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Technical Guidance Note

Watermist Systems
Compliance with Current Fire Safety Guidance

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The UK Watermist Co-ordination Group is formed from representatives drawn from BAFSA and the FIA. This document is issued for the guidance of BAFSA and FIA members involved in the design and installation of watermist systems used for fire suppression and extinguishment and should be read in conjunction with the contents of DD 8489 - 1: 2011, *Fixed fire protection systems. Industrial and commercial watermist systems. Code of Practice for design and installation* and the draft European standard prEN 14972, *Fixed fire-fighting systems - Watermist systems – Design and installation.* The NFPA 750 Standard contains the minimum requirements for the design, installation, maintenance and testing of water mist fire protection systems.

In providing this information BAFSA and the FIA make no warranties or undertakings as to its accuracy or completeness and assume no liabilities in connection with the way the advice and information is used.

This document is also Technical Guidance Note No 3, *Watermist Systems*, in the BAFSA suite of guidance notes.

bafsa

Fire Industry Association

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1.0 An introduction to watermist

1.1 Physical principles

The key to the success of watermist is ability of small water droplets to suppress or control a fire extremely efficiently. Although regarded by some as still being in its infancy compared with the more traditional forms of water-based fire suppression systems, watermist technology is not new.

Its 'intelligent use of water' in the form of very small water droplets was first successfully employed by Grinnell in its 'pepper pot' nozzle in the 1890s. Such systems proved to be a fast and efficient method of extinguishing fires by rapid cooling and oxygen displacement.

The land-based breakthrough for watermist technology came in the beginning of the 1990s and was linked to the rapid expansion of food processing production plants that were constructed to cope with the growing demand for ready-prepared meals and other convenience foods. The food industry was quick to recognise the immense benefits of watermist in rapidly suppressing or extinguishing the potentially disastrous fires which could result from the range of oil-based cooking processes carried on in such premises.

Another watermist application developed following the fire on the passenger ferry Scandinavian Star in April 1990, which killed 158 people. This tragedy galvanised the watermist Industry and in 1993 it conducted a large series of cabin and corridor fire tests. These fire tests were independently witnessed and led to improved International Maritime Organisation fire safety requirements on passenger ships and the development of installation guidelines and fire test procedures for alternative sprinkler systems.

Advances in watermist technology have led to the production of British, European and International Standards and Guidelines for the design, installation, commissioning and maintenance of watermist systems to combat Class A, B, C and F type fires in a wide variety of domestic, residential, commercial and industrial applications.

This Technical Guidance Note provides easy access to a range of third-party information to illustrate the benefits of incorporating watermist fire suppression into a particular building design.

It will allow all those involved in the building process, such as property developers, authorities having jurisdiction, architects, designers and end users to determine the most advantageous approach to compliance with building regulations. It also includes consideration of cost savings which can be achieved.

1.2 How watermist works

1.2.1 Watermist and the fire triangle

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

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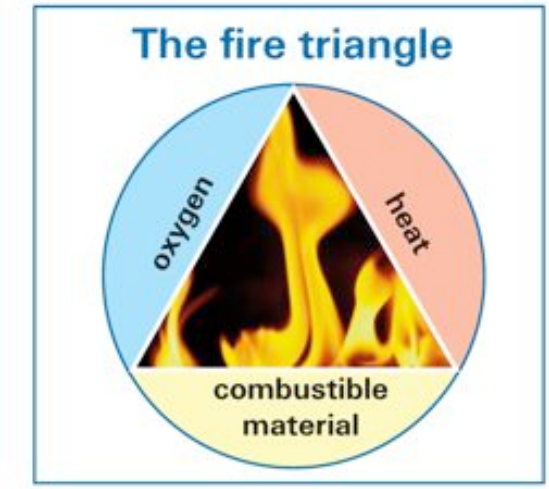


Fig.1. The fire triangle

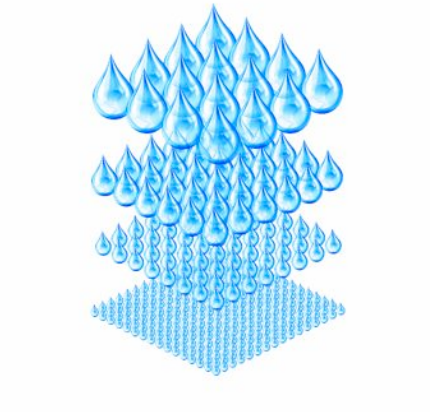


Fig.2. Water droplet size in relation to surface

A traditional sprinkler system removes the heat element of the triangle whilst watermist removes both the heat and oxygen elements of the triangle. It achieves this by dispersing water through specially designed nozzles at low, medium or high pressure. Generally, as system pressure increases, the water droplet size decreases. This, in turn, significantly increases the total surface area of the unit 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 at the flame front of a fire. This is because the heat absorption capacity of watermist 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 watermist – then quite a lot of energy is used, energy which is taken from the fire which has occasioned the watermist discharge. This reduces the strength of the fire.

