

Water mist systems for protection of buildings

Despite the resemblance with sprinkler systems, water mist works in a significantly different way from sprinkler systems.

INTRODUCTION

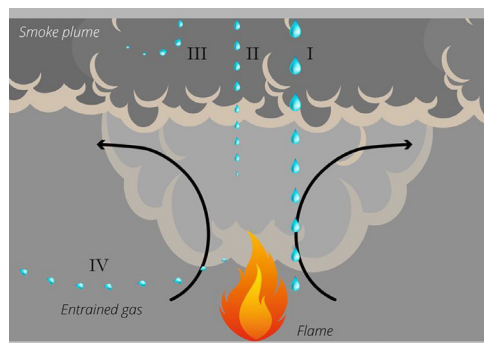
Water mist removes heat and dilutes oxygen elements of the triangle. It achieves this by dispersing water through specially designed nozzles at low or high pressure. Generally, as system pressure increases, the water droplet size decreases. This, in turn, significantly increases the total surface area of water and so leads to production of a greater volume of steam, removing more energy from the fire which generates the steam.

The smaller a water droplet size is, the larger the surface area becomes and the more effective the system becomes in rapidly reducing the temperature and oxygen concentration at the flame front of a fire. This is because the heat absorption capability of water mist is greater than any other water-based suppression system. To put it another way, when water is converted to steam – which is what happens to the water droplets in water mist – then quite a lot of energy is taken from the fire which has initiated the water mist discharge. This reduces the strength of the fire. Another consequence is that the droplets also act as a barrier to the radiant heat from the fire.

Most importantly, water mist requires the small droplets to reach the base of the fire so that it can be effective at suppression by cooling and suffocating and not primarily by wetting (wetting is a secondary mechanism), which is the case with large droplet systems (such as sprinklers which mainly rely on gravity). Water mist therefore relies heavily on the principle that while hot, less dense air rises, cooler air is being drawn to the fire's base.

Water mist systems are designed so that this can take place in several ways, non-exclusive examples as follows:

- Directional nozzles at the fire load from the top and/or sides to address the risk locally
- Nozzles placed closer to the base of the fire so that water mist is dragged to the flame front
- Deploying the mist in an enclosed compartment so that water mist entrains the fire gases, expands and suffocates the fire.



Nozzle design is also governed by the type of fire risk they are installed to protect and this varies greatly on whether the nozzle is designed to control, suppress or extinguish the fire. The intended application will also inform the nozzle location which may be ceiling, wall or even floor mounted.

APPLICATIONS

Where its use is appropriate, water mist can have a number of highly attractive features when compared to more widely used sprinkler systems including using reduced water storage and smaller diameter pipework. Significantly reduced water damage, post fire, may also be a benefit too.

Water mist should only be specified because of its suitability for the intended application when compared to other systems – not because of any claimed cost advantage.

Water mist technology is sometimes said to be 'closed protocol' (to adopt a term used of fire detection systems). This means that, unlike sprinklers, water mist manufacturers will supply proprietary nozzles, piping and pump designs for the specified applications, while sprinklers can use heads from any manufacturer with the confidence that these will perform in exactly the same way. The benefit for the sprinkler system is interoperability from different suppliers, the benefit for water mist is

IN THE UK, WATER MIST SYSTEMS SHOULD BE DESIGNED AND INSTALLED IN ACCORDANCE WITH ONE OF THE TWO REFERENCED STANDARDS



BS 8458



BS 8489



BS EN 14972-1

THERE ARE MANY ALTERNATIVE OR INNOVATIVE FIRE SUPPRESSION SYSTEMS AVAILABLE. WHERE THESE ARE USED IT IS NECESSARY TO ENSURE THAT SUCH SYSTEMS HAVE BEEN DESIGNED AND TESTED FOR USE IN BUILDINGS AND ARE FIT FOR THEIR INTENDED PURPOSE.

the design of a solution which, when correctly specified and installed, is optimised for that application.

Consequently, water mist systems can vary significantly in the way that mist is discharged depending on the application. For this reason, mist is considered “application specific” in that a domestic system will use significantly different designs than one used for protecting machinery. For example, in hangars, the nozzles might be placed on the floors with activation through fire detection systems. It is therefore important to ensure that the evidence provided by manufacturers and installers are specific for the intended application.

This also means that while system performance can be verified in the fire test protocols present in standards such as BS 8458, 8489 and BS EN 14972, the way in which systems are installed is prescribed by the system or nozzle manufacturer, not by the standards. The manufacturers’ requirements are defined in a Design, Installation, Operation and Maintenance manual and is a key document for stakeholders to reference, whether it is the installer or the AHJ, checking the installation has been done for its intended purpose and correctly. Water mist should comply with BS 8458, BS 8489 or the BS EN 14972 series.

