

BS 8489-1:2016



BSI Standards Publication

Fixed fire protection systems – Industrial and commercial watermist systems

**Part 1: Code of practice for design
and installation**

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This document comprises a front cover, an inside front cover, pages i to vi,
pages 1 to 70, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 8489 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 May 2016. It was prepared by Subcommittee FSH/18/5, *Watermist systems*, under the authority of Technical Committee FSH/18, *Fixed fire fighting systems*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

This part of BS 8489 supersedes DD 8489-1:2011, which is withdrawn.

Relationship with other publications

BS 8489 is published in the following parts:

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

Information about this document

This document converts DD 8489-1 into a full British Standard. It is a full revision of the Draft for Development, and incorporates the following principal changes:

- guidance on areas of operation;
- guidance on effective capacity of tanks;
- extension of scope of application to cover more areas in buildings when supported by test standards produced by other organizations.

Third-party testing/certification. Users of this British Standard are advised to consider the desirability of third-party testing/certification of conformity with this British Standard. It is usual in European countries for companies given the responsibility to design, install and maintain watermist systems in accordance with this current British Standard to be certified in this field by an independent certification body. There are a number of independent certification bodies that can attest conformity to this British Standard.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

This British Standard is intended for use by manufacturers, designers and installers of watermist systems, and for authorities having jurisdiction.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this British Standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Particular attention is drawn to the Water Supply (Water Fittings) Regulations 1999 [1], the Water Supply (Water Fittings) (Scotland) Byelaws 2014 [2] and the Water Supply (Water Fittings) Regulations (Northern Ireland) 2009 [3] in respect of requirements for any fire suppression system which conveys, or is likely to convey, water supplied by a water undertaker or licensed water supplier.

0 Introduction

0.1 Watermist systems

Fixed watermist systems for the fire protection of industrial and commercial hazards comprise specially designed nozzles mounted in pipework, secured within an industrial/commercial building, and connected via control valves to a dedicated water supply.

Specific areas within buildings can be protected by watermist where relevant fire test protocols exist.

Both single fluid and twin fluid watermist systems deliver a mist of small droplets which control, suppress or extinguish fire by:

- absorbing heat from the fire and its surroundings;
- smothering the flames by evaporation to steam;
- blocking radiant heat transfer to adjacent combustible materials.

Fires such as those involving flammable liquids (class B fires) can be extinguished using watermist. Fires such as those involving ordinary combustible materials (class A fires) can be controlled and suppressed using watermist. Watermist can also prevent flash-over.

With the high surface area of the droplets produced, watermist is able to absorb relatively large amounts of heat and thus provide efficient cooling.

Currently, the majority of applications for watermist relate to property and asset protection. However, under certain circumstances, watermist can improve tenability within the protected space and thus increase the chances of survival for personnel inside the protected areas. It can also enhance life safety in more general applications by protecting facilities upon which the safety of people depends.

The main elements of a typical watermist fire suppression system are shown in Annex A.

0.2 Test protocols

One of the greatest challenges to engineering of watermist fire suppression systems lies in determining whether the conditions of a particular test protocol are representative of the actual conditions in a given application based on an understanding of the dynamics of the interaction of watermist with fire. The following application parameters need to be determined as a minimum.

- a) Is the fuel similar to the test protocol (liquid or solid fuel, flash point, combustibility, quantity, arrangement)?
- b) Is the compartment volume equal to or less than the volume of the test room?
- c) Is the compartment height equal to or less than the test protocol?
- d) Is the compartment ventilation conditions similar (presence of fans, forced ventilation, etc., area of openings, position of openings)?
- e) are there more obstructions to the distribution of mist than the test protocol?
- f) Is the duration of protection provided by the listed system appropriate for the actual level of protection needed?

Watermist is a specific application solution which needs to be proven for each individual application and/or occupancy and to have demonstrated performance against standardized fire tests and component tests, as indicated by a report issued by the fire test laboratory.

