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Fixed fire protection systems – Industrial and commercial watermist systems

Part 1: Code of practice for design and installation

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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This part of BS 8489 supersedes DD 8489-1:2011, which is withdrawn.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 m*^{3};
- 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.

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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 m*^{3}

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.

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[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 ≤ 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.

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 ≤80 m³	BS 8489-5 or FM 5560:2016, Appendix A
Machinery spaces ≤260 m³	FM 5560:2016, Appendix C
Machinery spaces >260 m³	FM 5560:2016, Appendix E
Combustion turbines ≤80 m³	BS 8489-5 or FM 5560:2016, Appendix B
Combustion turbines ≤260 m³	FM 5560:2016, Appendix D
Combustion turbines >260 m³	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 m^2 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 m^2.

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 m^3 for intermediate and high pressure systems and less than 0.28 m^3 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].

Table 4 **Types of alarm for transmission**

Fault	Alarm type
Low pressure in town main	B
Fire in pump room	A
Electric pumpset:	
• power not available	B
• on demand (initiation device operated)	B
• start failure	B
• running	A
Diesel pumpset:	
• fault in controller	B
• automatic mode off	B
• on demand (initiation device operated)	B
• start failure	B
• running	A
Trace heating circuits	B
Low pressure:	
• pre-action type A system	B
• pre-action systems	B
Control valves:	
• water flow	A
Monitored watermist systems:	
• partially closed stop valves	B
• liquid levels	B
• low pressure	B
• power failure	B
• low temperature in pump room	B

NOTE Table reproduced from BS EN 12845:2004+A2, Table I.1.

6.5 Volume protection for enclosures

Positioning of nozzles in relation to obstructions and pressure relief openings should be in accordance with the manufacturer's design and installation manual.

7 Components

7.1 General

Components should be in accordance with BRE publication LPS 1283 [N1] or FM 5560:2016 or other appropriate standard that can be shown to give equivalent performance (e.g. a listed component in the LPCB Red Book [5]).

NOTE 1 Tests for nozzles, check valves, pressure switches and strainers are under development in CEN. They are at committee draft stage at the time of publication of this British Standard.

Components should be suitable for the expected operating temperatures and pressures.

NOTE 2 Water-based components conforming to the relevant part(s) of BS EN 12259 are deemed to meet this recommendation. For gas-propelled systems, components (e.g. gas cylinder valves, actuators and accessories) conforming to the relevant part(s) of BS EN 12094 are deemed to meet this recommendation.

NOTE 3 Attention is drawn to the requirements of the Pressure Equipment Regulations 1999 [6].

***Product certification**. Users of this British Standard are advised to consider the desirability of using components that are supported by accredited third-party assessment.*

7.2 Watermist nozzles

7.2.1 General

Watermist nozzles should be made of corrosion-resistant materials and should not be prone to damage by mechanical impact. The nozzles should be permanently marked to identify the manufacturer, unique model number, year of manufacture and K factor.

7.2.2 Open watermist nozzles

Open watermist nozzles should be equipped with blow-off caps or other protective devices, if the environment into which they are installed is prone to causing nozzle blockage by foreign materials. The nozzles and blow-off caps should be suitable for the temperatures into which they are installed.

These devices should provide an unobstructed opening upon system operation.

7.2.3 Automatic watermist nozzles

Automatic nozzles equipped with an integral thermal release element should operate at a predetermined nominal release temperature.

Automatic nozzles' thermal release elements should be colour coded in accordance with BS EN 12259-1 to indicate temperature rating.

Automatic nozzles should be equipped with blow-off caps or other protective devices, if the environment into which they are installed is prone to causing nozzle blockage by foreign materials. The nozzles and blow-off caps should be suitable for the temperatures into which they are installed.

These devices should not delay the operation of the thermal release element. They should provide an unobstructed opening upon system operation.

7.3 Piping and fittings

7.3.1 General

The pipework and fittings should be rated for at least the design pressure.

7.3.2 Pipe

Pipework materials should be one of the following:

- stainless steel, grade 316 or at least equivalent quality in respect to both corrosion and fire resistance;
- copper pipe conforming to BS EN 1057 with capillary or cold pressed fittings;
- galvanized steel piping conforming to BS EN 10255. A strainer, and downstream test valve, should be fitted at the termination of the galvanized piping upstream of the piping feeding the nozzles.

NOTE CPVC pipe is not suitable for use in pre-action systems or for high pressure watermist systems.

Pipework should be identified in accordance with BS 1710.

7.3.3 Pipe supports

Pipe supports should either be in accordance with ISO 6182-11 or have at least equivalent performance in terms of load, vibration and heat resistance.

Pipe supports should be suitable for the expected environmental conditions and for the expected temperature, including the stresses induced in the pipework by temperature variations, and should be able to withstand the anticipated dynamic and static forces.

Pipe supports should be designed and spaced according to the manufacturer's design and installation manual, but with spacing not greater than the intervals given in Table 5, Table 6 and Table 7 for the appropriate type of pipework.

Pipe supports should be located not more than 300 mm either side of any fitting or connection.

Table 5 **Maximum spacing of fixings for copper and stainless steel pipework**

Nominal diameter mm	**Horizontal run** m	**Vertical run** m
12	1.2	1.8
16	1.5	2.1
22	1.8	2.4
28	1.8	2.4
35	2.4	3.0
42	2.4	3.0
54	2.7	3.0

Table 6 **Maximum spacing of fixings for steel pipework**

Nominal diameter mm	**Horizontal run** m	**Vertical run** m
15	1.8	2.4
20	2.4	3.0
25	2.4	3.0
32	2.7	3.0
40	3.0	3.6
50	3.0	3.6
80	3.6	4.5

Table 7 **Maximum spacing of fixings for CPVC pipework**

Nominal diameter mm	Horizontal run m	Vertical run m
12	0.6	1.2
15	0.8	1.6
22	0.8	1.6
28	0.9	1.8
32	1.0	2.0
40	1.05	2.1
50	1.2	2.4
65	1.35	2.7
80	1.5	3.0

7.3.4 Flexible hoses

Flexible hoses used for interconnection in the watermist distribution pipework (excluding water supplies) should be in accordance with FM 5560:2016 or LPS 1261 [N2], and should have heat and pressure resistance capabilities equivalent to those of the pipe and fittings.

The shortest hose length that can conform to the manufacturer's installation requirements should always be used.

7.4 Valves

7.4.1 Control valves

In systems operating below 12.5 bar [4)], wet pipe control valves should conform to BS EN 12259-2 and dry valves to BS EN 12259-3. Valves should operate correctly with a single nozzle flowing.

Control valves for systems operating above 12.5 bar should be suitable for the pressures, temperatures and environment imposed on them.

Control valves should be in accordance with the acceptance criteria of the essential features of the tests for strength, fatigue resistance of springs and diaphragms, resistance to damage of sealing assemblies, resistance to ageing of non-metallic parts, endurance, reverse flow and corrosion resistance, as listed in BS EN 12259-2 or BS EN 12259-3 as appropriate. The valve should be made of corrosion-resistant material, or should have corrosion-resistant finishing.

NOTE Valves are expected to have a clear mark to indicate the correct way of installation.

For control valves with actuator mechanisms, such as pneumatic type, hydraulic type or electrical type, the specifications of the actuator should match the valve operation criteria.

Means should be provided to enable the correct functioning to be checked and maintenance to be carried out in situ.

4) 1 bar = 10^5 N/m^2 = 100 kPa.

7.4.2 Pressure-regulating valves

Pressure-regulating valves, where used, should be capable of providing a regulated output at the rated flow capacity and design setting, over the full range of pressures that are expected to be experienced over the course of the discharge period. Pressure set, point-adjusting mechanisms on the pressure-regulating valve should be tamper-resistant, and a permanent marking should indicate the adjustment. A means to indicate evidence of tampering should be provided.

NOTE The pressure-regulating valve's set point is expected to have been set by the manufacturer.

Permanent markings should indicate the inlet and outlet connections of the pressure-regulating valve.

7.4.3 Stop valves

All stop valves controlling the flow of water to watermist systems should have an open/shut indicator and should be securely fastened in the correct mode. This should include the stop valves on all water supplies, at the control valve(s) and all zone or other subsidiary stop valves. Additionally, the position of the valves may be monitored by supervisory switches to provide remote indication of their status (see Table 4).

7.4.4 Check valves

Check valves should be suitable for the applicable pressure class.

Check valves should be installed in accordance with the manufacturer's design and installation manual, if more than one section is fed by a common supply. Check valves should also be installed to prevent backflow, e.g. into the town mains or as a separation between pumps/water sources.

7.4.5 Safety valves

Pressure relief valves should be designed to withstand a pressure equal to 1.5 times the design pressure of the system.

7.4.6 Test and drainage facilities

Permanent test and drainage facilities should be provided immediately downstream of the water flow alarm switch on each zone. The test facility should simulate operation of any single automatic watermist nozzle. Adequate provision should be made for the disposal of waste water.

7.5 Strainers

Strainers should be made of corrosion-resistant materials. For pressure-bearing parts and for the sieve, metallic materials should be used. The flow direction should be given on the body of system strainers.

System strainers should be installed in each water supply connection. It should be possible to take out the sieve and the dirt particles of system strainers without having to remove the strainer housing.

All parts should be constructed in such a way that incorrect mounting will be obvious. Strainers should be designed in such a way that spheres with a diameter of more than 0.8 times the minimum nozzle waterway dimension cannot pass through the strainer. The strainer should have an aggregate open area of at least 1.5 times the cross-sectional area of the suction pipe.

The free flow through the distribution pipes should not be obstructed, i.e. no part of the strainer should protrude into that pipe waterway.

If the nozzle strainer is projecting from the nozzle inlet into the pipe fitting, the design should be such that a sphere with a diameter of 3 mm can pass between the inner surface of the pipe fitting and the outer surface of the strainer.

The pressure loss of the strainer should be taken into account during hydraulic calculation.

7.6 Pressure measuring equipment

Pressure measuring equipment should be installed according to the manufacturer's design and installation manual.

7.7 Water supply components

7.7.1 General

NOTE 1 Attention is drawn to the Pressure Equipment Regulations 1999 [6] with regard to the ability to withstand design pressure and to the requirements of the water regulations [1–3] [5] *for pressure testing at 1.5 times working pressure (twice for buried components).*

NOTE 2 Attention is also drawn to the requirement for the water supplier's consent to be obtained for the installation of any pump designed to deliver more than 12 L/m, regardless of whether it is supplied directly from the water main or indirectly from a storage cistern.

The components of low pressure systems should be in accordance with the relevant part of BS EN 12259. The components of systems with higher pressure should fulfil the same safety level as given in BS EN 12259.

Pressure vessels, vessels with external expelling gas, and pumps should be:

a) of suitable metal alloy or composite material to provide adequate protection against corrosion and sludge development;

b) compatible with the specific watermist system tested (see **6.1**).

7.7.2 Backflow prevention

The arrangement or device used to prevent backflow should be appropriate to the highest applicable fluid category to which the fitting is to be subjected on the downstream side.

NOTE 1 BS EN 1717 defines fluid categories and suitable arrangements and devices to protect against backflow. The requirements vary according to whether there is a direct connection or a tank supply, and whether additives are used.

NOTE 2 Attention is drawn to the water regulations [1–3] [5] *in respect of the requirement for backflow prevention and for materials that are in contact with wholesome water (e.g. upstream of the backflow prevention device).*

NOTE 3 Further information and guidance on the appropriate level of backflow prevention can be found in the WRAS Water Regulations guide *[4] or obtained from the water supplier.*

[5] 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].

8 Water supply, including additives

8.1 General

The water supply should be capable of supplying the maximum demand of both the hydraulically most unfavourable and the hydraulically most favourable AMAO (see Annex C).

NOTE 1 The hydraulically most unfavourable area is that which determines the design pressure requirements. The hydraulically most favourable is that which determines the design flow requirements.

The water supply can be based on either wholesome or non-wholesome water. If non-wholesome water is used, provision should be made to allow a thorough flushing of the system piping with wholesome water after operation of the system. If non-wholesome water is used for a closed head system, provision should be made to pre-charge the system with wholesome water.

NOTE 2 Attention is drawn to the legal duty of the installer of these systems to ensure that adequate backflow prevention systems are used to prevent the risk of backflow between the public supply and the pipework containing non-wholesome water.

NOTE 3 Attention is also drawn to the requirements of the water regulations [1–3] [6] in respect of the identification of non-wholesome pipework.

The water supply should be taken from one of the following:

- a connection with the public water distribution system, taking into account the requirements and restrictions from the local water authority;

  NOTE 4 Attention is drawn to the requirements of the water regulations [1–3] [6] in respect of connection with the public water distribution system.

- one or more automatic starting fire pumps;
- one or more pressurized containers.

8.2 Water quality

The water used in watermist systems should be demineralized water, deionized water, wholesome or sweet industrial water.

Watermist systems, with and without additives, may be used in combination with inert gas(es) which are used primarily to atomize the water and/or to reduce the oxygen concentration at the fire.

The water quality should be specified in the manufacturer's design and installation manual.

The water should be free from fibrous or other matter in suspension liable to cause accumulations in the system piping. Non-wholesome water should not be retained in installation pipework.

8.3 Additives

*COMMENTARY ON **8.3***

A watermist system is deemed to include additives when constituents other than those normally present in wholesome water are added to the water. Systems using non-wholesome water as emergency supply are not considered to include additives.

[6] 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].

Additives can be used in watermist systems for various reasons including the following:

- *preventing freezing in containers and system piping (wet systems);*
- *preventing water/container deterioration;*
- *preventing corrosion;*
- *fire suppression capabilities.*

Where additives are specified by the manufacturer as part of the system, these are deemed to be essential to the performance of the system.

The use of additives can increase the level of backflow protection required by the water regulations [1–3] [7]) *(see also* ***7.7.2****).*

The run-off from watermist systems with additives, including fire-fighting foams, can contain contaminated water as well as additive/foam solution. Attention is drawn to legal requirements for containment, collection and disposal of this run-off.

8.3.1 General

Watermist systems using additives should not be used in normally occupied areas unless they have been evaluated to be safe for human exposure at the maximum concentration of the additive that can be reached upon system discharge.

WARNING. Additives can be toxic and can cause skin irritation, eye irritation and inhalation difficulties.

NOTE For information on Legionella and fire-fighting systems, see Legionella and fire-fighting systems – A technical briefing note *[7].*

Additives that can be used with a specific watermist system should be listed in both the manufacturer's design and installation manual, and the user's operation and maintenance manual. The listing should include as a minimum:

- specific type of additive;
- specific concentration;
- method of mixing the additive with water;
- method of test to confirm concentration delivered and efficacy of the mixture.

Systems using additives should have a supply of additive sufficient for the discharge duration.

8.3.2 Identification

Watermist systems containing additives should be clearly identified on the system identification label. Warning labels should also be attached at all fill and flushing points. Material safety data sheets for each additive should be included in both the manufacturer's design and installation manual, and the user's operation and maintenance manual.

8.4 Duration

Designed quantities of water and additives (if used) should be capable of supplying the system in accordance with **6.2.1**d).

[7]) 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].

The durations should be based on the hydraulically most favourable operating areas, i.e. those areas where the maximum flow would be delivered.

Intermittent discharge systems should repeat the operating sequence throughout the required system duration.

The water supply should be capable of maintaining the necessary minimum pressure and the minimum water flow of the system during the system discharge time.

8.5 Continuity

8.5.1 General

All practical steps should be taken to ensure the continuity and reliability of water supplies. Where used, reduced capacity tanks should be not less than 30% of full capacity and the infill rate should be sufficient to ensure discharge durations in accordance with **6.2.1**.

Water supplies should be protected against the effects of frost (see also **8.5.2**), and should be installed under secure conditions to prevent tampering.

Water supplies should preferably be under the control of the user, or else a guarantee of the reliability and right of use should be obtained from the water company.

8.5.2 Frost protection

The stored water and the feed pipe and the control valve set should be maintained at a minimum temperature of 4 °C. If this is not possible, measures should be taken to ensure that the frost has no adverse effects on the system reliability, e.g. via additives.