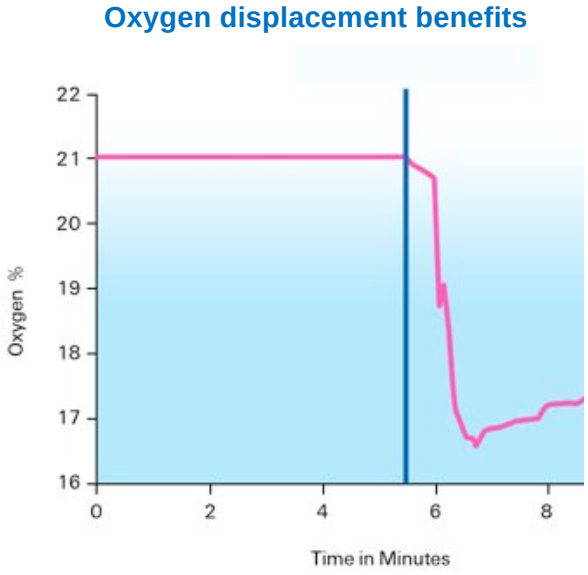
It takes 335kJ to heat 1 litre of water from 20°C to 100°C and 2257kJ to convert 1 litre of water to steam. Water expands 1700 times upon vaporisation so the high energy-absorption capability of small water droplets produces the rapid cooling and oxygen depletion characteristics that are unique to watermist.

1.2.2 The significance of the size of watermist droplets

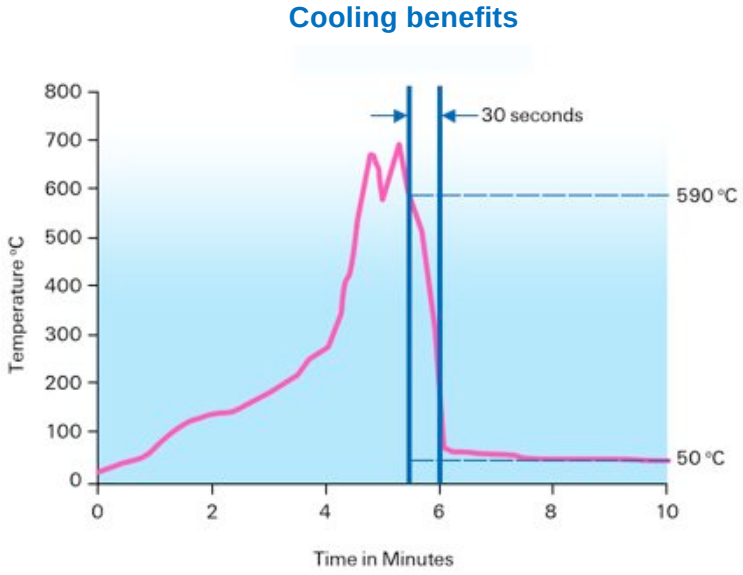
Fire engineers, consultants and specifiers will wish to approach the fire protection design task by carrying out a detailed fire risk assessment of the premises to be protected, and will establish the fire risk classifications (see 1.3 below) detected therein. Thus they can determine which type of watermist system and types of nozzles can best be used to deal with the perceived threat of fire.

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Graphs 1 and 2 illustrate actual test results for rates of oxygen depletion and of cooling by a watermist system which actuates about 5.5min after the start of a fire.



Graph 1. Reduction of oxygen concentration from 21% to 16.8% at the flame front during high pressure water discharge.



Graph 2. Reduction of temperature from 590°C to 50°C during initial 30sec of discharge (preburn time before manual operation).

1.3 Fire classifications

Various watermist systems have been developed either to suppress or extinguish fires involving fuels of classes A, B, C, D and F (but in what follows it has not been appropriate to develop reference to Class D, fires involving metals).

- Class A fires involve ordinary combustibles, solid materials, mainly of organic origin, such as wood, paper, textiles and straw etc.
- Class B fires involve flammable liquids such as oils, spirits, fats and certain plastics.
- Class C fires involve flammable gases such as methane, propane, hydrogen and natural gas.
- Class F fires involve the flammable cooking oils used within the food industry.

1.3.1 Watermist systems to provide object and volume protection

(a) Object protection

An object protection system is used to protect stand-alone equipment, such as diesel engine generator sets and deep fat fryers, by discharging water directly onto the fire risk by local application, as illustrated in Fig. 3. Open nozzles are fitted within a ‘dry system’ (see 1.3.3(b)) for this type of protection. The

nozzles have different spray angles and flow rates to maximise coverage and protection in the event of a fire.