System testing. Users of this British Standard are advised to consider the desirability of using a test facility that operates a quality system and has watermist testing in the scope of its accreditation. General requirements for the competence of testing and calibration laboratories are described in ISO/IEC 17025. Of particular importance with respect to testing of watermist fire suppression systems are:

- comprehensive understanding of watermist technology;
- ability to properly condition and characterize the fuels;
- the use of appropriate instrumentation and methodology to verify the compliance or non-compliance with the pass/fail criteria (as specified in the relevant standard listed in Table 1 and Table 2) and repeatability.

The watermist system is to be:

- 1) tested in accordance with a recognized test protocol;
- 2) published in a printed or online record by the testing laboratory.

Reliance is to be placed on the procurement and installation of:

- i) watermist equipment or systems that have demonstrated performance in standardized fire tests as part of a test and evaluation process;
- ii) watermist equipment and components that are listed for the intended application by the testing laboratory. This is to ensure reliability and performance of the equipment and components in the system.

A match needs to be established between test conditions on which the testing is based and the conditions of the actual installation and agreed through consultation with the authority having jurisdiction (AHJ), or other agencies with demonstrated qualifications in the field. Watermist systems can be assumed to be effective if they:

- use only components and equipment recognized by a testing laboratory;
- are based upon the laboratory test report of a recognized test protocol;
- are installed by trained personnel in accordance with the manufacturer's watermist system design and installation manual.

Where a watermist system application is not covered by a recognized standard fire test, additional testing might be required to meet the requirements of the AHJ.

1 Scope

This part of BS 8489 gives recommendations for the design, installation, commissioning and maintenance of watermist systems. It gives performance criteria for fixed watermist systems for specific industrial and commercial hazards, for both life safety and property protection.

The British Standard excludes:

- a) applications and occupancies which are not covered by relevant fire test protocols;
- b) watermist systems on ships, in aircraft, on vehicles and mobile fire appliances or for below ground systems in the mining industry;
- c) the use of watermist for explosion protection.

NOTE BS 8458 covers watermist systems in residential and domestic premises.

2 Normative references

Standards publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1710, *Specification for identification of pipelines and services*

BS 5839-1, *Fire detection and fire alarm systems for buildings – Part 1: Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises*

BS 7273-3, *Code of practice for the operation of fire protection measures – Part 3: Electrical actuation of pre-action watermist and sprinkler systems*

BS 7273-5, *Code of practice for the operation of fire protection measures – Part 5: Electrical actuation of watermist systems (except pre-action systems)*

BS 7671, *Requirements for electrical installations – IET Wiring Regulations – Seventeenth edition*

BS 8489-4, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 4: Tests and requirements for watermist systems for local applications involving flammable liquid fires*

BS 8489-5, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 5: Tests and requirements for watermist systems for the protection of combustion turbines and machinery spaces with volumes up to and including 80 m³*

BS 8489-6, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 6: Tests and requirements for watermist systems for the protection of industrial oil cookers*

BS 8489-7, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 7: Tests and requirements for watermist systems for the protection of low hazard occupancies*

BS EN 1057, *Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications*

BS EN 1968, *Transportable gas cylinders – Periodic inspection and testing of seamless steel gas cylinders*

BS EN 10255, *Non-alloy steel tubes suitable for welding and threading – Technical delivery conditions*

BS EN 12259 (all parts), *Fixed firefighting systems – Components for sprinkler and water spray systems*

BS EN 12845:2004+A2:2009, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*

BS EN 13445-5, *Unfired pressure vessels – Part 5: Inspection and testing*

BS EN 13501-1:2007+A1:2009, *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests*

BS EN 15004-1:2008, *Fixed firefighting systems – Gas extinguishing systems – Part 1: Design, installation and maintenance*

BS EN 60947-1: 2007+A1:2011, *Low-voltage switchgear and controlgear – Part 1: General rules*

BS EN 60947-4-1:2010+A1:2012, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

BS EN 62395 (all parts), *Electrical resistance trace heating systems for industrial and commercial applications*

BS EN ISO 14847, *Rotary positive displacement pumps – Technical requirements*

FM 5560:2016, *Approval standard for water mist systems*

ISO 6182-11, *Fire protection – Automatic sprinkler systems – Part 11: Requirements and test methods for pipe hangers*

Other publications

[N1]BRE GLOBAL LIMITED. *Loss prevention standard – Requirements and test methods for the approval of watermist systems for use in commercial low hazard occupancies*. LPS 1283. Issue 1.1. Watford: BRE Global Limited, 2014.