UK WATER MIST STANDARDS

BS 8458 and BS 8489 are the two system standards for water mist in the UK. BS 8458 is for residential and domestic applications using wet pipe systems while BS 8489 is for commercial and industrial systems, irrespective of nozzle type. The recent introduction of the BS EN 14972 series of documents has caused some uncertainty as to which standards should be called up. It is possible that at some future date BS 8458 and BS 8489 may be withdrawn or significantly amended. Until then, they work as alternative guidance, in much the same way that BS 9251 is used alongside BS EN 12845 for sprinklers. Water mist standards tend to be less prescriptive and more performance based than sprinkler standards to accommodate the many proprietary designs. The standards have the following objectives:

1. Define the adequate application of water mist.

The table below, from BS 8489 shows examples of occupancies where water mist can be specified. Each occupancy then defines the fire test protocol to which the system should be tested. The publication of BS EN 14972-1 has added several new test protocols, but many of these are not yet published. BAFSA’s advice as at October 2021 is to continue to use BS 8458 and B489 until the situation becomes clearer.

Table 1 Occupancies and acceptable fire test protocols for an automatic watermist system^{A)}

Occupancy	Description of occupancy	Exceptions	Fire test protocol
Apartments (where BS 8458 cannot be complied with or is not appropriate)	Lightly loaded non-storage and non-manufacturing areas with ordinary combustibles	Mat stores	BS 8489-7 FM 5560:2016, Appendix G
Churches			
Concealed spaces			
Gymnasiums	Expect fire with relatively low rates of heat release in these occupancies		
Hotel bed rooms and their access (only)			
Local lending libraries			
Residential or nursing or convalescent homes where BS 8458 cannot be complied with or is not appropriate			
Offices			
Restaurant seating areas			
Schools and university classrooms			
Unused attics in low hazard premises containing no combustible contents or stored materials and no electrical or mechanical services other than lighting			

NOTE The listed test protocols are applicable with the following limited parameters.

- BS 8489-7 covers Category 1, 2 and 3 systems for:
 - fire loads ≤ 500 MJ/m² (covered in Category 3 only);
 - ceiling heights ≤ tested height up to 5 m;
 - floor area = restricted and unrestricted;
- FM 5560:2016, Appendix G covers:
 - fire loads ≤ 150 MJ/m²;
 - ceiling heights ≤ tested height up to 5 m;
 - floor area = restricted and unrestricted.

^{A)} Specific areas within buildings can be protected by watermist where relevant fire test protocols exist.

2. Fire test Protocols

Annex C of BS-8458 and Parts 4, 5, 6 and 7 of BS 8489 details the fire test protocols for water mist systems for their specific applications: flammable liquid fires, combustion turbines and machinery spaces, industrial oil cookers and low hazard occupancies, respectively. If there is no test protocol for the intended use then this are not covered by the best practices adopted in the UK. These may rely on other standards such as FM 5560 and stakeholders, such as insurers and AHJs, must be consulted on its use beforehand given these are deviations from UK common practice.

TEST PROTOCOL	OCCUPANCY/APPLICATION	OBSERVATIONS
BS 8458	Residential and domestic premises	As defined stated in Table 1
BS 8489-4	Local applications involving flammable liquid	
BS 8489-5	Protection of combustion turbines and machinery spaces up to 80m ³	See also FM 5560-A/B
BS 8489-6	Industrial oil cookers	See also FM 5560-J
BS 8489-7	Low hazard occupancies	As defined in BS 8489-1 from Category I – III and limited by table 1 and associated notes

3. Water supply resilience, actuation and detection methods and components

Both BS 8458 and BS 8489 provide recommendation on key performance parameters to ensure systems will perform in the field as they have performed in the fire test protocols, for example:

‘The minimum flow and pressure required for a successful fire test should be met or exceeded by all the nozzles in any area of operation, e.g. if the fire test is passed using a constant pressure source then the use of a decaying pressure source is not permissible.’

The need for hydraulic calculations, for resilience of water and electrical supply are also detailed in these standards.

4. Design, installation, commissioning and maintenance

Instructions for the design and installation of water mist systems are specified in the manufacturer’s DIOM (as the standards state), however, the standard recommends the parameters that should be specified in the DIOM, such as nozzle spacing and AMAO, and how these must match those that have been fire tested. These are useful for stakeholders to use as a basis to verify that a product has clear and thorough specifications and to verify the installation has been carried out correctly, according to the DIOM.

TYPES OF MIST SYSTEMS

Water mist systems come in a wide variety of types. This is a non-exclusive example of some of the common system types by pressure to show how lower pressure, higher flow systems differ from lower flow, higher pressure systems.