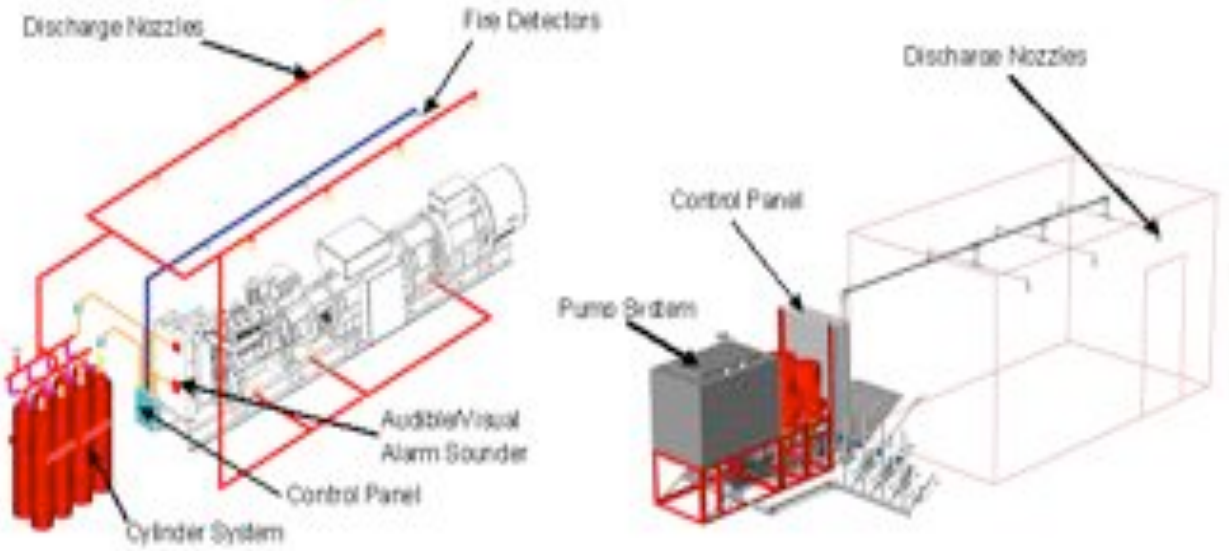


Fig. 3. Examples of watermist systems.

(b) Volume protection

Volume protection systems are used to discharge watermist throughout the entire protected area using open nozzles or closed, automatic 'heat sensitive' type nozzles where only the nozzles in the immediate vicinity of a fire are expected to operate. Typical applications include areas such as machinery spaces (open nozzles) and hotel bedrooms (automatic nozzles).

1.3.2 Water supply methods

Watermist can be delivered through the system's distribution pipework to the discharge nozzles using either a single or twin fluid delivery system.

A single fluid system generates watermist by delivering water through the nozzle under pressure from either pressurised cylinders or a low or high pressure pump system.

A twin fluid system generates watermist by mixing an inert gas fed from separate pipework to the water supply pipework, that mixture being delivered through the nozzle under pressure.

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1.3.3 Types of watermist systems – wet, dry, deluge, pre-action

(a) Wet system

This watermist system uses automatic, 'heat sensitive' type nozzles fitted into distribution pipework that is permanently charged with water and is used to protect areas where temperatures are above 4°C or are unlikely to fall below freezing point.

(b) Dry system

This watermist system again uses automatic, 'heat sensitive' type nozzles fitted into distribution pipework that is permanently charged with air, nitrogen or pressurised gas. In the event of a fire, when a nozzle operates, the pressure drop within the distribution pipework actives the system control unit to release water into the pipework where it is discharged through the open nozzle.

(c) Deluge system

A deluge system is designed to bring a large number of open nozzles into action simultaneously in the event of a fire. This is achieved when a pilot line, fire detection and alarm or manual over-ride is activated. This in turn operates the main control unit to release the water through all the open watermist nozzles to effect rapid control and extinguishment of the fire.

(d) Pre-action system



Fig. 4. A pre-action watermist system can protect, for example, a data centre.

These systems are commonly used for the protection of high value, 'mission- critical' areas such as data centres, server rooms or communications switches (see Fig. 4) or where sensitive electrical equipment and goods are stored. They provide prior warning of system discharge or prevent system discharge caused by accidental damage to a watermist nozzle or system pipework.

Such systems comprise a watermist installation plus an independent system of heat or smoke detectors installed in the same areas as the automatic, 'heat sensitive' nozzles. On receipt of a signal from two or more detectors, the main control panel automatically opens the control valves, allowing water to flow into the distribution pipework in readiness for the first watermist nozzle to operate.