[N2]BRE GLOBAL LIMITED. *Loss prevention standard – Requirements for testing flexible hoses for sprinkler systems*. LPS 1261. Issue 1.1. Watford: BRE Global Limited, 2005.

3 Terms and definitions

For the purposes of this part of BS 8489, the following terms and definitions apply.

3.1 additive

chemical or mixture of chemicals or gases, intentionally introduced into a watermist system for one or more of the following purposes:

- enhancement of, or compliance with, fire protection requirements;
- corrosion protection;
- frost protection

3.2 assumed maximum area of operation (AMAO)

maximum area over which it is assumed, for design purposes, that automatic watermist nozzles will operate in a fire

3.3 authority having jurisdiction (AHJ)

organization, office, or individual responsible for approving equipment, installations, and/or procedures

3.4 automatic nozzle

watermist nozzle (see 3.36) held closed by an integral thermal release element

3.5 backflow

movement of the fluid from downstream to upstream within an installation

[SOURCE: BS EN 1717:2000, 3.5]

3.6 backflow prevention device

device that is intended to prevent contamination of wholesome water by backflow in a water supply system

[SOURCE: BS EN 1717:2000, 3.6, modified – additional words included]

3.7 competent person

individual or organization that has the requisite training and experience, access to the requisite tools, equipment and information, and is capable of carrying out a defined task

3.8 design pressure

maximum pressure expected to be applied to a system component

3.9 discharge duration

sum of all the times that watermist discharges throughout one fire-fighting event

3.10 dry pipe system

watermist system using automatic nozzles in which the pipework is always charged with air or inert gas under pressure

NOTE The water flows into the piping system and out through any activated nozzles.

3.11 effective capacity

volume of stored water available to a pump, taking into account the air gap at the top and the unusable water at the base of the tank, which is affected by a vortex letting air into the pump suction

3.12 enhanced availability watermist system

watermist system with additional measures required for enhanced availability of the system

NOTE For example, for life safety or insurance purposes.

3.13 fire control

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

3.14 fire extinguishment

complete elimination of any flaming or smouldering fire

3.15 fire suppression

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

3.16 flash-over

stage in the development of a contained fire at which fire spreads rapidly to give large merged flames throughout the space

[SOURCE: BS 4422:2005, 3.426]

3.17 high-voltage electrical equipment

equipment with circuits with more than 1 000 V for alternating current and at least 1 500 V for direct current

NOTE See BS 7671 for full definition.

3.18 hydraulically most favourable area

area of operation for which the water flow is at its maximum for a specified pressure, measured at the main control valve or pumpset

3.19 hydraulically most unfavourable area

area of operation for which the system pressure, when measured at the main control valve or pumpset, is required to be at its maximum to achieve the specified flow rate

3.20 local application extinguishing system

extinguishing system consisting of a calculated supply of extinguishing media arranged to discharge directly on to an identified hazard

[SOURCE: BS 4422:2005, 3.534]

3.21 mains water supply

permanent network of pipes that convey wholesome water from a public or private water supply system to a customer service connection or user draw-off point

3.22 maintenance

combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function

3.23 manufacturer

organization responsible for manufacturing watermist equipment, including nozzles, and for producing the watermist system design and installation manual and the fire test documentation to which it is linked

3.24 manufacturer's design and installation manual

document containing design and installation rules for all details of a watermist system

3.25 monitored watermist system

system where the operational status is electrically monitored

NOTE For example, valve position and liquid level.

3.26 pre-action systems**3.26.1 type A pre-action system**

otherwise normal dry pipe system in which:

- the air/inert gas pressure in the installation is monitored at all times;
- the control valve set is activated by an automatic fire detection system but not by the operation of the automatic nozzles;
- at least one quick opening manually operated valve is installed in an appropriate position to enable the pre-action valve to be activated in an emergency

3.26.2 type B pre-action system

otherwise normal dry pipe system in which:

- the control valve set is activated either by an automatic fire detection system or by the operation of the automatic nozzles;
- independently of the response of the detectors, a pressure drop in the pipework causes the opening of the system control valve

NOTE See also BS 7273-3.