The trace heating system should conform to BS EN 62395 and should be monitored for power supply failure and failure of the heating element(s) or sensor(s). The piping should be Class A1 or A2 as defined in BS EN 13501-1:2007+A1 (or equivalent in existing national classification systems insulation). Duplicate heating elements should be provided over the unheated pipework. Each of the two elements should be capable of maintaining the pipework at the minimum temperature of not less than 4 °C. Each trace heating circuit should be electrically monitored and switched by separate circuits. Trace heating tape should not cross over other lengths of trace heating tape. Trace heating tape should be affixed on the other side of the pipe to the watermist heads. Trace heating tape should terminate within 25 mm from the pipe ends. All trace heated pipework should be lagged with insulating material of Class A1 or A2 as defined in BS EN 13501-1:2007+A1 (or equivalent in existing national classification systems), and should be not less than 25 mm thick with a water-resistant covering. All ends should be sealed to prevent ingress of water. Trace heating tape should have a maximum rating of 10 W/m.

The pump compartment should be maintained at or above the following temperature:

- 4 °C for electric motor driven pumps;
- 10 °C for diesel engine driven pumps.

8.5.3 Housing of equipment for water supplies

*NOTE 1 See also **9.2.2**.*

Water supply equipment, such as pumps, cylinders and tanks, should be housed in buildings or sections of premises used for no other purpose than housing fire protection systems (but see Note 2). The water supplies, stop valves and control valves should be installed such that they are safely accessible even in a fire situation.

NOTE 2 Local application water supplies may be installed in the same compartment as the protected hazard providing that they are not put at risk by the hazard.

8.6 Maximum and minimum water pressure

The maximum and minimum pressure of the water supply should be within the approved limits for the nozzles specified by the manufacturer in respect of the static pressure difference and the pipe hydraulic pressure loss.

8.7 Test devices

8.7.1 Self-contained systems

Self-contained systems should be equipped with permanent means to check the pressure or weight of pressurized cylinders. They should be equipped with means to check the water content, as applicable.

8.7.2 Pump and town main supplied systems

Watermist systems should be provided with permanent means for measuring maximum pressures and flows. Each supply to the system should be tested independently with all other supplies isolated.

For pump systems, a test line should be provided to give a means of establishing pump flow and pressure performance, and that strainers, where fitted, are free from obstruction.

Where practicable, means should be provided to measure the inflow to a non-full capacity tank of the watermist system. If this cannot be achieved then full-capacity tanks should be provided instead.

A test should be carried out to show that the water main supply provides a flow rate equal to the maximum demand flow (see **8.1**) plus 20%. This test should be carried out at a time of maximum demand on the water main.

8.8 Type of water supply

Watermist systems should be connected to one of the following water supplies, depending on the risk assessment for the hazard (see **6.1**):

- direct town mains with a single or duplicate feed, via appropriate backflow prevention devices;
- pressurized gas/water storage containers with single or duplicate sources of gas purge;
- pumps and tanks with single or multiple pumps and with single or duplicate tanks.

Single sources of supply should not be used for critical/enhanced availability applications. Dual sources should be used to provide redundancy and improve availability.

9 Pressurization systems

9.1 Cylinders and storage tanks

NOTE Attention is drawn to the Pressure Equipment Regulations 1999 [6]. Some watermist systems might require a written scheme of examination.

Cylinders should be supported and secured to prevent cylinder movement and possible physical damage. Facilities should be provided for servicing or verification of the contents of each cylinder. When any cylinder in a manifolded system is removed for maintenance, means should be provided to prevent leakage from the manifold if the system is operated.

Either cylinders should be installed in an area maintained within the temperature range specified by the manufacturer, or external heating/cooling should be provided to keep the temperature of the storage container within the specified ranges.

When the storage container(s) is placed in the hazard area being protected, provision should be made to ensure that the system operation is not adversely affected by its location.

Water storage tanks and cylinders should be internally protected against corrosion.

9.2 Pump systems

9.2.1 General

Pumps supplying watermist systems should be designed to start both automatically and manually. Pumps supplying watermist systems should be of sufficient capacity (flow and pressure) to achieve the necessary pressure and duration (see **8.4**). The prime mover should be rated at 110% of the rated power demand of the pump.

Pumps capable of pressurizing the system above its design pressure should be provided with a suitably sized pressure relief valve. The system pressure should not exceed the design pressure of any component that might be in contact with water.

Pumpsets should be anchored to prevent movement or displacement.

A stop valve should be fitted in the pump suction pipe, except in the case of submersible pumps, and a check valve and a stop valve should be fitted in the delivery pipe.

Valves on the delivery side should be fitted after any taper pipe.

Means for venting all cavities of the pump casing should be provided unless the pump is made self-venting by arrangement of its branches.

Arrangements should be made to ensure a continuous flow of water through the pump sufficient to prevent overheating when it is operating against a closed valve. This flow should be taken into account in the system hydraulic calculation and pump selection. The outlet should be clearly visible, and where there is more than one pump the outlets should be separate. To prevent overheating of the water, water flow through the pressure relief valve should not be directed back to the pump suction line. Flow may be directed back to the tank or to the drainage line of the system.

The pump inlet should be provided with a vacuum/pressure gauge and the pump outlet should be provided with a pressure gauge.

Except in the case of submersible pumps, the pumpset controller should be situated in the same compartment as the electric motor and pump. In the case of submersible pumps, a plate stating its hydraulic and power characteristics should be affixed to the pumpset controller.

Pumps should be fitted with a suitable strainer in the pump suction pipe, in order to prevent entrance of foreign material into the pump.

In the case of pumps under suction lift conditions, a strainer should be fitted upstream of the foot valve on the pump suction pipe. It should be fitted so that it can be cleaned without the tank having to be emptied.

In the case of pumps under positive head conditions, a strainer should be fitted to the pump suction pipe outside the tank. A stop valve should be installed between the tank and the strainer.

9.2.2 Pump compartment design and layout

Pumpsets should be housed in a compartment used for no other purpose than housing fire protection systems. It should be one of the following:

- a separate building having a fire resistance of not less than 60 min;
- a building adjacent to a watermist-protected building with direct access from outside having a fire resistance of not less than 120 min;
- a compartment within a watermist-protected building with direct access from outside having a fire resistance of not less than 120 min.

Pump house ventilation louvres allowing airflow to or from the outside need not be fire-resistant, but the louvres should be positioned to avoid the possibility of fire transmission through them.

Pump houses should be laid out such that there is easy unobstructed access from the pump house door to the following items of equipment within the pump house:

- pump drivers;
- pumps;
- controllers;
- batteries;
- fuel tanks;
- suction valves;
- delivery valves;
- test valves, flow meters and pressure gauges; and
- devices requiring maintenance.

Additionally the following devices should be located adjacent to the door:

- watermist system control valves (when located in the pump house); and
- automatic pump starting pressure switches and associated gauging and test valves.

9.2.3 Suction pipe

9.2.3.1 General

The suction piping, including all valves and fittings, should be designed in such a way as to ensure that the available net positive suction head (NPSH) at the pump inlet exceeds the required NPSH by at least 10% with the maximum demand flow and maximum water temperature.

Suction piping should be laid either horizontal or with a continuous slight rise towards the pump to avoid the possibility of air locks forming in the pipe.

With the maximum demand flow into the pump, the net positive suction head (NPSH) at the pump inlet flange at low water level (see **9.3.4**) should be not less than 5.88 m at any flow rate up to the maximum demand flow.

The variable P_s may be negative in a particular installation, although the NPSH should be positive.

NOTE NPSH may be calculated as follows:

$$NPSH = P_s + P_a - P_v - P_f$$
$$= P_s - P_f + 9.884$$

where:

- P_s *is the suction head measured from the low water level to the pump centre line or impeller eye, in metres (m);*
- P_a *is the absolute atmospheric pressure, assumed to be 10.194 at sea level, in metres (m);*
- P_v *is the water vapour pressure assumed to be 0.310 in the UK, in metres (m);*
- P_f *is the friction loss in suction pipework, i.e. pipes, fittings, valves, etc. at the maximum demand flow rate, in metres (m).*

9.2.3.2 Multiple units

Where there is more than one pumpset installed, the suction pipes should be interconnected with means to exclude one pumpset without affecting the other(s), unless designed to operate under suction lift conditions, in which case separate suction pipes should be provided for each pumpset. Where multiple pumps in parallel are configured for sequence starting, the starting arrangements should be configured to ensure that the required system pressures are sustained with no undue delays.

9.2.4 Centrifugal pumpsets

Centrifugal pumpsets should be designed and installed in accordance with BS EN 12845:2004+A2.

9.2.5 Positive displacement pumpsets

Positive displacement pumps should either meet the requirements of BS EN ISO 14847 or have technically equivalent system performance.

Pumpsets should be fitted with pressure relief valves and flow bypass arrangements in order to avoid damage to the pump and system.

NOTE Certain system features, such as the electrical power supply connections, location and sizing of circuit breakers, and supervision, are similar to conventional fire pump installations.

9.2.6 Electrically driven pumpsets

9.2.6.1 General

The electric supply system should be available at all times.

Up-to-date documentation should be kept available in the watermist valve or pump compartment.

NOTE Examples include installation drawings, main supply and transformer diagrams, connections for supplying the pump controller panel and motor, and control alarm circuits and signals.

Where two electric pumps are to be used, approval should be sought from the authority having jurisdiction, and additionally from the fire insurer where property protection is a consideration.

Account should be taken at the planning, design and installation stages of the potential need to replace pumpset assemblies or major sub-assemblies during the life of the building. Space should be made available for the use of lifting gear to remove machinery from within the pump room without resorting to major structural changes. Permanent lifting beams or hard points for attaching lifting equipment should be used where necessary to enable safe movement of machinery.

9.2.6.2 Electricity supply

The supply to the pump controller should be solely for the use of the watermist pumpset and separate from all other connections. Where permitted by the electrical utility, the electrical supply to the pump controller should be taken from the input side of the main switch on the incoming supply to the premises. Where this is not permitted, the supply should be taken from a connection from the main switch.

The fuses in the pump controller should be of high rupturing capacity, capable of carrying the starting current of all pump drivers for a period of not less than 20 s. Where multiple pumps are used in parallel, the electrical supply should be sized to accommodate one of the drivers in a stalled condition. Where all pumps are intended to start simultaneously, the electrical supply should be sized for all other drivers drawing their starting current. Where multiple pumps are configured for sequence starting, the electrical supply should be sized for one driver in stalled condition, one driver drawing starting current, and all other drivers drawing full load current.

NOTE Typical power supplies for watermist pumps are shown in Figure 1.

9.2.6.3 Main switchboard

The electrical connections in the main switchboard should be such that the supply to the pump controller is not isolated when isolating other services.

Each switch on the dedicated power feed to the watermist pump should be labelled:

FIREFIGHTING SYSTEM PUMP MOTOR SUPPLY –
NOT TO BE SWITCHED OFF IN THE EVENT OF FIRE

The letters on the notice should be at least 10 mm high and should be white on a red background. The switch should be locked to protect it against tampering. The label should be non-detachable, non-flammable, permanent and legible.

When connecting the main switchboard and the pump controller, the current for calculating the correct dimension for the cable should be determined by taking 150% of the largest possible full load current.

9.2.6.4 Pumpset controller

The pumpset controller should be able to:

a) start the pumpset automatically on receiving an initiating signal;

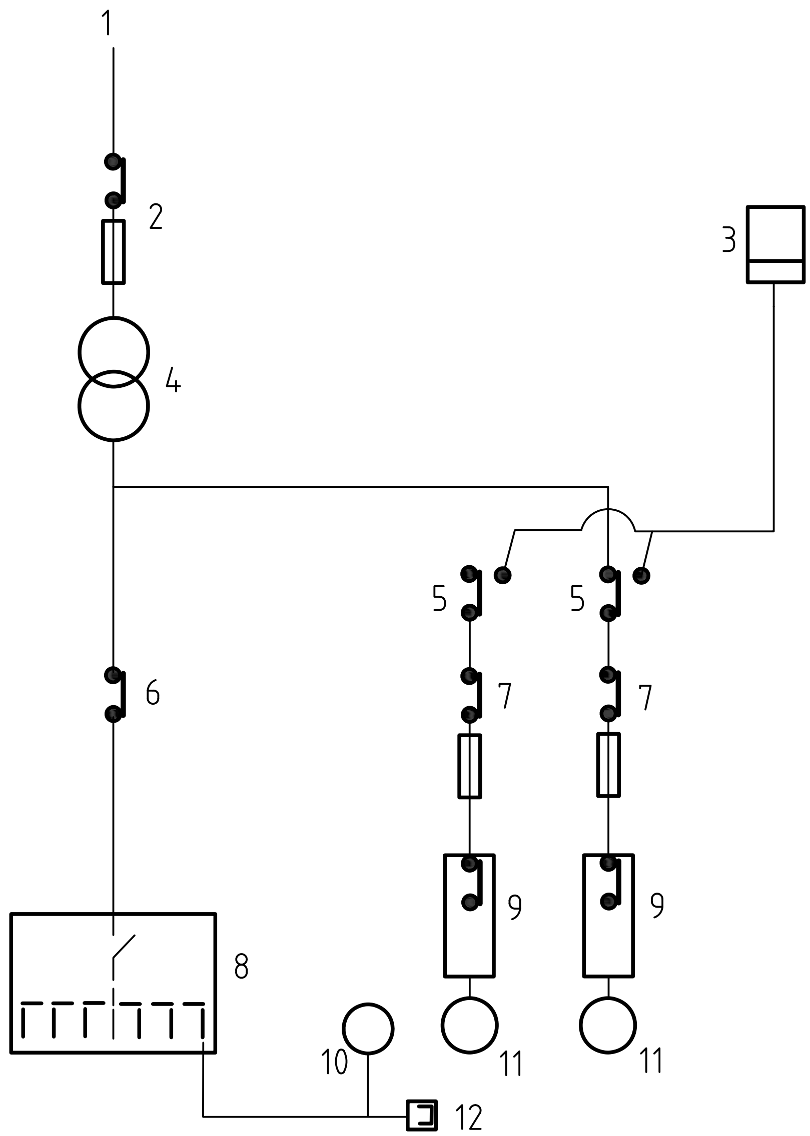
b) start the pumpset on manual actuation.

It should be possible to shut down the pumpset only manually; monitoring devices should not cause the pumpset to stop.

The controller should be equipped with a means of establishing deterioration in motor condition, e.g. an ammeter.

Contacts should conform to utilization category AC-4 as specified in BS EN 60947-1:2007+A1 and BS EN 60947-4-1:2010+A1.

Figure 1 **Typical power supplies for watermist pumps**



Key

1 Mains supply
2 Transformer isolation means and protection
3 Standby generator
4 Transformer
5 Change-over switch
6 Main switch for building services
7 Watermist pump isolating protective device
8 Main distribution board for building services (e.g. lighting, fans, battery chargers)
9 Watermist pump controller
10 Watermist jockey pump motor
11 Main watermist pump motor
12 Watermist pump house ancillary equipment

NOTE The arrangement for enhanced availability watermist systems is two independent power supplies using changeover panels in the event of one failure.

9.2.6.5 Monitoring of pump operation

The following equipment should be monitored continuously:

a) low pressure in town main;

b) water flow detector in pump room;

c) electric pump set:
   1) on demand;
   2) start failure;
   3) running;
   4) power not available;

d) diesel pump set:
   1) automatic mode off;
   2) start failure;
   3) running;
   4) fault in controller;

e) trace heating circuits;

f) low pressure:
   1) pre-action type A system;
   2) dry pipe and pre-action systems;

g) zoned systems:
   1) open control valve;
   2) partially closed control valve;
   3) partially open subsidiary valve;
   4) low mains pressure;
   5) water flow in installation;
   6) water flow in zone;

h) monitored systems:
   1) partially closed stop valves;
   2) liquid low water levels;
   3) low pressure;
   4) power failure;
   5) low temperature in pump room.

All monitored conditions should be visually indicated individually in permanently manned locations.

The visual fault indication should be yellow. The audible signals should have a signal strength of at least 75 dBA and should be able to be silenced.

A lamp test for checking the signal lamps should be provided.

All fire and fault signals should also be audibly and visually indicated at a location permanently attended by responsible personnel.

9.2.7 Diesel-driven pumpsets

Diesel-driven pumpsets should be in accordance with BS EN 12845:2004+A2, **10.9**, with the exception of the fuel tank size, which should be sufficient for not less than 3 h running at full load. Diesel engine cooling circuits usually use the same water as the watermist systems they serve. However, if additional water is used, this should also be taken into account.

9.3 Tanks

9.3.1 General

Water tanks should be monitored for water level and protected against the risk of freezing. A water level alarm sensor should initiate an alarm when the water level in the tank drops to 90% of its full level.