1.3.4 System classification – low, medium and high

The system classification is based on the atomisation ability of the watermist nozzle, its orifice, filters and strainers when water at operating pressure is discharged through the nozzle. Pressures are rated thus:

- low pressure is defined as less than 12.5bar.
- medium pressure is defined as between 12.5 and 35bar.
- high pressure ranges from 35 to120bar.

1.3.5 Low pressure watermist systems

These systems have been designed to retain all the proven performance and reliability of traditional water-based systems, while capturing the efficiency of small water droplet, watermist technology. The design of the nozzles provides reduced droplet sizes of 0.10mm diameter at a pressure of less than 12.5bar to deliver a typical flow of just 12 litres (2.6 gallons) per minute from each nozzle.

The result is reduced pipe diameters, ease of installation, less system weight and minimal water discharge. Low operating pressure also provides the option of using either copper or plated carbon steel pipework, as alternatives to stainless steel.

Low pressure frangible bulb systems ensure that only those nozzles operate which are in the immediate vicinity of the fire. They are ideally suited for the protection of rooms, corridors and spaces where light-to-moderate fire loads of ordinary combustibles exist. Low pressure open nozzle systems are ideal for the protection of hazards involving flammable liquids. The addition of aqueous film-forming foam (AFFF) will maximise extinguishing performance against these types of fires anywhere in the protected space.

1.3.6 Medium pressure watermist systems

These systems were primarily used for local applications as good, low-cost alternatives to the more efficient high pressure systems. With a minimum operating pressure of 35bar they were mainly used for the protection of diesel engine generator sets, boiler fronts and oil separators etc. However, in recent times the watermist industry has polarised its efforts within the high and low pressure market sectors and, as far as can be ascertained, it has withdrawn from the medium pressure market sector.

1.3.7 Watermist systems' performance

NFPA Standard 750 uses a definition of water droplet sizing to distinguish between watermist systems and other water-based systems such as sprinklers. Watermist is defined in NFPA 750 as a water spray for which 99% of the total volume of water discharged is in droplets with a diameter less than 1000 microns at the minimum design operating pressure of the watermist nozzle.

So what about a high pressure system? The average total surface area of the droplets in the mist from a typical high pressure water mist system is at least 100 times greater than conventional sprinkler droplets for the same volume of water. Therefore, significantly smaller amounts of water are required to absorb an equivalent amount of energy from a fire.

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Oxygen depletion is significantly increased by high pressure watermist at the flame front in both object protection and total flooding applications within completely enclosed spaces, particularly where the fire is large in relation to the space.

Wetting of surfaces is also an important effect where control of deep-seated fires is a prerequisite. A further highly beneficial effect of high pressure water mist is the dramatic reduction of harmful products of combustion caused by the washing out of smoke particles from the fire.

1.3.8 Watermist nozzles: types and applications

Watermist nozzle technology is defined by the following four main fire risk analysis requirements:

- Water pressure – high or low.
- Type of watermist discharge propellant – water or gas (single or twin fluid systems).
- Watermist atomisation technique of the discharge nozzle:
  - small orifices
  - external deflector plates
  - internal swirl plates
  - gas injection.
- Fire suppression, control and extinguishment objectives:
  Suppression: The sharp reduction of the rate of heat release of a fire and the prevention of re-growth.
  Control: The limitation of the growth of a fire by pre wetting adjacent combustibles and controlling ceiling gas temperatures to prevent structural damage.
  Extinguishment: The complete suppression of a fire until there are no burning combustibles.

(a) High pressure watermist nozzles

These nozzles are invariably manufactured from stainless steel due to the required high pressures of operation. Such nozzles are illustrated in Figs 5 and 6. The open and closed, 'heat sensitive' nozzle design is heavily influenced by the purpose of the nozzle.



Fig. 5. High pressure nozzles.



Fig. 6. High pressure nozzles.

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Fig. 7. Open and closed, heat sensitive low pressure watermist nozzles.

Some are designed to be directional in order to deliver a specific spray pattern at a protected risk whilst others are required to provide a diffusing mist for volume protection. In addition, some are designed for specific functions such as sidewall nozzles for the protection of hotel rooms or to provide water curtains in atrium buildings for life safety applications. There are even nozzles specifically designed for floor void protection within data centres.

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 Class A, B, C or F fires.

(b) Low pressure watermist nozzles

As can be seen from the open and closed, 'heat sensitive' low pressure watermist nozzles illustrated in Figure 7, their design is more in keeping with those of traditional water-based systems to reflect their operating pressures of between 11.6 and 17bar.



Fig. 8. Examples of low pressure watermist nozzles

A range of open and closed, 'heat sensitive' low pressure watermist nozzles is illustrated in Fig. 8. They have operating pressures of between 4.0 and 12.0bar.

Low pressure watermist open nozzles are primarily used to protect flammable liquid fire risks such as gas turbines. Closed, 'heat sensitive' nozzles have been designed primarily for area protection (total flooding) applications.