3.27 responsible person

person(s) responsible for or having effective control over fire safety provisions adopted in or appropriate to the premises or the building

3.28 single fluid system

system that generates watermist by the passage of water, or water with additive, through a nozzle

- 3.29 supplier**
company fully trained and authorized by a manufacturer for the design, installation, commissioning and maintenance of its fixed watermist systems
- 3.30 system duration**
total of discharge times plus any interspersed non-discharge times
- 3.31 twin fluid system**
system that generates watermist at a nozzle by mixing water with inert gas fed from a separate pipe(s) from the water supply
- 3.32 user's operation and maintenance manual**
document provided by the watermist design and installation company to the user's responsible person which sets out the procedures to be followed to ensure the ongoing satisfactory operation of the watermist system(s), and the frequency of such procedures
- 3.33 volume protection system**
watermist system designed to protect an enclosed volumetric space
- 3.34 water undertaker**
company licensed to provide a public water supply
- 3.35 watermist**
water spray for which the $D_{v0,90}$ is less than 1 mm measured in a plane 1 m from the nozzle at its minimum operating pressure
NOTE $D_{v0,90}$ is the drop diameter such that the cumulative volume, from zero diameter to the respective diameter, is nine tenths of the corresponding sum of the total distribution.
- 3.36 watermist nozzle**
component, with one or more orifices, which is designed to produce and discharge watermist
- 3.37 watermist system**
distribution system connected to a water supply, with atomizing media where required, that is fitted with one or more nozzles capable of delivering watermist intended to control, suppress or extinguish fire
NOTE Watermist systems can discharge water or a mixture of water and some other agent or agents, e.g. inert gases or additives.
- 3.38 wet pipe system**
watermist system using automatic nozzles in which the pipework is always charged with water under pressure
- 3.39 wholesome water**
water suitable for human consumption
NOTE Attention is drawn to the definitions given in the Water Supply (Water Fittings) Regulations 1999 [1] and equivalents in Scotland [2] and Northern Ireland [3].

4 General recommendations

4.1 Consultation

COMMENTARY ON 4.1

Some premises might have multiple authorities having jurisdiction (AHJs), who might be concerned with life safety, property protection, business continuity, heritage preservation and environmental protection. Some AHJs might impose additional requirements beyond those of this British Standard.

Where a watermist system or an extension or alteration to a watermist system is being considered within new or existing buildings, the designer should at an early stage contact any AHJs or others who might have a direct interest in the installation, including but not limited to:

- a) the water undertaker or licensed water supplier;
NOTE Attention is drawn to the requirement to gain consent under water regulations [1–3]¹⁾. Further guidance is given in the WRAS Water Regulations guide [4].
- b) the fire authority for the area or the lead authority;
- c) the licensing authority;
- d) the building control/standards body or approved inspector;
- e) the insurer(s) of the building and building contents.

4.2 Situations where contact with water might cause a hazard

Watermist systems should be designed and installed to ensure that contact between water and the following materials or substances is avoided.

- a) **Materials which react with water**
 Watermist systems should not be used for direct application to materials that react with water to produce violent reactions or significant amounts of hazardous products. These materials include:
 - 1) reactive metals, such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium;
 - 2) metal alkoxides, such as sodium methoxide;
 - 3) metal amides, such as sodium amide;
 - 4) carbides, such as calcium carbide;
 - 5) halides, such as benzoyl chloride and aluminium chloride;
 - 6) hydrides, such as lithium aluminium hydride;
 - 7) oxyhalides, such as phosphorus oxybromide;
 - 8) silanes, such as trichloromethylsilane;
 - 9) sulfides, such as phosphorus pentasulfide;
 - 10) cyanates, such as methylisocyanate.
- b) **Liquefied gases**
 Watermist systems should not be used for direct application to liquefied gases at cryogenic temperatures (such as liquefied natural gas), which boil violently when heated by water.