Tanks should be designed to provide a suitable air gap between the water inlet and the maximum water level, such that it acts as the backflow prevention device, with a drain valve, access to inflow valves for inspection, a readable water level indicator, and an overflow outlet.

The water inflow should be positioned so as not to influence the pump suction.

A valve should be placed at the outlet of the tank, between tank and pumps, for maintenance purposes.

Tanks (except for pressurized tanks) should be provided with some form of venting to atmosphere to avoid over/under pressure. This venting should include a screen to avoid particles from entering the vents and/or contaminating the water.

The tank should include a name plate indicating the volume of the tank and the liquid contained therein.

9.3.2 Connections to water networks

Connection to water networks should be provided with a strainer.

NOTE Attention is drawn to the legal requirement to provide a backflow prevention device.

The connection to the water network should have a capacity to provide the maximum system demand at the minimum design pressure. It should also include a flow and pressure verification facility.

9.3.3 Jockey pumps

A jockey pump should be able to supply the system with sufficient pressure to open an automatically activated nozzle or valve. It should not have sufficient flow capacity to sustain the pressure in the system above the pressure required to initiate the main watermist pump(s) when the smallest and/or most remote nozzle is operating.

A valve should be provided for test purposes at the jockey pump outlet. Some protection devices, e.g. a check valve, should be installed between the jockey pump and the pipe system to avoid breakage of the jockey pump due to the main pump operation.

Pumps should start automatically upon system actuation. Manual activation system should be provided.

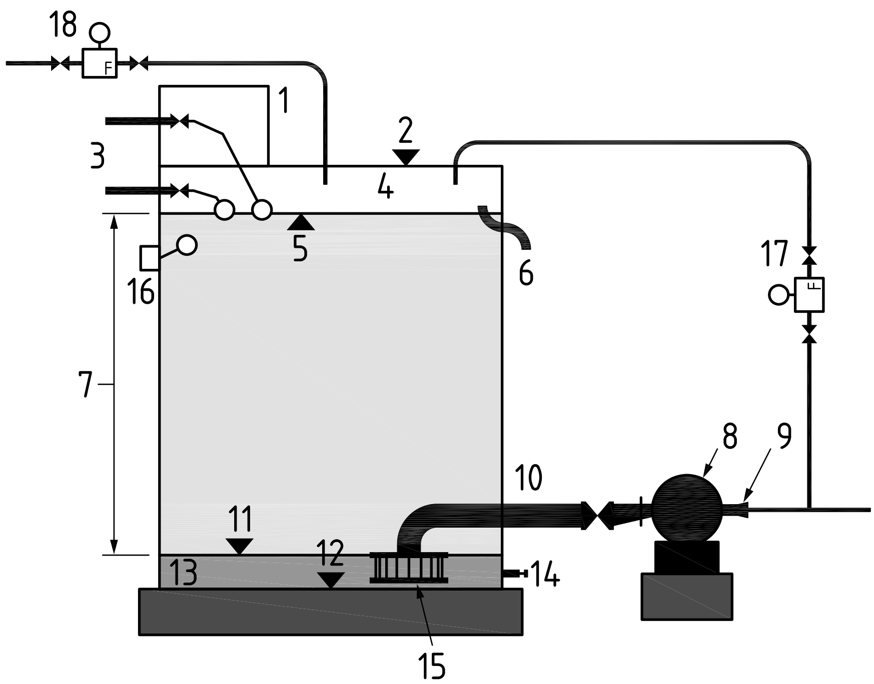
9.3.4 Effective capacity

Effective capacity of pump suction tanks should meet the recommendations given in **8.1** and **8.5.1**.

NOTE 1 Figure 2 shows how to calculate the effective capacity of tank with a vortex inhibitor. An example calculation is:

- *height from base to rim: 4 m;*
- *diameter: 2 m;*
- *dead water: 0.320 m;*
- *freeboard: 0.200 m;*
- *effective height: 4 – (0.320 + 0.200) = 3.48 m;*
- *effective capacity: $\pi 1^2 \times 3.480 = 10.932\ m^3$.*

Figure 2 **Effective capacity of tank with a vortex inhibitor**



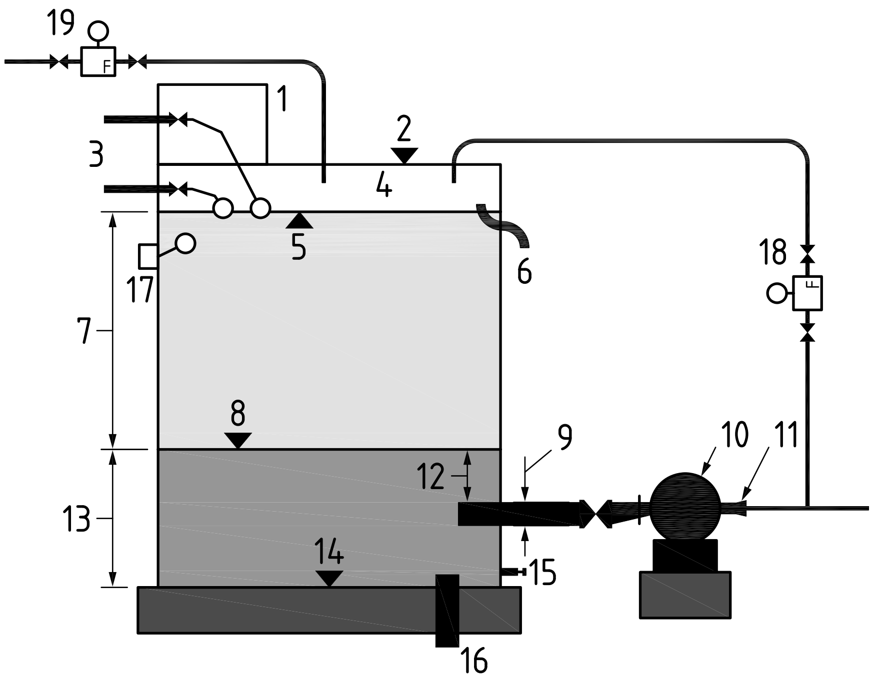
Key

1 Ball valve housing
2 Rim
3 Alternative water supply infill locations
4 Freeboard
5 Normal water level
6 Overflow (25 mm minimum)
7 Effective capacity
8 Pump
9 Pump delivery to nozzles
10 Pump suction, *d* mm
11 Low water level = top of vortex inhibitor
12 Base
13 Dead water
14 Drain
15 Vortex inhibitor
16 Water level alarm sensor
17 Pump flow test meter
18 Town main flow test meter

NOTE 2 Figure 3 shows how to calculate the effective capacity of tank without a vortex inhibitor. An example calculation is:

- *height from base to rim: 4 m;*
- *diameter: 2 m;*
- *dead water: 0.800 m;*
- *freeboard: 0.200 m;*
- *effective height: 4 – (0.200 + 0.800) = 3.7 m;*
- *effective capacity: $\pi 1^2 \times 3.700 = 9.420$ m³.*

Figure 3 **Effective capacity of tank without a vortex inhibitor**



Key

1 Ball valve housing
2 Rim
3 Alternative water supply infill locations
4 Freeboard
5 Normal water level
6 Overflow (25 mm minimum)
7 Effective capacity
8 Low water level
9 Pump suction, *d* mm
10 Pump
11 Pump delivery to nozzles
12 Height from top of suction pipe to low water level = 4*d*
13 Dead water
14 Base
15 Drain
16 Alternative suction location
17 Water level alarm sensor
18 Pump flow test main
19 Town main flow test meter

10 Commissioning

10.1 Pre-commissioning tests

10.1.1 General

The following checks should be made prior to commissioning of a watermist system.

a) It should be confirmed that the pipework has been cleaned and is free of swarf and debris by either flushing or use of pipe purging plugs.

b) The discharge should be checked via the test nozzle. To carry out this check, a test facility should be provided, at the end of the hydraulically most remote range pipe, consisting of a watermist head with the bulb removed and a quick-acting test ball valve. The quick-acting test ball valve should be located in an easily accessible position and should be secured in the closed position with a suitable strap or chain. The end of the test line should normally be capped or plugged. There should also be provision of a permanent drain or means to dispose of waste water.

c) The completed system should be checked against the approved documentation. This check should comprise a physical verification of protected risk system design, site conditions and risk limitations, which should include flow calculations of the as-built system.

d) A system inspection should be carried out. This should consist of a component review where the condition, connection and installation of components are checked for conformity to the system requirements. If any non-conformities are found, they should be rectified.

10.1.2 Pipework

10.1.2.1 Dry pipework

Dry pipework should be tested pneumatically to a pressure of not less than 2.5 bar [8] for not less than 24 h. Any leakage that results in a loss of pressure greater than 0.15 bar for the 24 h should be corrected. The time between a watermist system operating and water discharging (for watermist system installations charged with compressed air) should be not more than 60 s.

NOTE This is to ensure that the fire is started to be suppressed within an acceptable period of time and is not allowed to grow unchecked and unchallenged.

10.1.2.2 All pipework

All pipework should be hydrostatically tested for not less than 2 h, to a pressure of 1.5 times the maximum pressure to which the system will be subjected (measured at the installation control valves). For dry pipework, this test should be carried out immediately after the pneumatic test, or as soon afterwards as climatic conditions permit.

If the system fails to maintain the test pressure, the fault (such as permanent distortion, rupture or leakage) should be found, corrected and the test repeated.

[8] 1 bar = 10^5 N/m^2 = 100 kPa.

10.2 Commissioning tests

10.2.1 Electrical detection and actuation

Electrical detection and actuation should be in accordance with BS 5839-1, BS 7273-3 and BS 7273-5.

10.2.2 Mechanical equipment

Where systems are fitted with mechanical actuation, a functional check of the actuation system should be carried out.

All gas cylinders and water storage vessels should be fully charged.

The function of all resettable valves and actuators should be checked, unless testing of the valves would result in water discharge from the nozzles.

A check should be carried out of the sequential starting of multiple pumpsets up to the flow required for the hydraulically most favourable AMAO [see **6.2.1**, e)2)].

The system should then be tested once in accordance with **11.3.2**, **11.3.3** and **11.4.4.2**.

Full system discharge tests may be carried out where appropriate.

10.3 Handover documentation

The installer of the system should provide the user with the following:

a) a completion certificate stating that the system conforms to all the appropriate recommendations of this British Standard [9)], or giving details of any deviation from the recommendations;

b) results of the hydrostatic testing;

c) confirmation that the necessary flushing and cleaning operations have been conducted so that pipework is free of swarf and debris that could cause the nozzles to block;

d) results of the functional tests;

e) a complete set of operating instructions and as-built drawings, including identification of all valves and instruments used for testing and operation;

f) the user's operation and maintenance manual (see Clause **11**).

11 Inspection and maintenance

11.1 User's operation and maintenance manual

The installer should provide the user with an operation and maintenance manual which should include, but is not limited to:

a) any limitations in areas where the watermist system can be used safely (see **4.2**), taking into account the potential for at least skin irritation, eye irritation, inhalation toxicity and toxicity on human beings;

b) a listing of additives that can be safely used with the system (see **8.3.1**), including material safety data sheets (see **8.3.2**);

[9)] Such a certificate represents an installer's declaration of conformity, i.e. a claim by or on behalf of the installer that the product meets the recommendations of this British Standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

c) instructions to the user to notify interested parties of the intent to carry out tests and/or of the results, as appropriate;

d) a monitoring programme for the system and components in accordance with the manufacturer's design and installation manual, including instruction on the action to be taken in respect of faults;

e) general maintenance instructions (see **11.2**);

f) a user's programme for inspection and checking (see **11.3**);

NOTE This is intended to detect faults at an early stage to allow rectification before the system might have to operate.

g) a user's programme for service and maintenance (see **11.4**);

h) instructions to the user to have the test, service and maintenance schedule carried out by a competent person;

i) instructions to the user to keep records, including a logbook which should be held on the premises;

j) instructions to the user to return the system, together with any automatic pumps, pressure tanks and gravity tanks, to its proper operational condition, with all faults corrected, after any inspection, check, test, service or maintenance procedure.

11.2 General maintenance instructions

The user's operation and maintenance manual should include the following general maintenance instructions.

a) **Maintenance**. Watermist systems should be maintained by a competent person.

b) **Precautions while carrying out work**. Alternative fire precautions should be taken by the user while the system is not operational or after system operation.

c) **Replacement watermist nozzles and additives**. A stock of spare watermist nozzles should be kept on the premises as replacements for operated or damaged nozzles. Spare watermist nozzles, together with watermist nozzle spanners as supplied by the system supplier, should be housed in a cabinet or cabinets located in a prominent and easily accessible position where the ambient temperature does not exceed 27 °C.

The number and type of spare watermist nozzles per system should be not less than the number required to reinstate the system to operational status.

NOTE For automatic nozzles this quantity is based on the largest design area of operation.

The stock should be replenished promptly after spares are used.

Where systems contain high-temperature automatic nozzles, sidewall or other variations, an adequate number of these spares should also be maintained. The quantity should be based on the largest area of operation for each nozzle type.

Where appropriate, a supply of additive sufficient for one recharge should be held on site unless it can be made available within 24 h.

11.3 User's programme for inspection and checking

11.3.1 General

The installer should provide the user with a documented inspection and checking procedure for the system.

The programme should include instructions on the action to be taken in respect of faults and operation of the system, with particular mention of the procedure for emergency manual starting of pumps, and details of the weekly routine recommended in **11.3.2** and the monthly routine recommended in **11.3.3**.

Electrical detection and actuation systems should be inspected in accordance with BS 5839-1.

Water additives (where used) should be tested/replaced in accordance with the user's operation and maintenance manual.

11.3.2 Weekly routine

11.3.2.1 General

Each part of the weekly routine should be carried out at intervals of not more than 7 days.

11.3.2.2 Checks

The following should be checked and recorded:

a) all water and air pressure gauge readings on systems, trunk mains and pressure vessels. The pressure in the pipework in dry and pre-action installations should not fall at a rate of more than 1.0 bar per week;

b) all water levels in water storage tanks (including pump priming water tanks and pressure vessels);

c) the correct position of all main stop valves unless fitted with remote monitoring.

11.3.2.3 Automatic pump starting test

Tests on automatic pumps should be initiated locally via the pumpset and should be manually stopped. The tests should include the following.

a) When the pump starts, the starting pressure should be checked and recorded. To do this, the pressure switch from the main should be isolated and a drain valve opened at the pressure switch to simulate a drop in mains pressure.

b) Fuel and engine lubricating oil levels in diesel engines should be checked.

c) The oil pressure on diesel pumps should be checked, as well as the flow of cooling water through open circuit cooling systems.

11.3.2.4 Diesel engine restarting test

Immediately after the pump start test recommended in **11.3.2.3**, diesel engines should be tested as follows.

a) The engine should be run for 20 min, or for the time recommended by the supplier, whichever is longer. The engine should then be stopped and immediately restarted using the manual start test button.

b) The water level in the primary circuit of closed circuit cooling systems should be checked.

Oil pressure (where gauges are fitted), engine temperatures and coolant flow should be monitored throughout the test. Oil hoses should be checked and a general inspection made for leakage of fuel, coolant or exhaust fumes.

11.3.2.5 Trace heating and localized heating systems

Heating systems to prevent freezing in the system should be checked for correct function.

11.3.3 Monthly routine

The electrolyte level and density of all lead acid cells (including diesel engine starter batteries and those for control panel power supplies) should be checked. If the density is low, the battery charger should be checked and, if this is working normally, the battery or batteries affected should be replaced.

11.4 User's programme for service and maintenance

11.4.1 General

The installer should provide the user with a documented service and maintenance procedure for the system. The programme should include the routines recommended in **11.4.2** to **11.4.5**, together with an instruction for any additional procedures to be carried out by a competent supplier.

Electrical detection and actuation systems should be serviced and maintained in accordance with BS 5839-1.

Whenever an inspection is carried out, a signed, dated report of each inspection should be provided to the user and should include advice of any rectification carried out or needed, and details of any external factors, e.g. weather conditions, which might have affected the results.

11.4.2 Quarterly routine

11.4.2.1 General

The checks and inspections recommended in **11.4.2.2** to **11.4.2.9** should be made at intervals of not more than 13 weeks.

11.4.2.2 Review of hazard

The effect of any changes of structure, occupancy, storage configuration, heating, lighting or equipment, etc., of a building on hazard classification or installation design should be identified and assessed by a competent person in order that the necessary and appropriate modifications to the watermist system can be carried out.

11.4.2.3 Watermist nozzles

Watermist nozzles affected by deposits should be changed.

