 60 minutes dependent on the certified test results from the fire test protocol.

4.5 VENTILATION CONSIDERATIONS

As the mass of the water droplets decreases the droplets will be more affected by air movement (both natural and forced ventilation). It is essential that where ventilation is above the limit prescribed in the fire test protocol that measures are taken to turn-off or reduce the ventilation to within the tested limit. It may be that a judgement must be made as to whether a sprinkler system may be more appropriate (since the heavier droplet makes sprinklers less vulnerable to air flow). Ventilation may also delay the activation of heat sensitive nozzles through dispersion of the convective heat plume, and conductive cooling at the frangible element surface.

4.6 ENCLOSURE INTEGRITY OF ENCLOSURE

Water mist systems used for the protection of enclosures containing Class B fuels are required to have the enclosure sufficiently leak tight that oxygen cannot be drawn into the fire during discharge. Openings will need to be automatically closed prior to discharge of the system. Some fire test protocols permit the installation of nozzles over openings to exclude oxygen if this is proven in the testing.

These form part of the design and additional nozzles should be included in case automatic vent closure fails. This will require that the water supply quantity is increased.

4.7 NOZZLE POSITIONING

Nozzle positioning is a key parameter in water mist system design. Obstructions will affect the coverage and distribution of water mist and appropriate variations of nozzle locations, as tested, and approved, should be detailed in the DIOM. Water is two dimensional (not three dimensional as gas), so is unlikely to penetration enclosures (such as cabinets) useless there is heat for entrainment, or ventilation.

4.7.1 NOZZLE HEIGHTS AND SPACING

Installation of nozzles at the heights and spacings which have been validated by the nozzle manufacturer's tests is a crucial requirement. The maximum and minimum nozzle height and spacing must be detailed in the DIOM. Installation of nozzles above or below the maximum or minimum heights is unproven and may result in the failure of the system to perform as tested.

For Class A fire hazards many fire test protocols have a maximum ceiling height of between 2.4m and 5m. Higher heights may be permitted in the fire test protocol if the performance criteria are still met.

For Class B fire hazards the height is generally in the range of 5m to 8m. Again, as above larger (or lower) heights must be proven by testing and detailed in the DIOM.

4.7.2 NOZZLE TEMPERATURE RATINGS OR DETECTION SPECIFICATION

Where a thermal element (such as a frangible bulb) is used, the type of application will determine its temperature rating as certain occupancies may generate unwanted activations if the activation temperature is low (for example, in saunas and plant rooms). The temperature rating selected should be 30oC above the maximum ambient temperature. Higher temperature rated elements must have been proven by third-party fire tests and included in the DIOM.

The specification of systems which are activated by separate detection systems must be included in the DIOM and be the same or equivalent as those proven in fire testing.

4.8 INSTALLATION AND COMMISSIONING

The installation and commissioning procedures are critical to ensure that the system is put into service as intended by the design and proven by fire testing. Additional requirements beyond those in the standards should be detailed in the DIOM. If these are not followed there is a significant risk that the system will not function as intended.

The water mist contractor must provide the client/specifier with a copy of their DIOM that contains the design and installation rules for the system.

Particular attention should be given to the condition of the distribution pipework. It should be confirmed that prior to installation, the pipework has been cleaned and is completely free of any sharp edges, swarf or debris that could impair the functional efficiency of the system.

Open and automatic nozzle systems are subject to hydrostatic pressure tests as required in the standards. Note that these tests only check for pipe integrity at static pressures, not dynamic pressures. Where pipe work is subject to sudden shock, for example an open nozzle system increasing from zero pressure to 100 bars instantaneously, it is imperative that suitable fittings are used where there is a change of direction, for example a bend, else the pipe may come apart at the fitting.

Where pumps are installed, provision should be made for testing at full flow.

All valves in the critical water path (for example inlet to tank, pumps, and valves to the hazards) should be ensured as locked open and/or monitored.

The quality of water and filtration should be verified as within specification for the system.

The commissioning engineer must take responsibility for testing all aspects of:

- Electrical detection and signalling.
- Electrical or mechanical actuation.
- Pumps and tanks and/or water storage and gas container vessels.
- Valves including main control, isolation, zone, deluge and pre-action as required.
- Correct calibration of unloader valves and/or regulators as required.
- Discharge testing and/or pump flow tests (note that for multiple pumps it is important that there is a provision to test maximum flow demand from all pumps, not just per individual pump).
- Providing the client/specifier with a Completion Certificate stating that the system conforms to all the appropriate recommendations of the relevant British Standard and DIOM. All details of deviations from these documents MUST be notified and recorded. Review by a competent auditor is essential.

4.9 AVAILABILITY AND MAINTENANCE

Correct installation of the water mist system is only the start of its life in service. For it to be effective, it needs to be "available" during its lifetime. Regular maintenance is required to verify that the environment, hazard, or occupancy have not changed significantly over time as well as to verify that none of the components have been tampered with or damaged.