In the event of a fire, the heat sensitive bulb is designed to shatter when it reaches a pre-determined temperature allowing the nozzle to discharge watermist directly onto the seat of the fire. These types of nozzles are employed for the protection of risks such as machinery spaces or in rooms, corridors and spaces where light-to-moderate fire loads of ordinary combustibles exist.

1.3.9 Watermist pipes and fittings

The material used for the pipework and fittings for watermist systems is governed by the nature of the estimated fire/fuel load and the water pressure required to protect the perceived risk. High pressure systems normally require the use of stainless steel pipework and fittings. Low pressure system pipes and fittings can be of zinc-plated carbon steel or copper or cpvc depending on the type of application and risk involved.

Figures 9 and 10 illustrate some typical examples of pipework used.



Fig. 9. Examples of high pressure watermist pipes and fittings.



Fig. 10. Examples of low pressure watermist pipes and fittings.

By choosing watermist companies whose products and services comply with British, European and International Standards, specifiers are able to mitigate risk at every stage of a project, from design, manufacture, installation, commissioning and maintenance.

2.0 Compliant installations

2.1 Standards and approval authorities

Following increased awareness and interest in the application of watermist as an alternative firefighting medium, the organisations responsible for national and international standards and approvals documents have worked extremely hard to introduce and publish robust and updated watermist Standards and Approvals. Commercial, industrial, residential and domestic watermist systems can be specified and installed to a number of standards including those issued by BSI, CEN, FM and NFPA.

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(a) British Standards

DD 8458-1: 2010. *Fixed fire protection systems. Residential and domestic watermist systems. Code of practice for design and installation*

DD 8489-1: 2011. *Fixed fire protection systems. Industrial and commercial watermist systems. Code of practice for design and installation.*

(b) European Standard

CEN/TS 14972: 2011. *Fixed firefighting systems. Watermist systems. Design and installation.*

(c) International Standards

FM5560: 2009. *American National Standard for Water Mist Systems.* (This American National Standard is to be revised and republished in December 2012.)

FM5580. *Approval Standard for Hybrid (Water and Inert Gas) Fire Extinguishing Systems*, 2009.

NFPA 750: 2010. *Standard on Water Mist Fire Protection Systems*. This American Standard is to be revised and re-published in 2014.

2.2 How the British Standards work

Watermist standards provide recommendations for the design, installation, commissioning and maintenance of fixed watermist systems for low and high pressure watermist covering both residential and domestic, and commercial and industrial, applications.

2.2.1 Residential and domestic watermist standards

These apply to occupancies not exceeding 20m in height and to domestic occupancies. BSI's DD 8458-1 primarily covers watermist systems used for life safety purposes, but can also apply to property protection for the following:

- Residential - apartments, residential homes, HMOs, boarding houses, care facilities and dormitories etc.
- Domestic - individual houses, flats and maisonettes etc.

Important note: If the fire/fuel loading in any given occupancy exceeds that which would normally be found in a residential or domestic living room, kitchen or bedroom, or if the fire hazard is greater than that of a conventional residential or domestic occupancy, then this Draft for Development will not be suitable for use. Key indicators of adverse fire hazard include significant volumes of video tapes, books, paper and institutional catering facilities, and the configuration of the building (e.g. high ceilings, large volumes), ventilation and its contents. In those circumstances DD 8489 should be used.

2.2.2 Commercial and industrial watermist standards

BSI's DD 8489-1 (see 2.1(a) above) may be applied to hazards involving the following:

- Local applications - involving flammable liquid fires, as detailed in DD 8489-4.
- Combustion turbines and machinery spaces - with volumes up to and including $80m^3$, as detailed in DD 8489-5.
- Industrial oil cookers - as detailed in DD 8489-6.

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- Low hazard occupancies - as detailed in DD 8489-7.

Important note
Standardised tests and pass/fail criteria for these applications are given in DD 8489-4, DD 8489-5, DD 8489-6 and DD 8489-7 respectively. It is envisaged that further standardised tests will be added to the DD 8489 series when available.

2.3 How the Standards must be applied

Before the relevant Standards can even be applied to the design of a system, a period of consultation should first take place to seek approval with specific parties where a watermist system is being considered, regardless of whether the system is an extension or alteration within a new or existing building. This approval should be sought from the following authorities having jurisdiction:

- The water supply authority (*Note*: It is a requirement to gain consent under Water Regulations as defined in the Water Regulations Guide).
- The building control authority.
- The fire authority.
- The insurer(s) of the premises and premises' contents.

Once this approval has been given, it is essential that the specifier seeks a written technical specification from the preferred lists of watermist contractors on how the system will be designed, installed, commissioned, tested and maintained in accordance with the recommended watermist Standards. This is because in essence, it will involve buying a comprehensive package comprising tested components to form a system that replicates independent third-party testing and certification.