NOTE Watermist nozzles in deep fat fryers and spray booths require more frequent cleaning and/or protective measures.

11.4.2.4 Pipework and pipe supports

Pipework and hangers should be checked for corrosion and mechanical damage, and remedial action taken as necessary.

The pipework should be checked for electrical earthing connections. System pipework should not be used for earthing electrical equipment, and any earthing connections from electrical equipment should be removed and alternative arrangements made.

11.4.2.5 Water supplies and their alarms

Each water supply should be tested with each control valve set in the system. The pump(s), if fitted, in the supply should start automatically and the supply pressure should be not less than the appropriate value recommended in **9.2**, recognizing any changes identified in **11.4.2.2**. The sequential starting of multiple pumps, and pumps using multiple drivers, should be undertaken.

11.4.2.6 Electrical supplies

Any secondary electrical supplies from diesel generators should be checked for satisfactory operation.

11.4.2.7 Stop valves

All stop valves controlling the flow of water to the system should be operated to ensure that they are in working order, and securely refastened in the correct mode. This should include the stop valves on all water supplies, at the alarm valve(s) and all zone or other subsidiary stop valves.

11.4.2.8 Fire alarm flow and/or pressure switches

Fire alarm flow and/or pressure switches should be checked for correct function.

11.4.2.9 Replacement

The number and condition of replacement parts held as spare should be checked and replenished as necessary.

11.4.3 Half-yearly routine

11.4.3.1 General

The checks and inspections recommended in **11.4.3.2** to **11.4.3.6** should be made at intervals of not more than 6 months.

11.4.3.2 Dry and open-head control valves

The moving parts of dry and open-head control valves in dry pipe installations and subsidiary extensions should be exercised in accordance with the supplier's instructions.

11.4.3.3 Examination of cylinders and vessels

Cylinders and water storage vessels should be examined externally for signs of damage or unauthorized modification, and for damage to system hoses. The contents should be checked and confirmed that they are within 5% of correct charge pressure. Any showing a greater loss should be replaced or refilled.

11.4.3.4 Valves

The function of all resettable valves and actuators should be checked, unless testing of the valves would result in water discharge from the nozzles.

11.4.3.5 Fire and rescue service and remote alarm receiving centre

The electrical transmission and receipt should be checked.

11.4.3.6 Test of fire detection and alarm system

The fire detection and alarm system should be tested and serviced in accordance with BS 5839-1. All auxiliary functions, e.g. plant shut-down, should be checked at this time.

11.4.4 Yearly routine

11.4.4.1 General

The checks and inspection recommended in **11.4.4.2** to **11.4.4.5** should be made at intervals of not more than 12 months.

At least annually, or more frequently as required, all systems should be thoroughly inspected and tested for correct operation by competent personnel.

11.4.4.2 Automatic pump flow test

Each water supply pump in the installation should be tested at the full load condition (by means of a permanent test line connection coupled to the pump delivery branch downstream of the pump outlet check valve), and should give the pressure/flow values stated on the nameplate or system demand requirements if multiple pumps are to run simultaneously.

Appropriate allowances should be made for pressure losses in the supply pipe and valves between the source and each control valve set.

11.4.4.3 Diesel engine failed-to-start test

The failed-to-start alarm should function correctly when tested in accordance with BS EN 12845:2004+A2, **10.9.7.2**.

Immediately after this test the engine should be started using the manual starting system.

11.4.4.4 Infill valves on water storage tanks

Infill valves on water storage tanks should be functionally tested to determine whether they operate correctly. Appropriate remedial action should be taken if necessary.

11.4.4.5 Pump and system strainers

Water should be flowed through pump and system strainers at least annually, and the strainers should then be inspected and cleaned as necessary. Where strainers are clogged by corrosion products, the source and cause of the corrosion should be identified and remediated.

11.4.5 Three-yearly routine

11.4.5.1 General

The checks and inspections recommended in **11.4.5.2** to **11.4.5.4** should be made at intervals of not more than 3 years.

11.4.5.2 Storage tanks

All tanks should be examined externally for corrosion. They should be drained, cleaned as necessary and examined internally for corrosion.

All tanks should be repainted and/or have the corrosion protection refurbished, as necessary.

11.4.5.3 Water supply stop valves, control and check valves

All water supply stop valves, control and check valves should be examined and replaced or overhauled as necessary.

11.4.5.4 Testing of nozzles

Twenty nozzles, or 1%, whichever is greater, should be removed from various parts of the system. The removed nozzles should be tested in accordance with Annex D.

11.4.6 Ten-yearly routine

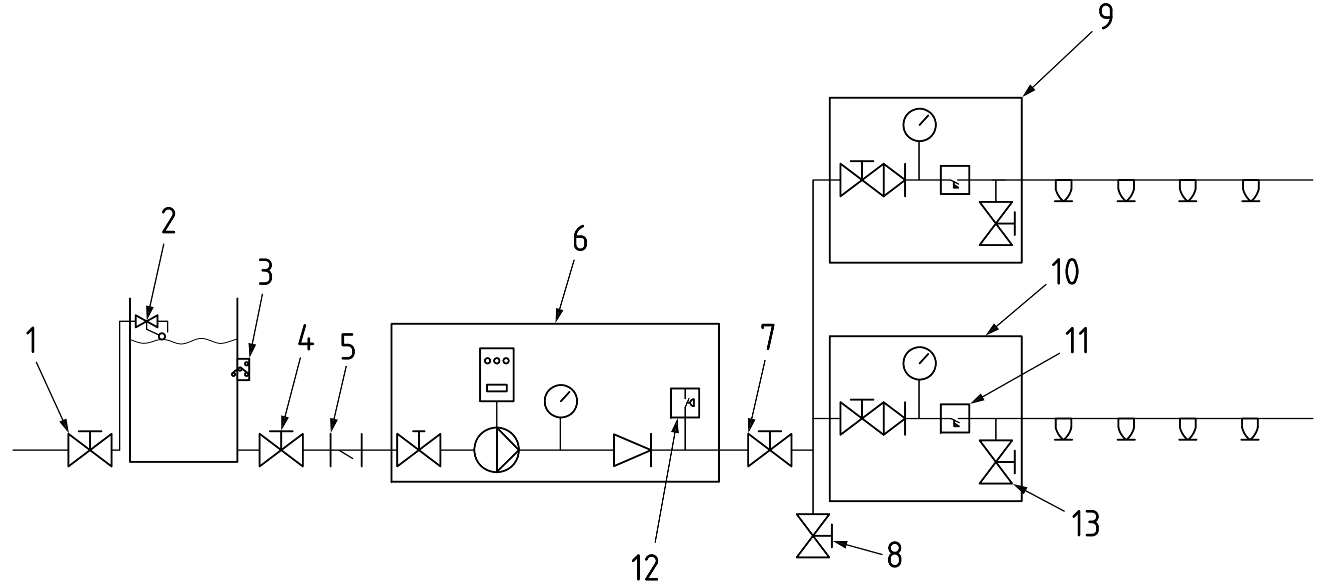
At intervals of not more than 10 years, all storage tanks should be cleaned and examined internally and the fabric attended to as necessary.

All pressure vessels should be hydrostatically tested in accordance with BS EN 13445-5 or BS EN 1968 as appropriate.

Annex A (informative) Elements of a typical watermist fire suppression system

The main elements of a watermist fire suppression system are shown in Figure A.1 to Figure A.3.

Figure A.1 **Fire pump and tank system**



Key

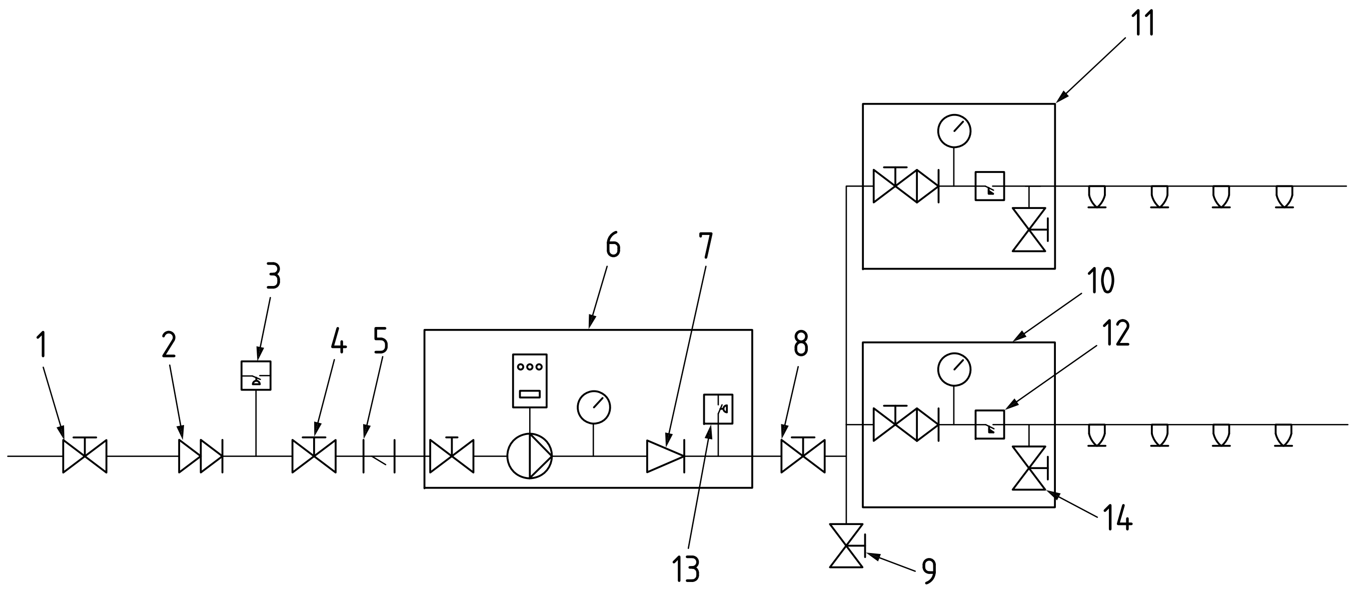
1 Tank isolation valve
2 Float valve
3 Low level alarm
4 Suction isolation valve
5 Strainer
6 Fire pumpset
7 Outlet isolation valve
8 System drain valve
9 Zone valve
10 Additional zone valve where needed
11 Alarm flow switch
12 Pump pressure switch
13 Alarm test valve

Nozzle
Isolation valve
Stop valve
System drain valve
Flow switch
Pressure switch
Pressure gauge
Non-return valve

Strainer
Hydraulic pump
Control panel
Water tank

NOTE Mains isolation valve and backflow prevention device omitted for clarity.

Figure A.2 **Fire pump and town mains system**

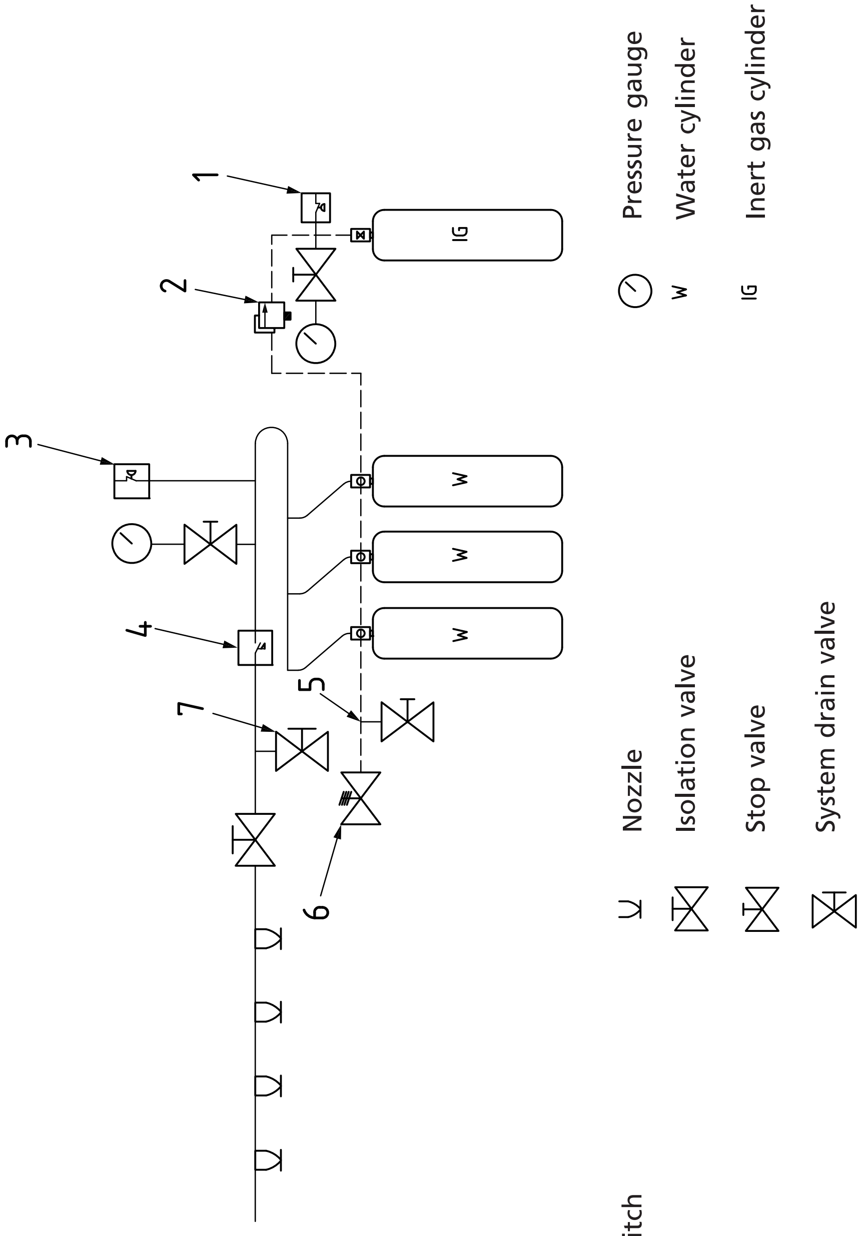


Key

1 Mains isolation valve
2 Backflow prevention device
3 Inlet low pressure switch (optional)
4 Inlet isolation valve
5 Strainer
6 Fire pumpset
7 Non-return valve
8 Outlet isolation valve
9 System drain valve
10 Zone valve
11 Additional zone valve where needed
12 Alarm flow switch
13 Pump pressure switch
14 Alarm test valve

Nozzle
Isolation valve
Stop valve
System drain valve
Flow switch
Pressure switch
Pressure gauge
Non-return valve
Strainer
Hydraulic pump
Control panel
Backflow prevention device

Figure A.3 **Cylinder-based system**



Key

1 Propellant low pressure switch
2 Propellant regulator
3 System low pressure switch
4 System flow switch
5 Propellant vent valve
6 Propellant safety vent
7 System drain valve

Annex B (normative) Enhanced availability provisions for volume protection systems

B.1 General

B.1.1 Subdivision into zones

The area covered by automatic watermist nozzles to be controlled by any zone valve set should have the following restrictions:

a) the watermist system should be subdivided into zones, with a maximum of 200 automatic nozzles per zone or a plan area of 2 400 m^2, whichever is the lesser;

b) compartments should be watermist-protected throughout; unprotected areas should be separated from protected areas by a minimum of 60 min fire resistance or as determined by the AHJ, whichever is the greater;

c) the watermist zone should cover not more than one floor level, which may however include a mezzanine floor no greater than 100 m^2;

d) car parks and areas involving the unloading and storage of goods should be covered by separate unzoned systems.

B.1.2 Wet pipe installations

Watermist systems for enhanced availability should be of the wet pipe type using copper, steel or stainless steel tubing.

B.1.3 Nozzles

Nozzles should be automatic with "quick response" sensitivity and with an operating temperature suitable for the protected area.

B.2 Control valves

B.2.1 General

*COMMENTARY ON **B.2.1***

The following types of control valve are suitable for enhanced availability watermist service:

- *pre-action control valve;*
- *wet control valve.*

During servicing and maintenance of the control valves, the watermist system should be fully operational in all aspects. This can be achieved either by two wet control valves (Figure B.1) or by one wet control valve and full bore valved bypass if maintenance can be out of hours (Figure B.2). A single watermist control valve set should not be used for enhanced availability protection purposes.

Tail end pre-action valves may be installed without the alarm line connections.

B.2.2 Duplicate watermist main control valve

Figure B.1 shows a stop valve on each side (i.e. upstream and downstream) of each of a pair of control valves, with each set of three valves connected in parallel to the feed main. One set of three valves should be designated as the primary installation main control valve set with the upstream and downstream stop valves normally open. The stop valve on the secondary installation valve set should be normally closed.