Note that water mist nozzles are not interoperable, so that if nozzles are required to be replaced, only those of the original manufacturer can be used. Where nozzles are unavailable (for example manufacturer has ceased trading) then it is probable that all the installation may become redundant.

The DIOM should include detailed maintenance instructions covering all the individual weekly, monthly, quarterly, and annual test procedures including additional measures required to those detailed in the referenced standard.

As with many building systems the internet has increased the adoption of remote monitoring and testing of systems to report faults or the need for maintenance. The same principles are being adopted by water mist suppliers. The aim is to provide notification of faults well before the annual check takes place, resulting in, potentially, a more efficient and effective on-demand maintenance as opposed to a reactive or scheduled maintenance. The objective is to maximise availability and reduce the possibility and the time of system downtime due to a fault which would only be observed during routine maintenance. Note this function is dependent on the resilience of the internet, interconnecting routers and servers, and the management software in both system control panel and maintainer off-site monitoring equipment.

Annexes

1.0 DEFINITION OF PERFORMANCE OBJECTIVES

Fire Control - limitation of fire growth and structural damages (by cooling of the objects, adjacent gases and/or by pre-wetting adjacent combustibles)

Fire Extinguishment - complete elimination of any flaming or smouldering fire

Fire Suppression - reduction in the heat release rate and prevention of re-growth of a fire over the discharge duration

2.0 PUBLISHED BS/EN WATER MIST STANDARDS

BS 8458: 2015 Fixed fire protection systems – residential and domestic watermist systems – code of practice for design and installation

BS 8489 Fixed fire protection systems – Industrial and commercial watermist systems

- Part 1:2016 Code of practice for design and installation
- Part 4:2016 Fire performance tests and requirements for watermist systems for local applications involving flammable liquid fires
- Part 5:2016 Fire performance tests and requirements for watermist systems for the protection of combustion turbines and machinery spaces with volumes up to and including 80m³
- Part 6:2016 Fire performance tests and requirements for watermist systems for the protection of industrial oil cookers
- Part 7:2016 Fire performance tests and requirements for watermist systems for the protection of low hazard occupancies

BS 8663 Fixed fire protection systems – Components for watermist systems

- Part 1:2019 Specification and test methods for watermist nozzles

BS EN 14972 Fixed firefighting systems. Water mist systems

- 14972-1 Design, installation and maintenance of water mist systems
- 14972-2 for shopping areas
- 14972-3 for offices, school classrooms and hotel
- 14972-4 for non-storage occupancies
- 14972-5 for car garages
- 14972-6 for false floors and false ceilings
- 14972-7 for low hazard occupancies
- 14972-8 and -9 machinery spaces
- 14972-10 atrium protection
- 14972-11 for cable tunnels
- 14972-12 commercial deep fat fryers
- 14972-13 for wet benches
- 14972-14 and -15 combustion turbines
- 14972-16 for industrial oil cookers
- 14972-17 for residential occupancies

BS EN 17450 Fixed firefighting systems — Water mist components

- Part 1:2021 Product characteristics and test methods for strainer and filter components
- prEN 17450-2 nozzles
- prEN 17450-3 check valves
- prEN 17450-4 control deluge valves and actuators
- prEN 17450-5 pressure switches

3.0 OTHER STANDARDS & REFERENCES

Approved Document B: 2019 incorporating 2022 amendments
Volume 1: Dwellings
Volume 2: Buildings other than dwellings

Automatic water mist systems for domestic and residential premises (Welsh Government August 2021 https://gov.wales/water-mist-systems-guidance

BS 5306 Fire protection installations and equipment on premises
Part 0:2020 Guide for selection, use and application of fixed firefighting systems and other types of fire equipment

BS 7273 Code of practice for the operation of fire protection measures

Part 3:2008	Electrical actuation of pre-action water mist and sprinkler systems
Part 5:2008	Electrical actuation of water mist systems (except pre-action systems)

BS 9991:2015 Fire safety in the design, management and use of residential buildings – Code of practice

BS 9999:2017 Fire safety in the design, management and use of buildings – Code of practice

BS EN ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories

FIA Guidance Document - Watermist pipe test guide

FIA Guide to Block Plans for Watermist Installations

FIA Guidance on Additional Requirements for Watermist Systems Protecting High-Rise Buildings

FM5560:2021 Examination Standard or Water Mist Systems

LPS1655:2015 Requirements and Test Methods for the LPCB Approval of Personal Protection Water Mist Systems

UL2167:2021 Water Mist Nozzles for Fire Protection Service

VdS3188en:2020 Water Mist Sprinkler Systems and Water Mist Extinguishing Systems (High Pressure Systems) Planning and Installation