¹⁾ The Water Supply (Water Fittings) Regulations 1999 [1], the Water Supply (Water Fittings) (Scotland) Byelaws 2014 [2] and the Water Supply (Water Fittings) Regulations (Northern Ireland) 2009 [3].

c) **High-voltage live electrical equipment**

Watermist systems should not be installed in the presence of high-voltage live electrical equipment, except where a risk assessment and testing have been carried out and have determined that it is safe to do so.

NOTE It is preferable that high-voltage electrical equipment be de-energized prior to discharge of the watermist.

4.3 Local application

Local application extinguishing systems should be designed and installed for the object being protected, together with its associated hazards, in accordance with the design parameters established through representative fire tests (see 6.1).

Where a risk assessment shows that the spread of fire could involve two or more objects of local application, the watermist system should be designed for the combined hazard.

4.4 Volume protection

COMMENTARY ON 4.4

Volume protection systems are either open nozzle systems, where all nozzles discharge simultaneously throughout the entire enclosure, or automatic nozzles, where only the nozzles in the immediate vicinity of the fire are expected to operate.

Volume protection systems should be designed and installed for the hazards to be protected within the volume, in accordance with the design parameters established through representative fire tests (see 6.1).

Where the spread of fire is likely to involve two or more enclosed volumetric spaces, account should be taken of adjacent fire hazards, and the watermist system should be designed for the combined hazard.

NOTE 1 An enhanced availability system might be needed where a watermist system is being provided for compliance with a regulatory requirement, or where watermist is proposed as an alternative means of compliance in respect of a life safety measure.

NOTE 2 The installation of an automatic door closing mechanism is expected to improve the effectiveness of the system by ensuring that any doors to the volume being protected are kept shut.

4.5 Oxygen depletion

Systems using an inert gas as a form of propellant for the watermist should conform to the safety requirements specified in BS EN 15004-1:2008, Clause 5.

4.6 Foam additives

COMMENTARY ON 4.6

The flammable liquid extinguishing properties of foam, including the ability to spread readily over pool fires, can contribute to the effectiveness of a watermist system. The use of water/foam mixtures can improve the effectiveness of the system and minimize re-ignition potential.

Foam may be used in applications where:

- *there are obstructions between the watermist source and the fire (e.g. pool fires under open floors); and/or*
- *the system is required to extinguish rather than suppress the fire.*

Foam extinguishing media are specified in BS EN 1568.

See also 8.3.

If a system is designed to be used with a foam additive, any testing should be carried out in combination with this additive.

NOTE Unless such systems are tested as installed, it is impossible to determine whether they will function as designed.

5 Detection, actuation and control

5.1 Detection

The fire detection response is of paramount importance for correct and efficient system functioning. Only detection systems which ensure response characteristics similar to the conditions under which the watermist system was tested (see 6.1) should be used.

NOTE Automatic nozzles have their own thermally activated element.

Where electrical detection systems are used, they should conform to BS 5839-1.

5.2 Actuation and control

COMMENTARY ON 5.2

System actuation can be mechanical, hydraulic, pneumatic or electrical, initiated by smoke, flame or heat.

Requirements for pneumatic heat actuated systems are specified in DD CEN/TS 14816.

5.2.1 General

Alarms or indicators or both should be used to indicate the operation of the watermist system or failure of any supervised device. The type (audible/visual), number and location of the devices should be in accordance with BS 5839-1. It should be possible for the fire and rescue service to be able to determine that the system has operated and, if the system is zoned, in which zone the fire has occurred.

NOTE The nature and extent of audible and/or visual alarms are determined by the particular application.

5.2.2 Electrical actuation

Electrical actuation should be in accordance with BS 7273-3 or BS 7273-5 as appropriate.

5.2.3 Non-electrical actuation

Where pneumatic, hydraulic or mechanical control equipment is used, the lines should be protected against crimping and other possible damage. Where installations could be exposed to adverse conditions that could affect the integrity of the installation (electrical cable, pipework, key parts, etc.), appropriate precautions should be taken to counteract such occurrence.

5.2.4 Manual actuation

If a watermist system is equipped with a manual triggering device, the device should be in accordance with BS 7273-3 and BS 7273-5.