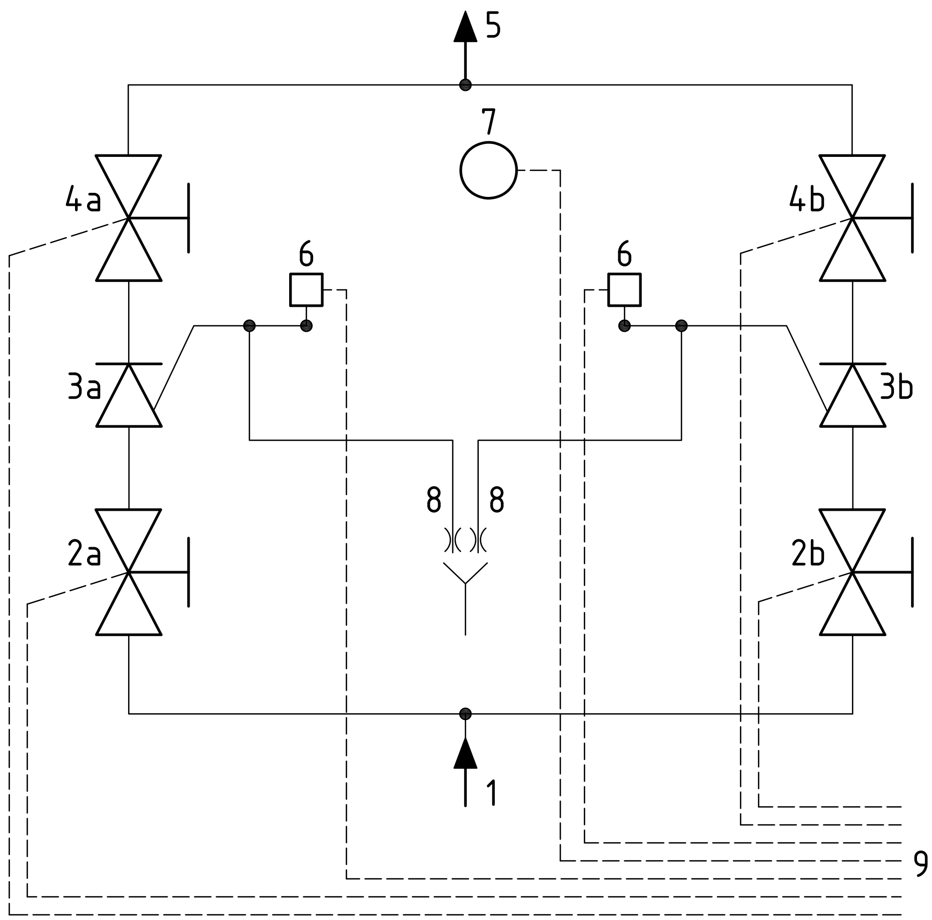
B.2.3 Wet pipe watermist main control valve with bypass arrangement

The watermist main control valve set should have two normally open stop valves one each side (upstream and downstream) of a single wet control valve, with a bypass connection of the same nominal bore around all three valves. The bypass should be fitted with a normally closed stop valve. This type of arrangement is shown in Figure B.2.

B.2.4 Nominal size

Stop valves and control valves should be the same nominal diameter as the pipework.

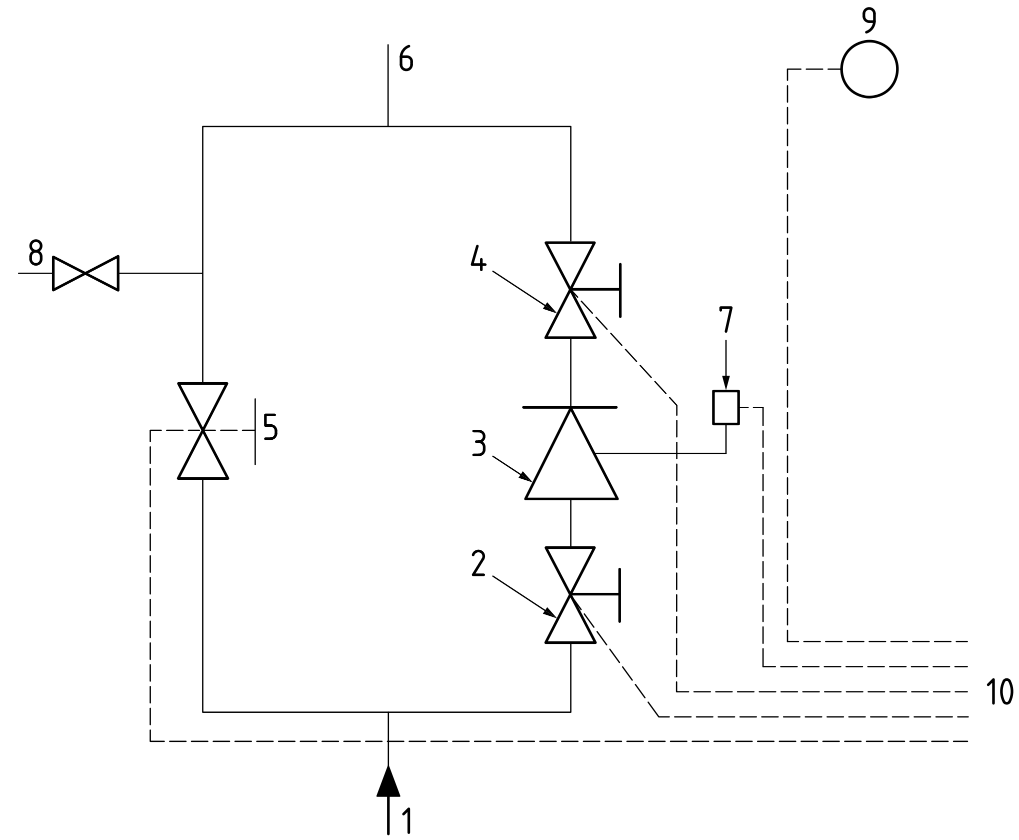
Figure B.1 **Duplicate installation control valve arrangement**



Key

1 Water supply
2a Upstream stop valve – control valve A
2b Upstream stop valve – control valve B
3a Installation control valve A
3b Installation control valve B
4a Downstream stop valve – control valve A
4b Downstream stop valve – control valve B
5 Installation
6 Electrical devices for remote alarm indication
7 Audible alarm
8 Alarm line restricted drain with visible outflow
9 Electrical monitoring connections

Figure B.2 **Wet pipe watermist control valve arrangement with bypass**



Key

1	Water supply	6	Installation
2	Upstream stop valve	7	Electrical device for remote alarm indication
3	Installation control valve	8	Installation drain
4	Downstream stop valve	9	Audible alarm
5	Bypass stop valve	10	Electrical monitoring connections

B.2.5 Alarm connections

Each control valve set should be connected to a water flow alarm and a device for remote alarm indication, both located as close as possible to the control valve. A single alarm may be common to a group of wet control valves providing that they are in the same valve room and an indicator is fitted to each control valve to show when it is operating. There should be a low level alarm line drain in close proximity to the control valve(s). The drain should be arranged so that any flow of water from the drain can be seen.

B.3 Monitoring

Watermist systems should be provided with tamper-proof devices to monitor the status of:

a) each stop valve (i.e. either fully open or not fully open), including any subsidiary stop valves, capable of interrupting the flow of water to watermist nozzles;

b) water flow into each zone immediately downstream of each zone subsidiary stop valve, to indicate the operation of each zone, by means of a water flow alarm switch capable of detecting a flow equal to or greater than that from any single automatic watermist nozzle;

c) water flow through each control valve set.

The monitoring devices should be electrically connected to a control and indicating panel, installed at an accessible location on the premises, where the following indicators should be provided:

1) green visual indicators to indicate that each monitored stop valve is in its correct operational position;
2) audible devices and amber visual indicators to indicate that one or more control valve sets are not fully open;
3) audible devices and amber visual indicators to indicate that one or more zone subsidiary stop valves are not fully open;
4) audible devices and amber visual indicators to indicate that the static pressure in any trunk main supplying the system has fallen to a value 5% or more below the normal static pressure;
5) audible devices and red visual indicators to indicate that water is flowing into the watermist system;
6) audible devices and red visual indicators to indicate that water is flowing into one or more zones.

Facilities should be provided at the indicator panel for silencing the audible alarms, but the visual indicators should continue to operate until the watermist system is restored to the normal standby condition. Fire and fault signals should be indicated at a permanently manned location. Any change in the panel alarm or fault indication after the audible alarm has been silenced should cause it to resume sounding until it is again silenced or the panel reset to the normal standby condition. Alarm panels should be compatible with BS 5389-1.

B.4 Maintenance

During maintenance of the wet control valve, stop valves 2 and 4 as identified in Figure B.2 should be closed, and stop valve 5 should be opened. On completion of maintenance, the stop valves should be returned to their normal positions.

Only one zone of a multi-zone watermist systems should be shut down at a time. A system zone should be shut down for the minimum time necessary for maintenance.

The partial or complete shut-down of an enhanced availability watermist system should be avoided wherever possible. Only the smallest part of the installation necessary should be isolated.

Insurers should be informed and other fire precautions put in place during the zone shutdown.

When a zone (or zones) is charged or recharged with water after draining, a flushing valve(s) should be used to check that water is available in the zone (or zones).

Individual control valves in a duplicate control valve set, where required, should be separately serviced, provided the water supply to the installation is maintained.

The following procedure should be followed before servicing duplicate control valve sets. The stop valves to the duplicate alarm valve should be opened. The stop valves to the control valve to be serviced should be closed and an alarm test carried out immediately on the other control valve; if water is not available, the stop valve should be opened immediately, and the fault rectified before proceeding (see Figure B.1).

Before carrying out work on the operational watermist installation control valve (3a), the isolated installation control valve (3b) should be checked for condition and fitness for service. The installation control valve (3b) should be commissioned in accordance with the supplier's instructions, and the upstream (2b) and downstream (4b) stop valves opened. When the installation control valve (3b) is in service, the upstream (2a) and downstream (4a) stop valves should be closed, to isolate installation control valve (3a). The control valves (3a and 3b) should be serviced in accordance with the supplier's instructions.

B.5 Water supplies for enhanced availability

*NOTE This subclause gives details of water supplies for enhanced availability watermist systems and provides guidance on measures for enhanced availability watermist systems. General recommendations for water supplies are given in Clause **8**.*

The system should have a water supply comprising two pump suction tanks with a 10 year maintenance-free life, and at least two 100% duty pumps or at least three 50% duty pumps.

There should be two pump suction tanks, where each is independent of the other and where:

a) one is a half-capacity tank, i.e. holding half the specified water volume of a single full capacity tank for the 30 min system discharge duration; and

b) one is a tank of a reduced capacity, based upon the specified water volume of a single full capacity tank minus the infill provided over the 30 min.

Tanks should be capable of being refilled within 24 h.

Where direct town main connections or reduced capacity tanks dependent on inflow are proposed, a written agreement should where possible be obtained from the water supplying company at the design stage agreeing that the user or their agent may undertake quarterly flow tests at the maximum demand flow. Town main connections should be fed from two independent sources.

If it is not possible to obtain a written agreement to undertake flow tests on the town main, direct town main connections and reduced capacity suction tanks should not be used.

Whichever water storage arrangement is used, the total design capacity of the water supply, including any inflow for a reduced capacity tank, should be at least equivalent to a single full holding capacity tank as appropriate to the hazard and pipework design.

Where pumps are used to draw water from two tanks, each pump should be arranged to draw water from either tank and arranged so that any one pump or either tank can be isolated.

The watermist system water supplies should be generally not be used as connections for other services or other fixed fire-fighting systems.

Annex C (informative) Assumed maximum areas of operation for typical watermist systems

C.1 General

The assumed maximum area of operation (AMAO) is the maximum area over which it is assumed, for design purposes, that nozzles will operate in a fire.

There are two significant AMAOs:

- **hydraulically most unfavourable area** (see **3.19**): the location in a nozzle array of an area of operation of specified shape at which the water supply pressure measured at the water source is the maximum needed to give the specified density;
- **hydraulically most favourable area** (see **3.18**): the location in a nozzle array of an area of operation of specified shape at which the water flow is the maximum for a specific pressure measured at the water supply source.

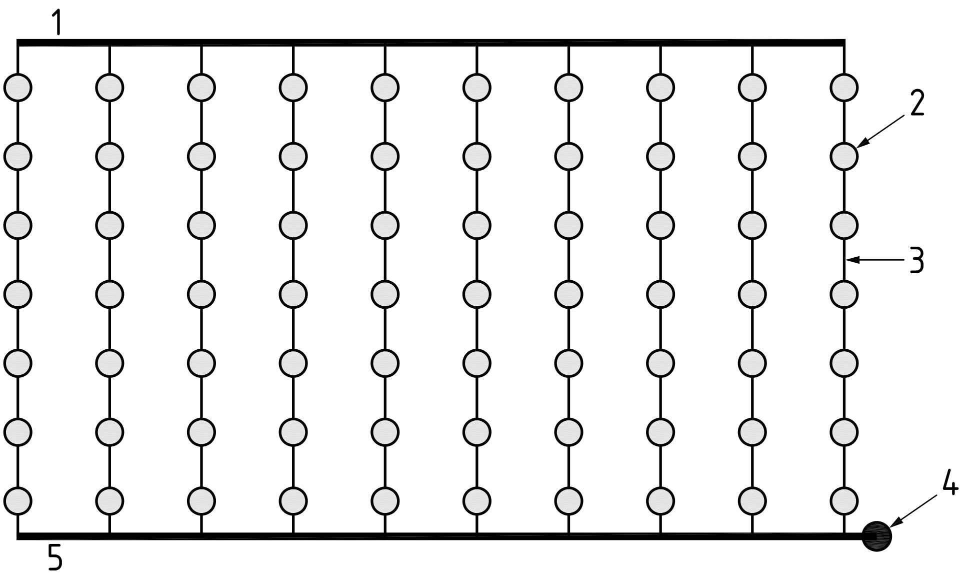
The water supply source in a calculation is usually at the pump.

C.2 Typical system component layouts

C.2.1 System components gridded layout

A typical gridded layout is shown in Figure C.1.

Figure C.1 **System components gridded layout**



Key

1 Far main (distribution pipe)

2 Nozzles

3 Ranges

4 Section valve

5 Near main (distribution pipe)

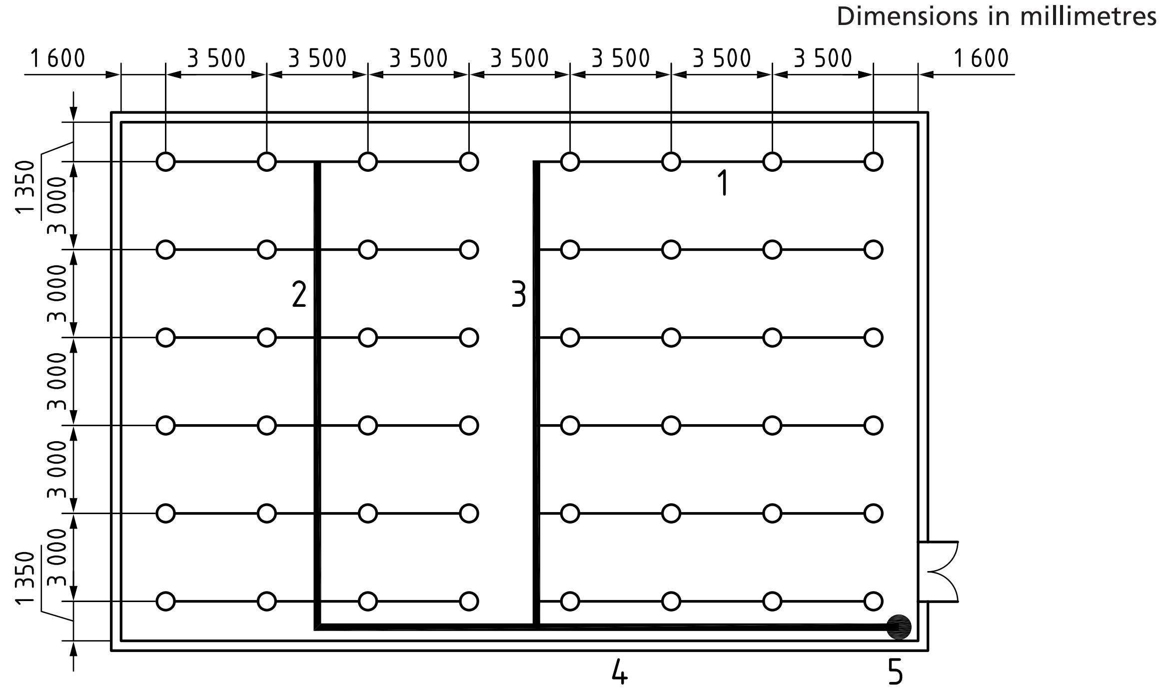
C.2.2 System components terminal layout

A typical terminal layout is shown in Figure C.2.