	LOW PRESSURE	HIGH PRESSURE
Pressure	Typically 5-12 bar	Typically not less than 35bar up to 200 bar
Pipework	(Typically 20-65 mm): Stainless steel, copper, approved CPVC. Corrosion and fire resistant	Smaller bore, higher wall thickness. Typically stainless, 12mm – 30mm. Corrosion and fire resistant
Water & pressure supply	Normally use stored water and electric pumps due to higher flow	Can be stored water (tanks) or mains supply. High-pressure pumps or high-pressure cylinders

Maintenance	As per DIOM and BS EN 14972 or BS 8458/8489, whichever is the most onerous. Smaller orifices may require checks of nozzles and strainers to ensure these are not blocked. Nozzles to be sample tested after five years.	As per DIOM and BS EN 14972 or BS 8458/8489, whichever is the most onerous. Much smaller orifices typically require checks of nozzles and strainers to ensure these are not blocked. Cylinder-based systems require 10 year pressure test. Nozzles to be sample tested after five years.
Fire service inlet	Fire service may be able to supplement stored water supply by pumping-in subject to availability of connections	Fire service may be able to supplement stored water for tank systems provided filters are in place
Shared water supply	Can share water supply with other water-based fire protection system	If as a cylinder system, cannot share existing water supplies with other water-based fire protection
Density	Typical water flux density 2 – 3.5 lpm/m ³	Typical water flux density 1 – 2 lpm/m ³
Dry or wet pipes	Typically wet systems only	Most systems are wet but deluge systems and some innovative systems are dry.

PERSONAL PROTECTION WATER MIST SYSTEMS

A self-contained water mist system is essentially a sprinkler system in one room of a building, for one person. These systems are designed for people who spend most of their time confined to a specific area of their home. Water mist systems use a spray of fine water droplets that can suppress a fire by cooling, wetting and displacing oxygen.

INNOVATIVE SYSTEMS

As BS 8489 states: ‘there are many alternative or innovative fire suppression systems available. Where these are used it is necessary to ensure that such systems have been designed and tested for use in buildings and are fit for their intended purpose.’

COMPLIANCE AND CERTIFICATION

Regardless of the technology used, watermist, sprinklers or otherwise, there is an increased confidence in system reliability and performance when moving from compliance to certification.

A declaration of compliance is a first party statement by the installer or manufacturer against an established standard. It can be applied to the system, to components or to an installation. Installer certification schemes provide third party evidence of competence of installers. However, because of the many proprietary designs, it is common for some manufacturers to establish a distributor network of licensed and approved contractors who enter into contractual agreements with the manufacturers to install systems according to the DIOM. Confirmation and verification of such undertakings should be provided to those procuring systems.

Third party conformity bodies such as laboratories and certification schemes provide independent evidence of installer competence, component reliability or system performance. These can be an independent verification certificate of performance against a standard’s fire test protocol to a full system and component certification.

While BS 8458, BS 8489 and BS EN 14972-1 set out the essential features of water mist fire suppression systems and include some limited fire test protocols, they are not component test standards.

Standards and certifications for water mist installations, system and components:

	NOZZLE	PUMP	CONTROLLER	SYSTEMS	INSTALLER
UK National Standards	BS 8663-1	Not published	Not published	BS 8458 BS 8489 Series BS EN 14972 Series	BS 8458 BS 8489 Series BS EN 14972 Series
UK Certification Standards	BS 8663-1 LPCB Schedule of requirements, SD0231 Appendix 4.	Not published	Not published	LPS 1283 (Commercial low hazard) LPS 1285 (Domestic and residential)	LPCB will certify installers against the published LPS standards
UK Residential certification	Five manufacturers have certificated nozzles	None yet	None yet	None yet	FIRAS: 7 IFCC: 5 LPCB None (as at Oct 2021)
Other standards	EN 17450-2 (In progress) UL 2167 EN 12259-1 is the standard for sprinkler heads and deluge nozzles and is sometimes quoted	EN 17451 and EN 122259-12 UL 448	EN 17450-4 (In progress) UL 218	FM 5560 Water mist systems FM 5580 Hybrid water and inert gas systems	

In the UK, traditionally it has been the LPCB which has tested, certificated and listed active fire system components. In the water mist section of RedBookLive there is a strong caveat printed in bold which relates to the approval of individual components – ‘Water mist component approval does not mean LPCB water mist system approval’.

INSTALLING RESIDENTIAL AND DOMESTIC SYSTEMS IN WALES AND SCOTLAND

Since September 2021 the installation of residential wet pipe water mist systems (as an alternative to sprinklers) in premises in Wales which are mandated by Regulation 37A of Building Regulations and the Domestic Fire Safety (Wales) Measure 2011 must comply with the Welsh Government guidance document¹. BAFSA understand that the guidance has also been adopted by Scottish Building Standards.

1. <https://gov.wales/sites/default/files/publications/2021-08/guidance-automatic-water-mist-systems-for-domestic-and-residential-premises.pdf>