6 Design and installation

6.1 General

Before designing a watermist system, the volume, occupancy or object to be protected should be identified and a hazard analysis carried out to establish the exact nature of the potential fire hazard(s) affecting that volume, occupancy or object. If enhanced availability is required for volume protection systems, the recommendations in Annex B should be followed in addition to those in 6.1 to 6.5.

Tests should then be carried out, simulating the volume or object to be protected in conjunction with the identified hazard. If tests have already been carried out for this application, and verified by the AHJ or testing laboratory as being reliable, then those tests should be used.

Tests for the specific applications listed in Table 1 and Table 2 should be carried out in accordance with the most relevant fire test protocol listed in those tables (see Note 1). The main fire performance objective of the watermist system under test should be evaluated in terms of fire extinguishment, fire suppression or fire control, as appropriate for the volume or object to be protected. The scope and limiting parameter (e.g. fuel arrangement, ceiling detail, ventilation) are specified in each test protocol and these limits should be adhered to when using a test protocol for an application.

NOTE 1 Other tests for these applications may be used if they can be shown to give acceptable fire performance, e.g. at least equivalent results.

NOTE 2 Tests for other applications may be used if they can be shown to be repeatable and to have clear pass/fail criteria.

NOTE 3 A watermist system uses different design criteria (e.g. nozzle type and spacing) based on different test protocols for different areas in a building. For example, in a hotel the design criteria are different for the bedrooms, dining hall, kitchen and car park.

System testing. Users of this British Standard are advised to consider the desirability of using a test facility that operates a quality system and has watermist testing in the scope of its accreditation. General requirements for the competence of testing and calibration laboratories are described in ISO/IEC 17025. Of particular importance with respect to testing of watermist fire suppression systems are:

- comprehensive understanding of watermist technology;
- ability to properly condition and characterize the fuels;
- the use of appropriate instrumentation and methodology to verify the compliance or non-compliance with the pass/fail criteria (as specified in the relevant standard listed in Table 1 and Table 2) and repeatability.

When a successful set of test results is obtained (see 6.2.1 and the standards listed in Table 1 and Table 2), the components and parameters used in that test, as set out in the test reports (see the relevant clauses in the standards listed in Table 1 and Table 2), should be incorporated into the manufacturer's design and installation manual, together with any other system constraints crucial to the operation.

Sufficient and relevant design and installation information should be provided to enable the replication of the system as tested.

The manufacturer should describe and/or specify the procedure for the installation of the system.

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. If the fire test is passed using a constant pressure source then a decaying pressure source should not be used, and vice versa.

Unless otherwise established by testing, ventilation and power/fuel supplies to equipment in watermist-protected enclosures should be shut down upon activation of the watermist system.

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) Churches Concealed spaces Gymnasiums 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	Lightly loaded non-storage and non-manufacturing areas with ordinary combustibles Expect fire with relatively low rates of heat release in these occupancies	Mat stores	BS 8489-7 FM 5560:2016, Appendix G

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 $\leq 500 \text{ MJ/m}^2$ (covered in Category 3 only);
 - ceiling heights $\leq$ tested height up to 5 m;
 - floor area = restricted and unrestricted;
- FM 5560:2016, Appendix G covers:
 - fire loads $\leq 150 \text{ MJ/m}^2$;
 - ceiling heights $\leq$ 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.

Table 2 Occupancy and acceptable fire test protocol of Class B and Class F fire hazards operated by a deluge system

Occupancy	Fire test protocol
Machinery spaces $\leq 80 \text{ m}^3$	BS 8489-5 or FM 5560:2016, Appendix A
Machinery spaces $\leq 260 \text{ m}^3$	FM 5560:2016, Appendix C
Machinery spaces $> 260 \text{ m}^3$	FM 5560:2016, Appendix E
Combustion turbines $\leq 80 \text{ m}^3$	BS 8489-5 or FM 5560:2016, Appendix B
Combustion turbines $\leq 260 \text{ m}^3$	FM 5560:2016, Appendix D
Combustion turbines $> 260 \text{ m}^3$	FM 5560:2016, Appendix F
Industrial oil cookers	BS 8489-6 or FM 5560:2016, Appendix J
Pool and spray fires – local application	BS 8489-4 or FM 5560:2016, Appendix I

6.2 System design

6.2.1 General

Watermist systems should meet the following criteria.