This procedure is vital because watermist is a relatively new technology for certain more recent applications and systems can vary considerably in the way different manufacturers' products and systems work.

A written technical specification will be required as evidence of the competency of the proposed watermist contractor and their willingness and ability to follow the watermist Standards to the letter. If any aspect of the watermist Standard is omitted, then the specifier is advised to remove the offending contractor from the preferred list of suppliers.

2.4 Other Standards and references

Occasionally, there may be bespoke designed systems that are outside the scope of DD 8458-1: 2010 and DD 8498-1: 2011. In these circumstances it may be necessary to refer to other Standards.

The design of watermist systems is based on full-scale fire tests conducted by recognised international test houses and approved and evaluated by third-party approval/certification bodies to ensure the systems will repeatedly perform to the specified design requirements of the relevant Standards, which could include items from the list in Table 1.

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Table 1. Watermist Standards.

Standard	Title
NFPA 750	National Fire Protection Association American Standard on Watermist Fire Protection systems
FM5560	Factory Mutual American Standard for Watermist Fire Protection Systems
UL2167	Watermist Nozzles for Fire Protection Services
EN TS 14972	European Technical Specification for Fixed Firefighting Watermist Systems
IMO A800	International Marine Organisation Standard for Watermist Systems
BS 5839 – Part 1: 2002 (as amended)	Fire Detection and Alarm Systems for Buildings
BS 7671	Requirements for electrical installations – IEE Wiring Regulations – Seventeenth edition
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 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 15004-1: 2008	Fixed firefighting systems. Gas extinguishing system. Part 1: Design, installation and maintenance

3.0 OEM (Own Equipment Manufacturers)

Watermist equipment manufacturers invest significant sums of money on an annual basis to secure approval for their products from fire equipment approval authorities, government agencies, insurance providers and fire trade associations. Therefore, it is hardly surprising that these manufacturers regularly undertake contracting projects themselves, in addition to licensing the use of their products to preferred distributors/partners throughout the world.

3.1 Manufacturers' links with contractors

A common method that manufacturers use to maximise potential sales of their products is to establish a distributor network of licensed and approved contractors who enter into contractual agreements with the manufacturers to guarantee that high standards of excellence and corporate governance will be maintained. This partnership between manufacturer and contractor can reassure specifiers that they have made the correct choice in the award of a contract.

However, if these required management control procedures are lacking and detailed attention to approvals and standards cannot be supported by written documentation, on-site problems with design,

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installation, commissioning, testing and maintenance may arise. These problems could lead to loss of business continuity and resilience and result in financial loss and possible litigation.

3.2 Certification of equipment

Physical and written evidence of equipment and system certification is vital to ensure that serious and far-reaching problems do not occur both during and after completion of a watermist project. Therefore, specifiers of watermist systems should ensure that the components that make up a watermist 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.

The system and all its components should also be installed to the relevant UK, European or international standard covering items such as the following:

- control valves, water pumps and inert gas pressure cylinders;
- distribution pipework, couplings and fittings;
- watermist 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 equipment;
- manual actuation equipment.

3.3 Certification of installers

At the time of writing, there is only one certification body listing watermist installers - Warrington Certification Limited. This company is UKAS-approved for providing certification services for a range of fire protection systems and equipment.

Their FIRAS Certification scheme for installers has been instrumental in improving standards of passive and active fire protection product and system installation. Approval of an installer under FIRAS, the Warringtom scheme, is an endorsement of competency in the installation of many products and systems.

Important Note: Because the Warrington watermist installation certification scheme is a recent introduction at the time of this document's development, it is recognised that some installers may be in the process of applying or qualifying for approval. Specifiers should ask an installer their status with respect to FIRAS.

4.0 Validating competence

Validating the competence of an installer is essential in safeguarding the interests of the specifier and end-user. Installers with third-party certification are regularly and independently audited both internally and externally to assess their performance and standards. There follow brief accounts of some third-party certification schemes.

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ISO 9001: 2000 Certificate - For design, installation, servicing and inspection of watermist, fire detection and alarm, foam and gaseous fire suppression systems within the UK, all in accordance with relevant Standards.

BS OHSAS 18001: 2007 Certificate - For design, installation, servicing and inspection of watermist, fire detection and alarm, foam and gaseous fire suppression systems within the UK, all in accordance with relevant Standards.

ISO 14001: 2004 Certificate – This certificate recognises the environmental systems approach of the watermist contractor for consultancy, design, modification, installation, integrated maintenance, inspection and repair, workshop and engineering support, performance, verification, interface engineering, and training and servicing of watermist, fire detection and alarm and gas suppression systems and associated operating equipment along with inspection, testing and re-testing.