C.2.3 System components looped layout

A typical looped layout is shown in Figure C.3.

Figure C.2 **System components terminal layout**



Key

1 Ranges and nozzles

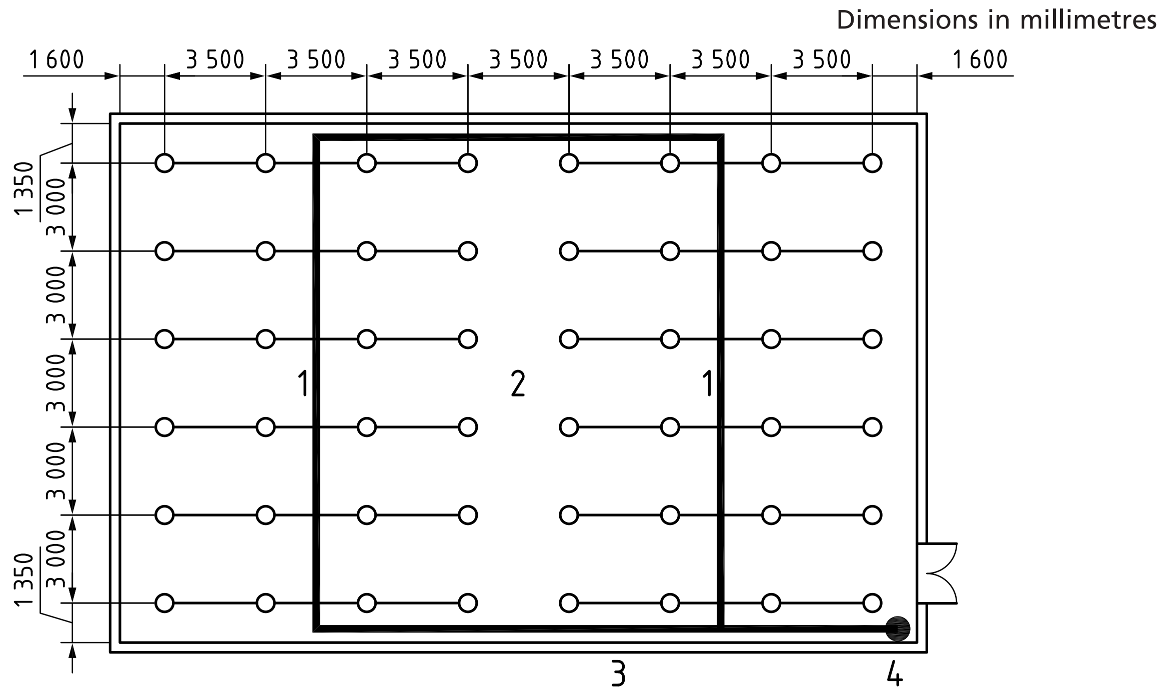
2 Distribution main centre feed

3 Distribution main end side feed

4 Main distribution pipe

5 Section valve

Figure C.3 **System components looped layout**



Key

1 Looped distribution main

2 Ranges and nozzles

3 Main distribution pipe

4 Section valve

C.3 AMAOs to be determined by full hydraulic calculation

The hydraulically most unfavourable area might not be the geographically most remote area.

It is not necessarily at the remote end of the pipework array furthest from the pump.

For instance, an area nearer the pump may have more closely spaced nozzles and the pressure demand due to the extra flow might make it the hydraulically most unfavourable area.

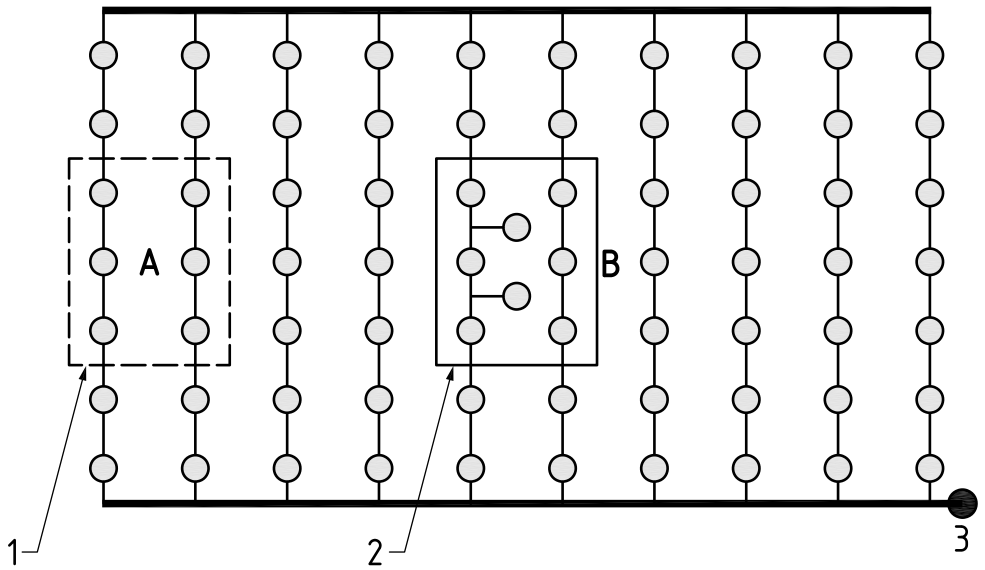
Smaller pipe diameters can also force an area to be more unfavourable.

An area may have extra nozzles under obstruction that demand a higher pressure due to the extra flow.

The hydraulically most unfavourable area is usually the one that requires the highest pressure.

In some instances the hydraulically most unfavourable area is the most physically remote from the water supply. However, there can be instances where the hydraulically most unfavourable area is not the most geographically remote, due to additional nozzles being required in a particular area, as illustrated in Figure C.4.

Figure C.4 **Selection of hydraulically most remote operating area**



Key

1 Usual location of remote area

2 Most likely location of remote area due to extra nozzles

3 Section valve

The hydraulically most favourable operating area might not be the geographically most favourable area.

It is not necessarily the area nearest the pump.

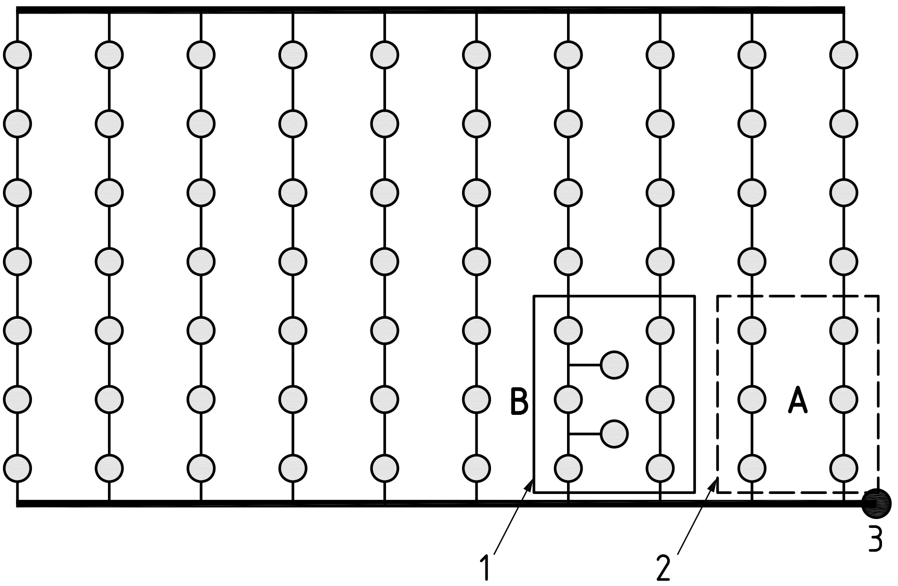
For instance, an area further from the pump may have more closely spaced nozzles and their combined flow might make it the hydraulically most favourable operating area.

Larger pipe diameters can also force an area to be more favourable.

The hydraulically most favourable operating area is usually the one that requires the highest flow.

Selection of the hydraulically most favourable operating area is illustrated in Figure C.5. In this example the additional nozzles in area B result in a greater flow than that required for area A.

Figure C.5 **Selection of hydraulically most favourable operating area**



Key

1 Most likely location of favourable area due to extra nozzles

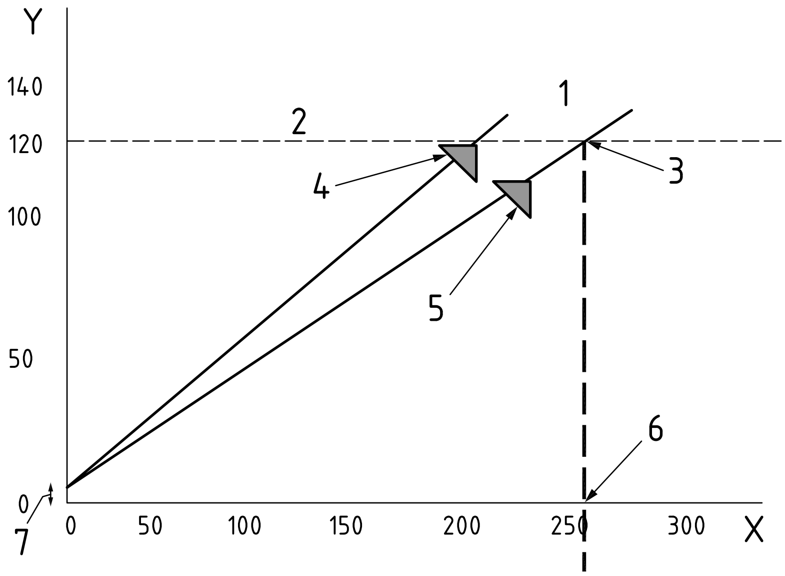
2 Usual location of favourable area

3 Section valve

C.4 Most unfavourable and most favourable AMAO demands and the pump supply curve

The most unfavourable and the most favourable AMAO demands and the pump supply curve are shown in Figure C.6. The most unfavourable area requires the greatest pressure in order to deliver the required flow. The most favourable area requires the greatest flow in order to meet the required pressure.

Figure C.6 **Most unfavourable and most favourable AMAO demands and the pump supply curve**



Key

1 System curves

2 Pump curve

3 Intersection of favourable area system curve and pump curve

4 Remote area 200 L/min at 119 bar, highest pressure and nearest to pump curve

5 Favourable area 225 L/min at 112 bar, highest flow and furthest to the right

6 Maximum flow = 255 L/min, used to size the stored water tank (255 × 10 min = 2 550 L)

7 System curve start point at the static pressure equal to the height of the highest nozzle in the AMAO

X Pressure (bar)

Y Flow (L/min)

C.5 Calculating the number of nozzles and actual area of AMAO

The number of nozzles required depends on the roof structure, ceiling tile layout, mechanical and electrical services and everything else that congests the roof or ceiling area. Obstructions that commonly cause the designer to exceed the estimated number of nozzles in the AMAO include wind bracing, lighting, cable trays, wide ducting, excessive structural, pipe racks and tall cabinets. Extra nozzles in the AMAO result in larger pumps and stored water tank size.

There is a definite minimum and maximum number of nozzles (excluding nozzles below obstructions).

In uncongested areas the minimum number of nozzles can be used in the AMAO.

If the area to be protected is very congested with other services and the nozzles have to be spaced closer together, the number of nozzles in the AMAO increases.

The following examples are for an AMAO of at least 72 m², assuming that nozzles can be spaced at a maximum of 4.5 m and a minimum of 2.5 m apart.

NOTE 1 The AMAO is usually larger than 72 m².

If the decimal place is anything other than .00, the number has to be rounded up. Rounding down results in an incorrect calculation.

a) **Example 1**. The minimum number of nozzles in the AMAO is when they are spaced at their maximum dimensions. The area covered by each nozzle is 4.5 m × 4.5 m = 20.25 m².

   Therefore 72 m² / 20.25 m² = 3.555 nozzles, which is rounded up to 4 operating nozzles. The actual area of the AMAO is 4 nozzles × 20.25 m² = 81 m².

   This is the least it can be in this instance, as removing any nozzles reduces the AMAO below the required 72 m².

   The maximum number of nozzles in the AMAO is when they are spaced at their minimum dimensions. The area covered by each nozzle is 2.5 m × 2.5 m = 6.35 m².

   Therefore 72 m² / 6.25 m² = 11.52 nozzles, which gets rounded up to 12 operating nozzles. The actual AMAO is 12 nozzles × 6.25 m² = 75 m².

   This is the least it can be in this instance, as removing any nozzles reduces the AMAO below the required 72 m².

   With spacing at 4.5 m max. and 2.5 m min., the number of nozzles has to be between 4 and 12.

   NOTE 2 The number of nozzles can increase if nozzles below obstructions have to be taken into consideration in the hydraulic calculations.

b) **Example 2**. If each nozzle covers an area of 12 m² there are 6 nozzles in the AMAO

   = 72 m² divided by 12 m² = 6.00 nozzles

   The actual area of the AMAO = 72 m².

c) **Example 3**. If each nozzle covers an area of 10 m² there are 8 nozzles in the AMAO

   = 72 m² divided by 10 m² = 7.20 nozzles, which is rounded up to 8.

   The actual area of the AMAO = 80 m².

d) **Example 4**. If each nozzle covers an area of 7.850 m² there are 10 nozzles in the AMAO

   = 72 m² divided by 7.850 m² = 9.17 nozzles, which is rounded up to 10.

   The actual area of the AMAO = 78.5 m².

e) **Example 5**. For 72 m² AMAO, each nozzle covers an area of 13.435 m²

   = 72 m² divided by 13.435 m² = 5.359 = 6 nozzles

   The actual area of the AMAO = 80.61 m².

f) **Example 6**. For 144 m² AMAO, each nozzle covers an area of 12.125 m²

   = 144 m² divided by 12.125 m² = 11.876 = 12 nozzles

   The actual area of the AMAO = 145.5 m².

g) **Example 7**. For 144 m² AMAO, each nozzle covers an area of 15 m²

   = 72 m² divided by 15 m² = 9.6 = 10 nozzles

   The actual area of the AMAO = 150 m².

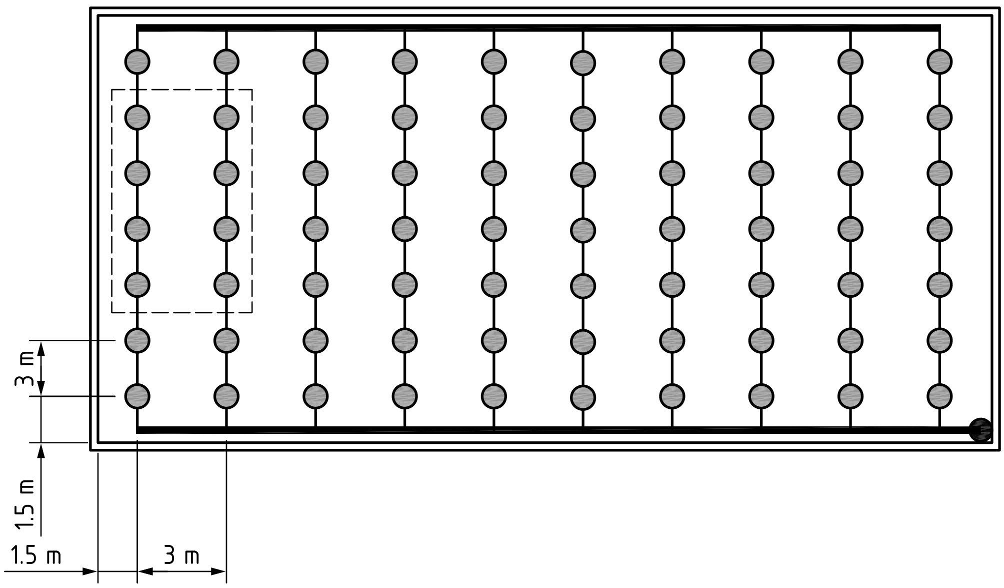
h) **Example 8**. For 72 m² AMAO, each nozzle covers an area of 8.315 m²

   = 72 m² divided by 8.315 m² = 8.659 = 9 nozzles

   The actual area of the AMAO = 74.835 m².