- a) Nozzles should be positioned and oriented in accordance with the manufacturer's design and installation manual and should meet at least the established design parameters (see 6.1). These should address, but are not limited to:
 - 1) minimum and maximum heights;
 - 2) minimum and maximum distances between nozzles;
 - 3) minimum and maximum distances from nozzles to walls;
 - 4) the location of nozzles with regard to obstructions;
 - 5) positioning of nozzles with regard to ceiling (flat, pitched or curved);
 - 6) nozzle protection;
 - 7) nozzle ceiling plates used with flush, recessed or concealed nozzles;
 - 8) minimum and maximum flow rates and pressures;
 - 9) additive requirements, where applicable.
- b) There should be a minimum of four nozzles for the AMAO.
- c) Thermally activated nozzles should have quick-response heat-responsive elements in accordance with BS EN 12259-1 in terms of temperature ratings and selection of the temperature rating for installed maximum ambient conditions.

NOTE 1 Concealed or recessed nozzles may be used only if their performance is verified by fire testing in accordance with the tests listed in 6.1.

- d) The system duration should be as follows.
 - 1) For extinguishing systems, the duration should be at least twice the time taken to extinguish the fire and to prevent re-ignition as established in the test (see 6.1).

NOTE 2 Other factors such as the run-down time of a turbine and the time necessary to secure fuel lines to rotating equipment might also need to be taken into account, depending on the application.
 - 2) For suppression systems using automatic nozzles, the duration should be commensurate with the nature of the occupancy as defined in Table 1 and should in all cases be not less than 60 min.

e) The water supply should be as follows.

- 1) For extinguishing systems using open nozzles, the water supply should be based on the minimum discharge duration given in Table 3, and the maximum dimensional and area coverage including spacing of nozzles as established by the tests listed in Table 2.
- 2) For suppression systems using automatic nozzles, the water supply should be based on the minimum discharge duration [see d)2)] and the flow to all nozzles in the hydraulically most favourable AMAO. Structural fire separation should not be used between rooms to define a smaller AMAO than that required by the risk, unless prior agreement has been obtained from the AHJ.

NOTE 3 The AMAO for applications listed in Table 1 is 72 m² when configured as wet or pre-action systems.

NOTE 4 Attention is drawn to the requirements of the water regulations [1–3]²⁾, in respect of situations where water for the system is drawn from the public supply.

If the type of occupancy is not listed in Table 1 or Table 2 then the AHJ(s) should be consulted to agree which type of occupancy should apply, whether additional measures are needed (see 6.2.2), or whether an alternative system is more appropriate.

NOTE 5 In some cases it might be appropriate to consult a suitably qualified fire engineer to determine the suitability and specification of the watermist system.

Table 3 Occupancy, operating volume and discharge duration for Class B and Class F fire hazards operated by a deluge system

Occupancy	Operating volume	Minimum discharge duration (min.)
Machinery spaces	<80 m ³	10
Machinery spaces	<260 m ³	10
Machinery spaces	>260 m ³	60 ^{A)}
Combustion turbines	<80 m ³	10
Combustion turbines	<260 m ³	10
Combustion turbines	>260 m ³	60 ^{A)}
Industrial oil cookers	As per test protocol	10
Pool and spray fires – local application	As per test protocol	10

^{A)} Unless verified as lower according to certification against fire protocol.

6.2.2 Special circumstances

In some circumstances, enhanced performance, reliability and resilience arrangements should be provided, if an assessment shows them to be necessary. Where appropriate, the designer should consult the relevant AHJ(s).

NOTE 1 Examples of such arrangements include:

- extended duration of water supply;
- making water supplies more robust, such as by the provision of redundancy in the pumping arrangements or the provision of back-up electrical supplies;
- increasing the design discharge density or design area of operation.

²⁾ The Water Supply (Water Fittings) Regulations 1999 [1], the Water Supply (Water Fittings) (Scotland) Byelaws 2014 [2] and the Water Supply (Water Fittings) Regulations (Northern Ireland) 2009 [3].