LPS 1014 Certificate - This certificate recognises that the watermist contractor has met the certification requirements for fire detection and alarm systems covering design, installation, commissioning, servicing and inspection, testing and re-testing.

LPS 1204 Certificate - This certificate recognises that the watermist contractor has met the certification requirements for gaseous fire suppression systems covering design, installation, commissioning, servicing and inspection, testing and re-testing.

LPS 1048 Certificate - This certificate recognises that the watermist contractor has met the Level 4 approved sprinkler contractor requirements for sprinkler systems covering design, installation, commissioning, servicing and inspection, testing and re-testing.

5.0 Watermist installation, commissioning and maintenance

FIRAS certification for meeting the requirements for contractors installing watermist systems covers all the mandatory requirements for installation, commissioning and maintenance of watermist systems. For those watermist contractors who are in the process of applying for this certification or considering their application, it is highly recommended that system specifiers seek physical evidence of the contractor's ability to install, commission and maintain the watermist system to the requirements outlined in sections 5.1, 5.2 and 5.3.

5.1 Installation

The watermist contractor must provide the client/specifier with a copy of their 'Watermist Design and Installation Manual' that contains all the design and installation rules for the referenced 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.

5.2 Commissioning

A programme of works must be provided by the watermist contractor that outlines the notice period required prior to the commencement of commissioning. In addition, commissioning and snagging of the

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works must be undertaken by a commissioning engineer who reports directly to the watermist contracts manager.

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

- electrical detection and actuation in accordance with BS 5839 -1: 2002, BS 7273 – 3 and BS 7273 – 5;
- any mechanical actuation checks of watermist equipment;
- the fully charged state of all water storage vessels, main water control valves and required gas cylinders;
- a complete functional check of all re-settable valves and actuators unless testing of these components resulted in system discharge through the watermist nozzles;
- a full system discharge test that may be required where appropriate.

5.3 Maintenance

A user's operating and maintenance manual should include detailed maintenance instructions covering all the individual weekly, monthly, quarterly and annual test procedures for all the mechanical and electrical components that make up the overall watermist system.

The full list of these components and their test requirements can be found in:

- DD 8458-1: 2010. *Fixed fire protection systems. Residential and domestic watermist systems. Code of practice for design and installation.*
- DD 8489-1: 2011. *Fixed fire protection systems. Industrial and commercial watermist systems. Code of practice for design and installation*

6.0 Applications and limitations

6.1 Risk analysis

A detailed risk analysis is an indispensable precondition for determining the best form of fire protection or firefighting medium required to control, suppress or extinguish a specific risk. Initial risk analysis will determine whether the fire risk to be protected is Class A, B, C or F. An important factor in risk analysis is the required function of the watermist system. For example, is the system primarily required for property and asset protection or for enhanced reliability (life safety) applications? These factors will determine whether a low or high pressure watermist is best suited to protect the required risk, taking into account the speed at which it is required to operate.

Currently, most 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.

6.2 Means of escape

For residential and domestic watermist applications, means-of-escape requirements in flats and maisonettes are normally based on 'a remain in place' policy - or 'defend *in situ*' as outlined in BSI's

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DD 8458-1: 2010. Therefore, alarm arrangements should comply with any guidance specified by the Authority Having Jurisdiction.

While most watermist applications currently relate to property and asset protection, it is accepted that watermist can improve tenability in certain circumstances within protected spaces by rapidly cooling the room/space temperature sufficiently enough to afford safe passage away from the seat of the fire. This feature can significantly increase the chances of survival of personnel working within these protected spaces.

In addition, watermist can play a vital role within modern glass buildings. Glazing in that environment generally consists of fire-resisting, toughened, laminated or wired glass and each of these systems will offer varying degrees of fire resistance and all but one will offer high insulation properties.

There are several inherent problems in the use of glazing for compartmentation or on escape routes. Glass will fail when subjected to high thermal shock conditions (rapid cooling when hot) or by the existence of a steep temperature gradient across the surface, which again can result in the failure of the glazing. By maintaining the integrity and insulation of glass panels, watermist systems can allow people to pass by a fire and not be exposed to more than 2.5kW/m^2 (the heat from a 2-bar electric fire, say). Independent fire tests have shown that glass integrity was maintained for 61min without any detriment whatsoever to the glass when watermist actuates onto glass.

6.2.1 Smoke precipitation

Smoke is made up of mostly solid substances dispersed in a gas. To date, watermist under normal conditions cannot fully wash smoke to a level comparable with a dedicated system. Although watermist has been shown to be capable of capturing some water-soluble gases, minimal soluble and non-soluble gases such as carbon monoxide cannot be captured but can be dispersed (with local concentration reduction).

6.2.2 Visibility reduction

Watermist may have two effects on visibility that must be considered relevant to the evacuation of normally occupied areas. These are:

- reduction of light and visibility (possibly down to a few metres);
- light diffusion in various directions and a loss of visual contrast that could lead to people within the area becoming disoriented.