Figure C.7 illustrates the method of calculating the number of nozzles operating in both the most favourable and most unfavourable AMAOs. Area per nozzle = 3 m × 3 m = 9 m² = 8 nozzles in the AMAO.

Figure C.7 **Calculating the number of nozzles**



C.6 Method of calculating the area per nozzle

C.6.1 Regular spacing

The method of calculating the area per nozzle is shown in Figure C.8 for regular spacing. The actual area covered by each nozzle is central to determining the number of nozzles operating in the AMAO.

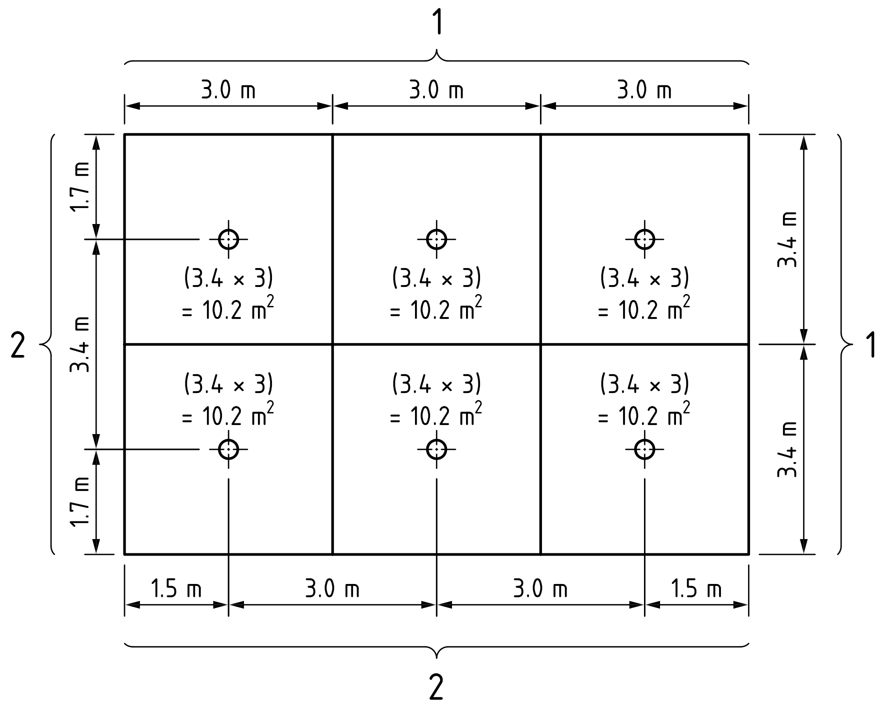
C.6.2 Irregular spacing

The method of calculating the area per nozzle is shown in Figure C.9, Figure C.10 and Figure C.11 for irregular spacing.

For irregular spaced nozzles, the area for each nozzle needs to be determined. The actual area per nozzle is illustrated in Figure C.10.

Figure C.11 gives further examples of how to calculate the area per nozzle when the spacing and/or the compartment is irregular.

Figure C.8 **How to calculate the area per nozzle (regular spacing)**

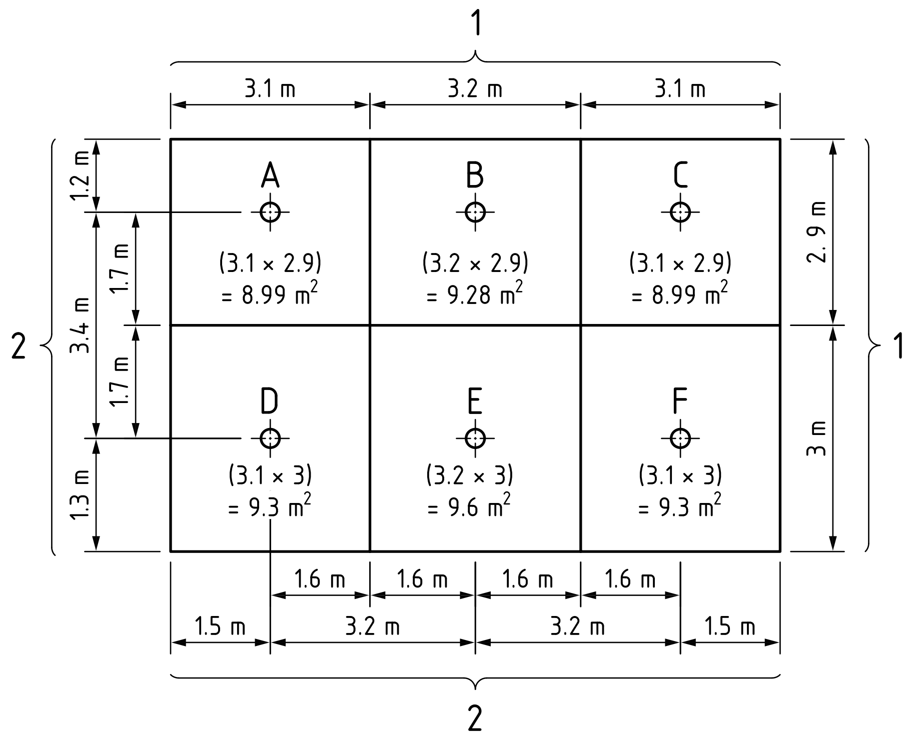


Key

1 Distance covered by nozzle

2 Centre line between nozzles

Figure C.9 **How to calculate the area per nozzle (irregular spacing)**

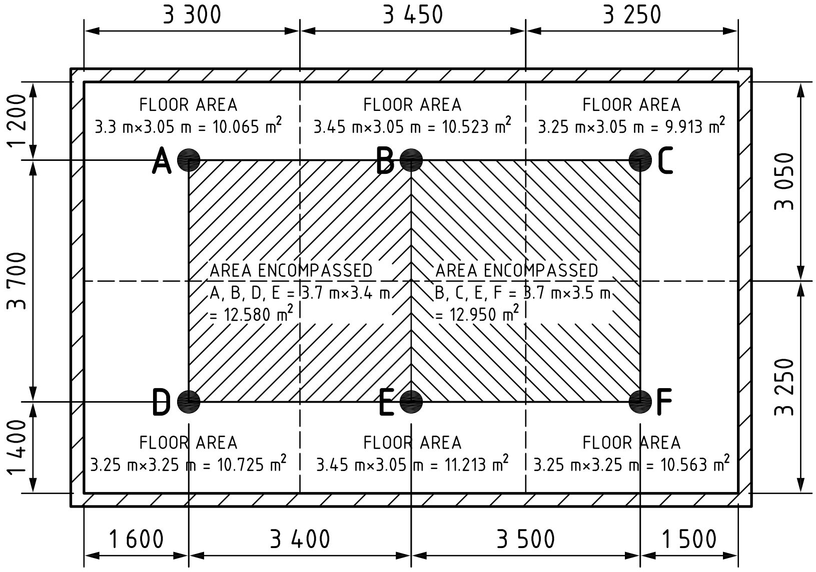


Key

1 Distance covered by nozzle

2 Centre line between nozzles

Figure C.10 **Actual area per nozzle**



The floor areas shown above, when added together, are used only to calculate the AMAO. To achieve correct water distribution, the areas encompassed by nozzles A, B, D, E or B, C, E, F need to be used in the hydraulic calculations.

C.7 Shape of the AMAO

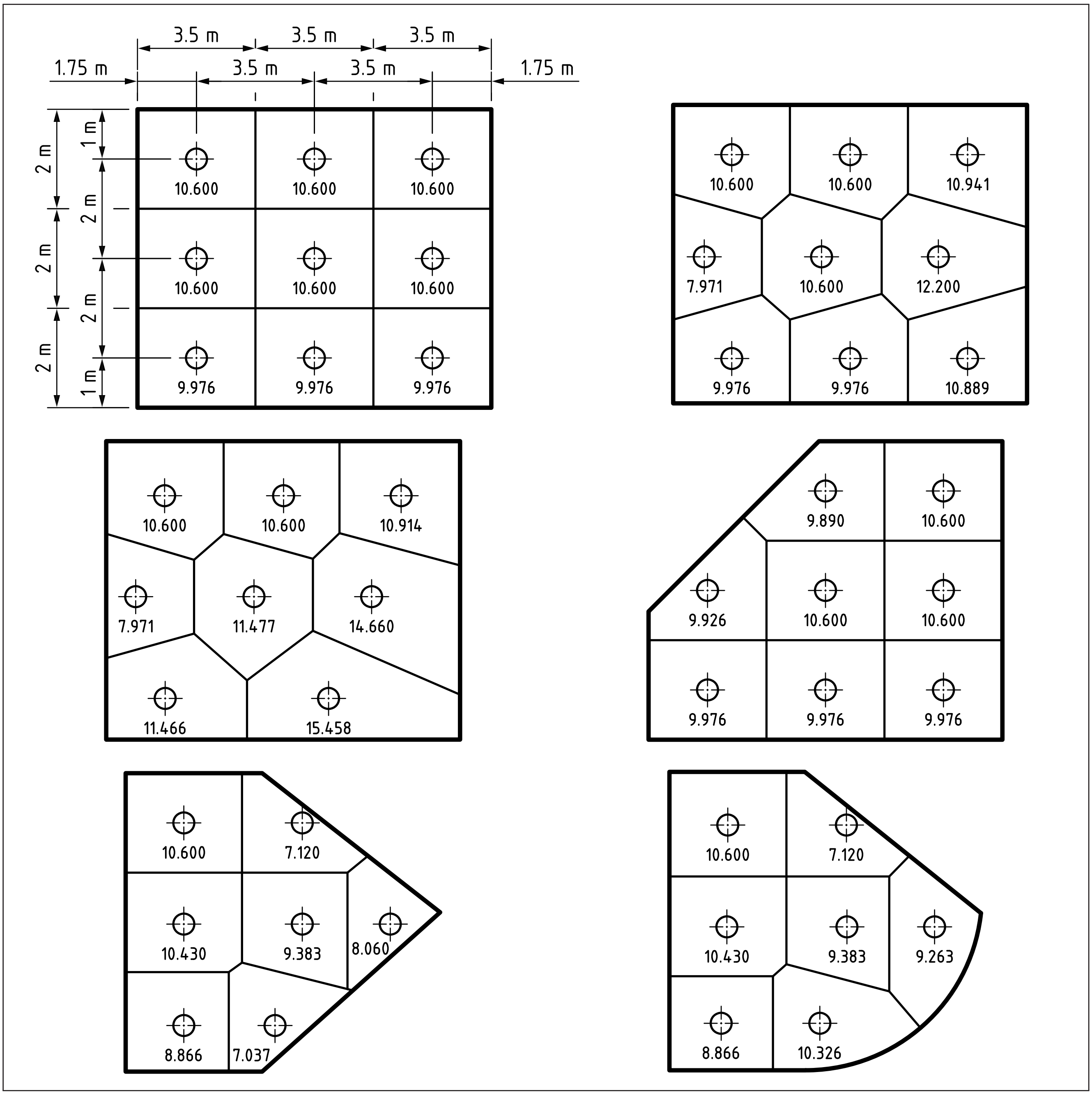
C.7.1 General

The two significant AMAOs have different shapes, and the pipework configuration can also affect the shape.

The factors determining the shape of the AMAO can include:

- Is it an unfavourable area?
- Is it a favourable area?
- Is the pipework layout a terminal arrangement?
- Does the pipework layout have a “looped” main configuration?
- Is the pipework layout gridded?
- Is the gridded layout designed so that the ranges are parallel to the apex of the roof?
- Has fire separation been used (with the agreement of the AHJ) to define a smaller AMAO?

Figure C.11 **Area per nozzle – irregular nozzle spacing – further examples**



C.7.2 Shape of the hydraulically most unfavourable location

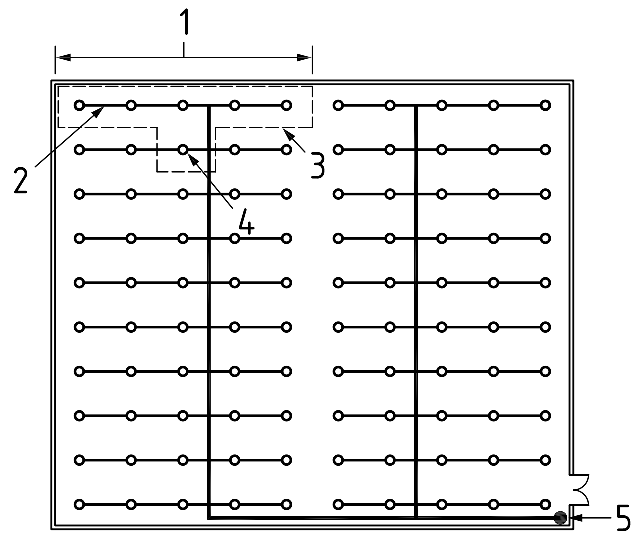
The AMAO is as near as possible rectangular, symmetrical with respect to the nozzle layout, and configured as follows.

a) In the case of terminal and looped configurations, the far side of the area is defined by the range, or pair of ranges where there is an end-centre layout. Nozzles not constituting a full range or pair of ranges are grouped as close as possible to the distribution pipe on the next upstream range row to the rectangular area. The shape of the hydraulically most unfavourable area in a looped main system is calculated in the same way as a terminal system. In the case of terminal pipe configurations, the far side of the area is defined by the range, or pair of ranges where there is an end-centre layout. Nozzles not constituting a full range or pair of ranges are grouped as close as possible to the distribution pipe on the next upstream range to the rectangular area. The terminal configuration is shown in Figure C.12 and the looped configuration in Figure C.13.

b) In the case of gridded configurations where ranges run parallel to the ridge of a roof having a slope greater than 6°, or along bays formed by beams greater than 1.0 m deep, the far side of the area has a length *L* parallel to the ranges, such that *L* is greater than or equal to twice the square root of the area of operation. Normal gridded configurations are shown in Figure C.14. In the case of normal gridded configurations where the ranges run up and down with the slope of the roof, the far side of the area has a length *L* parallel to the ranges, such that *L* is greater than or equal to 1.2 times the square root of the area of operation. Gridded configurations when range pipes run parallel to the roof apex are shown in Figure C.15.

c) In the case of all other gridded configurations the far side of the area, has a length *L* parallel to the ranges, such that *L* is greater than or equal to 1.2 times the square root of the area of operation.