NOTE 2 Situations where such arrangements might be necessary include:

- dwellings with a fire loading greater than that which would normally be found in the occupancy;
- very tall buildings;
- buildings of older construction;
- buildings with large undivided attics or basements;
- buildings with significant volumes of structural timber;
- buildings with open ventilation ducts and flues;
- buildings with atria, or where a risk assessment shows that the spread of fire could involve two or more enclosed volumetric spaces;
- buildings with adjacent unprotected areas;
- buildings housing vulnerable people;
- buildings with fire engineered design solutions.

6.2.3 System type and size

The protected area in volume protection wet pipe and pre-action systems, served by a single control valve, should be not more than 10 000 m².

Type A pre-action systems should only be installed in areas where considerable damage could occur if there was an accidental discharge of water. In the event of a fault in the fire detection system, the installation should operate as an ordinary dry pipe system.

Type B pre-action systems may be installed wherever a dry pipe system is called for and the spread of fire is expected to be rapid.

The net volume of a dry system, served by a single control valve, should be less than 0.15 m³ for intermediate and high pressure systems and less than 0.28 m³ for low pressure systems, unless a calculation shows that the maximum time between the most remote nozzle opening and water discharging is less than 60 s.

NOTE Where a proven hydraulic calculation can be provided to ensure compliance with the maximum time of 60 s, then the size of the protected area and/or volume of a dry system can be increased.

6.2.4 Pipework

6.2.4.1 Pressure loss

System piping should be hydraulically designed to deliver the required water flow and pressure to the AMAO (see Annex C) in accordance with the manufacturer's design manual and 8.1.

Only appropriate and validated calculation procedures should be applied, e.g. the Darcy–Weisbach formula for liquid flow systems.

6.2.4.2 Air venting

Vent valves should be provided where air pockets can accumulate in normally water-filled pipework.

6.2.4.3 Installation

The pipework should be installed in accordance with the manufacturer's design and installation manual and should be protected against internal corrosion. Pipes and fittings should be installed in such a way that the pipework is not exposed to damage, e.g. by fire, by passing vehicles, by frost, or by contact with dissimilar metals. Where systems are installed in corrosive environments, suitably corrosion-resistant materials and components should be used. The possibility of thermal expansion in very long straight pipe runs should be addressed where applicable.

NOTE Attention is drawn to the requirements of the water regulations [1–3]³⁾, in respect of pipework installation and backflow prevention devices.

Systems within electrical sub-stations or switchrooms should be effectively bonded and earthed to prevent metalwork becoming electrically charged. Bonding should be carried out in accordance with BS 7671.

All pipework should be checked for electrical earthing connections. Pipework should not be used for earthing electrical equipment. Any earthing connections from electrical equipment should be removed and alternative arrangements made.

6.2.4.4 Drainage

All systems should be installed in such a way that the entire pipework system can be drained.

6.3 Electrical design

6.3.1 General

Electrical installations should conform to BS 7671.

6.3.2 Transmission of alarms

Alarms should be connected to an alarm panel in the watermist control room or pump room and be transmitted onwards depending on the nature of the alarm (e.g. fault or fire condition). Alarms should be transmitted to a permanently attended location, on or off the premises, or to a responsible person in such a way that appropriate action can be taken immediately.

Signals such as water flow indication, which could be indicative of a fire, should be shown as fire alarms (alarm level A in Table 4).

Technical faults such as a power failure, which could prevent the system operating correctly in case of fire, should be shown as fault (trouble) alarms (alarm level B in Table 4).

6.4 Air velocity, openings and ventilation

Air velocity, openings and ventilation should be in accordance with the manufacturer's instructions, based on test results.

Wherever possible, the ventilation system should be shut down automatically before the system operates. In those cases where this is not possible or desirable, the air velocity and/or total leakage area should be within the limits specified by the manufacturer on the basis of tests.

³⁾ The Water Supply (Water Fittings) Regulations 1999 [1], the Water Supply (Water Fittings) (Scotland) Byelaws 2014 [2] and the Water Supply (Water Fittings) Regulations (Northern Ireland) 2009 [3].