With these facts in mind, the system designer should specify measures to safeguard staff working in normally occupied areas. These measures should include a reasonable time delay for staff to evacuate the area prior to the system being activated. This time delay can be calculated by determining travel distances required by staff to reach designated safe exit routes from the protected area.

6.3 Electrical conductivity

Conductivity is limited even in extremely fine droplets of a watermist system because even de-mineralised water can become conductive as the water droplets become contaminated during system discharge by combustion particles and smoke. Therefore, it is vital that complete shutdown of exposed electrical equipment is achieved in the event of a fire. Observing the distance and positioning of nozzles in relation to electrical equipment outlined in the appropriate standards and the manufacturer's design and installation manual can also reduce levels of conductivity.

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6.4 Water discharge times

Water discharge times will vary depending upon whether the watermist system is designed for residential and domestic or commercial and industrial applications:

- 10min water discharge time for domestic applications;
- 30min water discharge time for residential applications;
  (Both residential and domestic systems should meet the pass criteria outlined in Annex A of DD 8458 -1: 2010 for the total time of discharge with all nozzles operating in the room concerned.)
- for industrial extinguishing systems which are required for local applications involving flammable liquid fires, combustion turbines up to and including 80m^3, industrial oil cookers, and low hazard occupancies, the duration should be at least twice the time taken to extinguish the fire and to prevent re-ignition as established in tests carried out in accordance with DD 8489-4, DD 8489-5, DD 8489-6 and DD 8489-7 respectively.
- for commercial suppression systems using automatic nozzles, the duration should be commensurate with the nature of the hazard as defined in BS EN 12845 (e.g. 30min, 60min or 90min) and should in no case be less than 30min.

6.5 Ventilation considerations

In some instances the very fine water droplets of watermist behave more like a gas than a liquid, and can be affected by air movement and/or the size, character and internal layout of a building. Therefore in all cases where this situation might occur, as established by risk assessment, especially in industrial and commercial applications, any ventilation system must be shut down prior to system discharge.

For residential and domestic applications such as private homes and care homes, DD 8458 -1: 2010 has introduced some well documented and proven generic tests that relate to acceptable ventilation air flows. However, in larger locations such as shopping centres and theatres, to date there are no such test data available.

6.6 Protection enclosure integrity

Although the use of watermist for area protection (total flooding systems) is less susceptible to room leakage than gaseous fire suppression systems, it is the responsibility of the installer to specify the acceptable equivalent leakage volume for any protected area on the basis of tests.

6.7 Nozzle positioning

Nozzle positioning is a key factor in the success of watermist system design, so appropriate notice must be taken of the presence of potential obstacles, because the buoyant and lightweight watermist droplets may swirl round obstacles and may not provide the three-dimensional penetration which is a feature of gaseous fire suppression systems. It is essential that nozzle positioning should strictly follow the requirements outlined within the manufacturer's design and installation manual.

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6.8 Nozzle heights and spacing

Compliance with nozzle heights and spacing that has been validated by the nozzle manufacturer's tests is a crucial requirement. Compliance ensures the correct amount of water is discharged with enough kinetic energy to reach the seat of the fire and to ensure the efficient generation of water droplets to extinguish or suppress the fire, as described in the manufacturer's design and installation manual.

In general, maximum heights for nozzle installation are between 5m and 6m. However, greater nozzle heights could be considered under special circumstances if validated by nozzle manufacturer's third-party-certificated tests.

It is equally vital that compliance with minimum distances is also strictly adhered to, especially for object protection applications. The discharge from nozzles that are too close together may impede the formation of the required water droplet characteristics at the seat of the fire or even cause unwanted turbulence at the seat of the fire.

7.0 Bespoke testing – approach and purpose

Before the advent of DD 8458-1: 2010 and DD 8489-1: 2011, it was not uncommon for some watermist contractors to extrapolate beyond fire test data limits as justification for their proposed watermist designs. Thankfully, standards of excellence in the design, installation, commissioning and testing of watermist have significantly progressed and are now in keeping with other traditional forms of firefighting media.

Strict compliance with the fire tests outlined in DD 8458 -1: 2010 and DD 8489-1: 2011will reassure the watermist system specifier that any doubt about the integrity and functional efficiency of a proposed watermist system can be discounted.

However, it should also be remembered that situations could arise where a watermist system may be the most suitable option to protect a special type of risk that is not covered by DD 8458 -1: 2010 and DD 8489-1: 2011. In this instance it is strongly advised that the watermist contractor responsible for the design and installation of this type of system arranges a bespoke test (authenticated by a third-party certification body) to provide the specifier with clear physical evidence that the proposed watermist system will perform in the required manner.

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