Figure C.12 **Hydraulically most unfavourable area terminal layout**



Key

1 Length defined by range

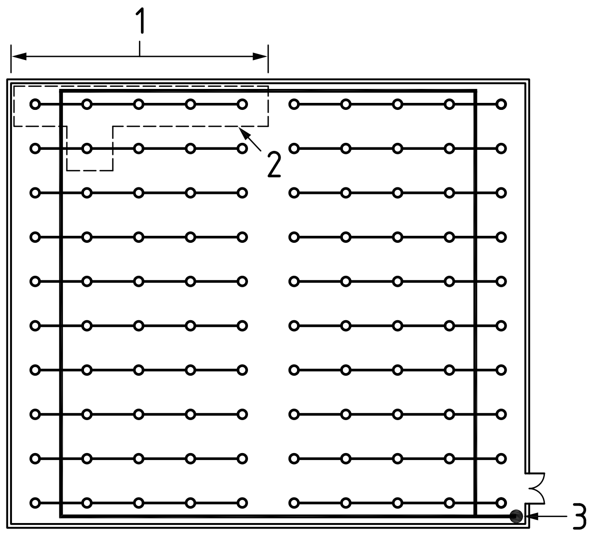
2 Range

3 Remote area

4 Next upstream range row

5 Section valve

Figure C.13 **Hydraulically most unfavourable area looped layout**



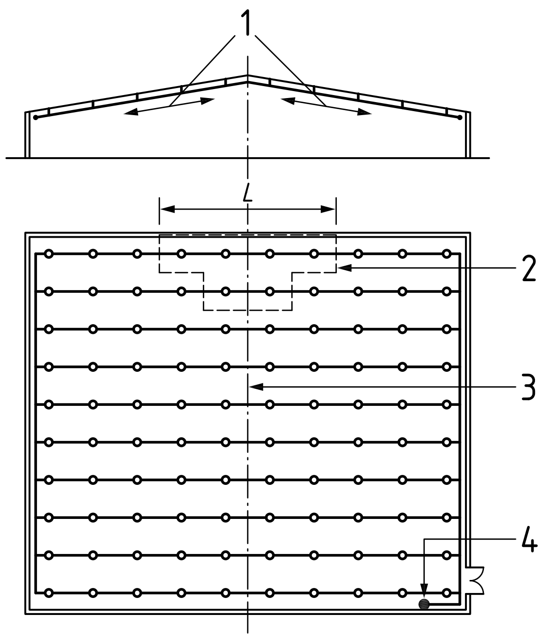
Key

1 Length defined by range

2 Remote area

3 Section valve

Figure C.14 **Hydraulically most unfavourable area in a normal gridded layout**



Key

1 Ranges run up and down the slope of the roof

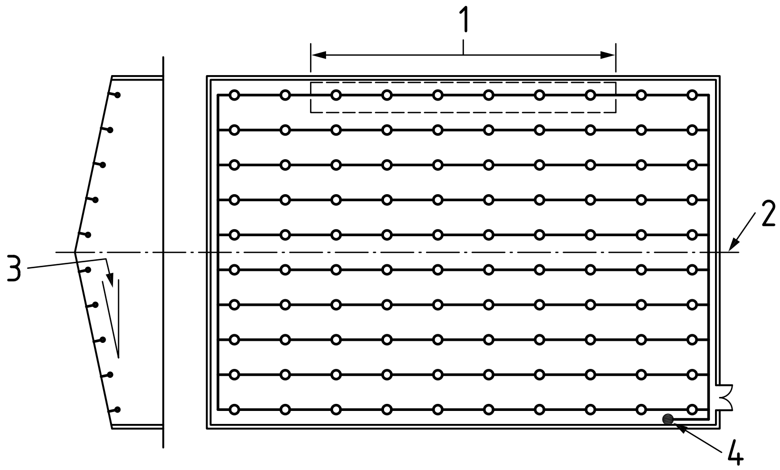
2 Remote area

3 Apex of roof

4 Section valve

L $1.2 \times \sqrt{72} = 1.2 \times 8.485 = 10.182$ m

Figure C.15 **Hydraulically most unfavourable area, gridded layout ranges parallel to roof**



Key

1 Length = 2 × $\sqrt{72}$ = 2 × 8.485 = 16.971 m

2 Apex of roof

3 Roof slope more than 6°

4 Section valve

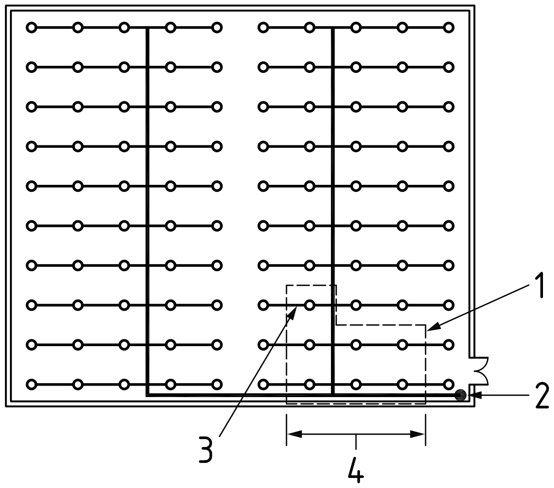
C.7.3 Shape of the hydraulically most favourable location

The AMAO is as near as possible square, and configured as follows.

a) In the case of terminal and looped configurations, the area where possible includes nozzles on one distribution pipe only. The number of nozzles calculated to be operating on ranges, or pairs of ranges in end-centre installations, are located on each range or pair of ranges at the hydraulically most favourable location. Nozzles not forming a full range or pair of ranges are located on the next range row at the hydraulically closest locations.
The shape of the favourable area in a looped main system is calculated in the same way as a terminal system. The area of operation is as near as possible square and as follows: in the case of terminal and looped configurations, the area where possible includes nozzles on one distribution pipe only. Nozzles calculated to be operating on ranges, or pairs of ranges in end-centre installations, are located on each range or pair of ranges at the hydraulically most favourable location. Nozzles not forming a full range or pair of ranges are located on the next range row at the hydraulically closest locations. The terminal configuration is shown in Figure C.16 and the looped configuration in Figure C.17.

b) In the case of gridded configurations, the area is located on ranges at the hydraulically most favourable location. The gridded configuration is shown in Figure C.18. Nozzles not forming a full range length are located on the next range row at the hydraulically closest locations (see Figure C.18).
The location of AMAO is likely to be the same regardless which way the ranges run.

Figure C.16 **Hydraulically most favourable area terminal layout**



Key

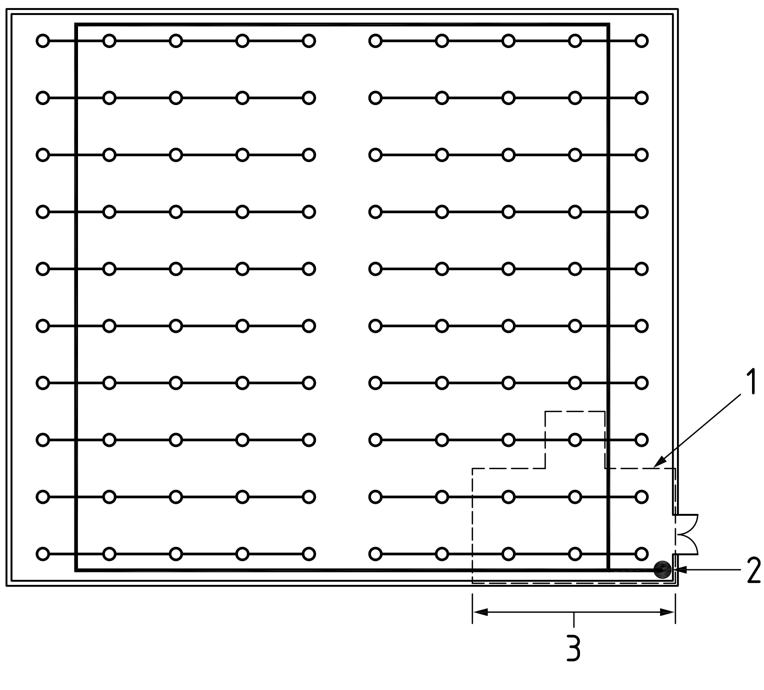
1 Favourable area

2 Section valve

3 Next range row at hydraulically closest location

4 Length = $\sqrt{72}$ = 8.485 m (minimum)

Figure C.17 **Hydraulically most favourable area looped layout**



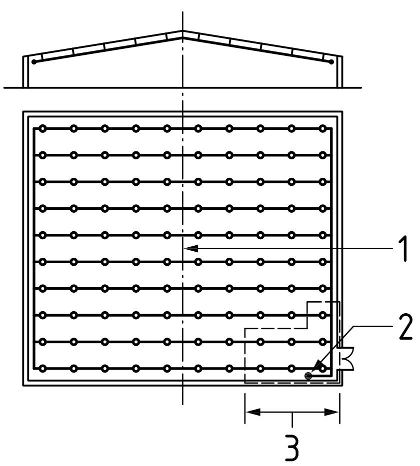
Key

1 Favourable area

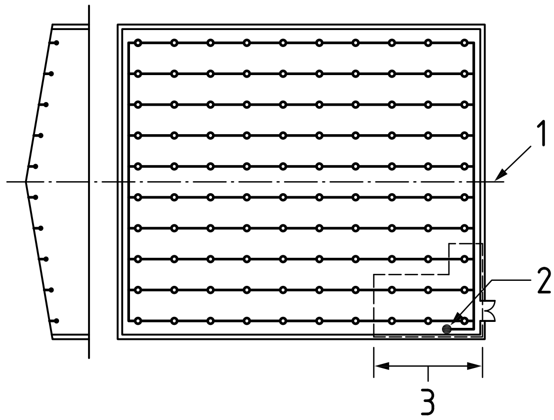
2 Section valve

3 Length = $\sqrt{72}$ = 8.485 m (minimum)

Figure C.18 **Hydraulically most favourable area in a gridded layout**



a) Parallel to slope



b) Parallel to apex

Key

1 Apex of roof

2 Section valve

3 Length = $\sqrt{72}$ = 8.485 m (minimum)

C.8 Length of the AMAO

AMAOs always start at the midpoint between nozzles and the wall/boundary. This is illustrated in Figure C.19.

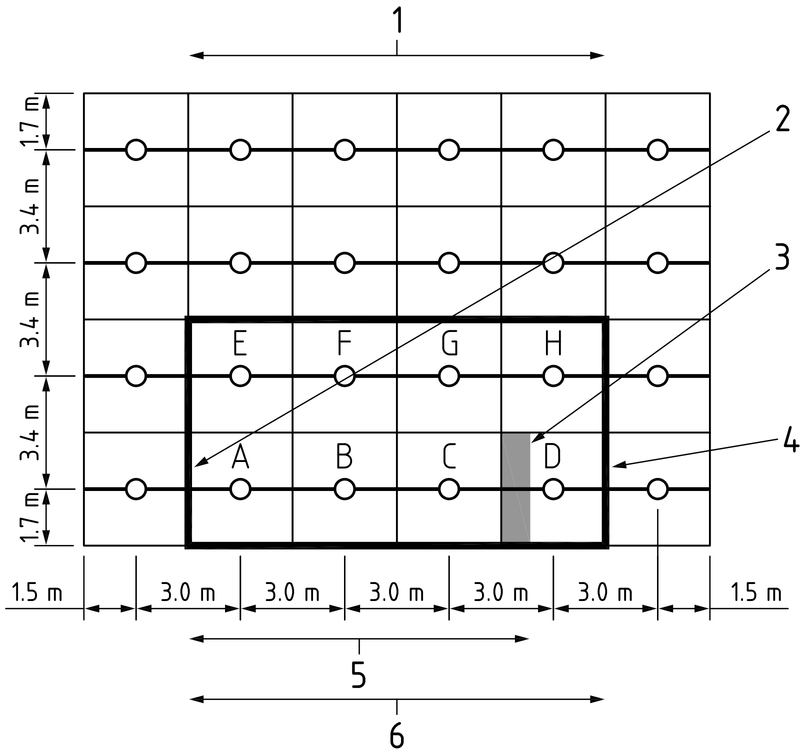
C.9 Relocation of section valves

As the section valve (system feed point) location moves clockwise so do the hydraulically most unfavourable and favourable AMAOs. This is illustrated in Figure C.20.

C.10 Calculating the nozzles operating in the most unfavourable AMAO

Figure C.21 shows an example of how to calculate the nozzles operating in the most unfavourable AMAO. In this example, the calculation starts to the left of nozzle A.

Figure C.19 **Guidance on where the length of the AMAO starts and finishes**



To select an AMAO of 72m²:

- Length = $1.2 \times \sqrt{72} = 1.2 \times 8.485 = 10.182$ m.
- Start at mid point between nozzles (key item 2).
- Measure 10.182 m from the midpoint and parallel with the range.
- The shaded area (key item 3) is not covered by nozzle C; it is covered by nozzle D.
- The AMAO length needs to be stretched to the mid point after nozzle D (key item 4).
- This gives the actual length of the AMAO which in this case has to be 12 m long.

  A + B + C + D = 3 m × 3.4 m × 4 nozzles = 40.8 m²
- Then add the next range of:

  E + F + G + H = 3 m × 3.4 m × 4 nozzles = 40.8 m²
- This gives a total of 81.6 m² in the AMAO.

Key

1 Ranges run from left to right

2 Mid point between nozzles

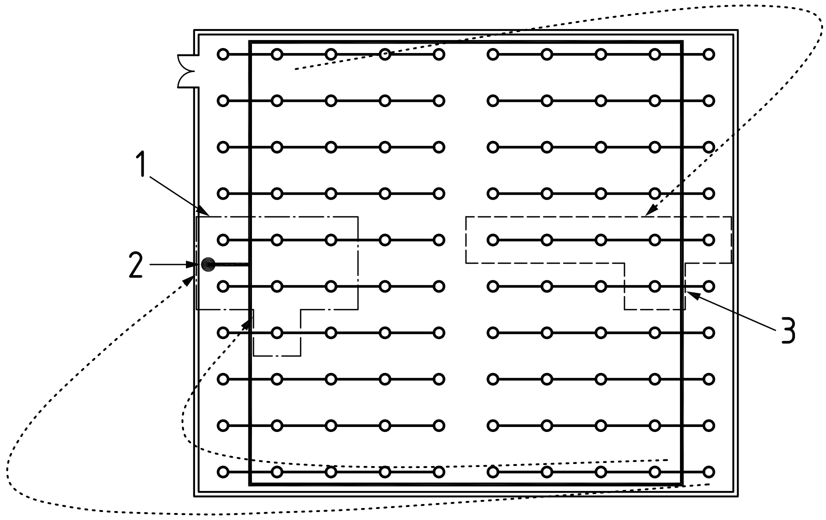
3 Area not covered by nozzle C

4 AMAO length stretched to mid point after nozzle D

5 Length = $1.2 \times \sqrt{72} = 10.182$ m

6 Actual length of AMAO = 12 m

Figure C.20 **Relocation of section valves**



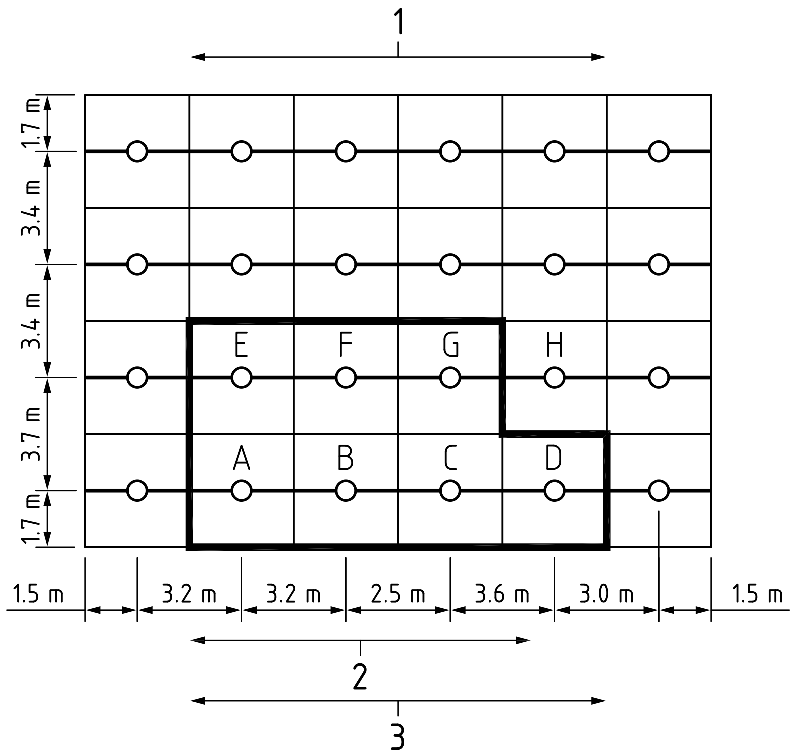
Key

1 Favourable area

2 Section valve

3 Remote area

Figure C.21 **Calculating the nozzles operating in a hydraulically most unfavourable AMAO of 72 m²**



Nozzle areas

A = 3.2 m × 3.55 m = 11.360 m²

B = 2.85 m × 3.55 m = 10.118 m²

C = 3.05 m × 3.55 m = 10.828 m²

D = 3.3 m × 3.55 m = 11.715 m²

E = 3.2 m × 3.55 m = 11.360 m²

F = 2.85 m × 3.55 m = 10.118 m²

G = 3.05 m × 3.55 m = 10.828 m²

Total area A – G = 77.214 m²

Key

1 Ranges run from left to right

2 Length = 1.2 × $\sqrt{72}$ = 10.182 m

3 Actual length of AMAO = 12.4 m

Annex D (normative)

Testing of nozzles

The watermist nozzles should be evaluated for:

- function;
- *K*-factor;
- operating temperature;
- thermal response.

Testing of the watermist nozzles should be in accordance with the following clauses from BS EN 12259-1:1999, with the tests applied to watermist nozzles instead of sprinklers:

- function: BS EN 12259-1:1999, **4.6**, except that minimum nozzle and/or system pressure and maximum nozzle pressure should be applied;
- *K*-factor: BS EN 12259-1:1999, Annex C, except that minimum nozzle and maximum nozzle pressures should be applied;
- operating temperature: BS EN 12259-1:1999, **4.6**, except that minimum nozzle and/or system pressure and maximum nozzle pressure should be applied;
- thermal response: BS EN 12259-1:1999, **4.15**.

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