FIRE-GAS

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Fire sprinkler systems for domestic and residential occupancies Code of practice

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Contents

Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 October 2014.
It was prepared by Subcommittee FSH/18/2, *Sprinkler systems*, under the authority of Technical Committee FSH/18, *Fixed fire fighting systems*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 9251:2005, which is withdrawn.

Relationship with other publications

Attention is drawn to the requirements of BS EN 806, with particular regard to backflow prevention, to BS EN 805 where appropriate, and to BS 1710 for guidance on identification and marking of pipework.

Sprinkler protection for industrial premises and commercial buildings other than those listed in this standard is specified in BS EN 12845. Where sprinklers are not installed primarily for life protection in domestic and residential occupancies, sprinkler installations conforming to BS EN 12845 might be more appropriate than those conforming to BS 9251.

Guidance on the application of sprinkler systems is given in BS 9991, BS 9999, the Building Regulations 2010, Approved Document B for use in England [1], [2], Wales [3], [4] and its equivalents in Scotland [5] and Northern Ireland [6].

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- introduction of building categorization based on occupancy risk;
- change of building height limit;
- variation in sprinkler head design density;
- increase in sprinkler head spacing;
- expanded guidance on preliminary work and consultation;
- expanded guidance on water supplies;
- additional measures for vulnerable people and multi-occupancy premises.

This British Standard is intended for the use of designers, engineers, architects, surveyors, contractors, installers and authorities having jurisdiction.

Product certification/inspection/testing. Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of system conformity with this British Standard. Appropriate conformity attestation arrangements are described in BS EN ISO 9001. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Fire sprinkler systems for domestic and residential applications are designed and installed as a measure in the protection of life in the event of fire. This British Standard presumes that the sprinkler protection will form part of an integrated fire safety system as part of the building design.

The recommendations contained in this British Standard result from the best technical information available to the committee at the time of writing. Firefighting and life protection encompasses a wide field of endeavour and as such it is impracticable to cover every possible factor or circumstance that might affect implementation of 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.

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 of this 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.

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 [7], the Water Supply (Water Fittings) (Scotland) Byelaws 2014 [8] and the Water Regulations (Northern Ireland) 2006 [9] in respect of requirements for any fire sprinkler system which conveys, or is likely to convey, water supplied by a water undertaker or licensed water supplier.

Introduction

Sprinkler systems have demonstrated their value in protecting life and property in industrial and commercial applications for many years. The advent of sprinklers that operate at an earlier stage in the development of a fire, plus the recognition that the largest numbers of deaths from fire occur in the home, have led to the introduction of sprinkler systems specifically designed for domestic and residential occupancies.

A correctly designed and installed sprinkler system can detect and control a fire at an early stage of development and activate an alarm. Operation of the system rapidly reduces the rate of production of heat and smoke, allowing more time for the occupants to escape to safety or be rescued.

This British Standard accordingly covers design, installation, components, water supplies, maintenance and testing of residential sprinkler systems installed for the purpose of reducing risk to life.

In classifying the design of the system for any occupancy, care needs to be taken when considering the fire loading such that it does not exceed that which would normally be expected in that occupancy.

Residential sprinkler systems consist of a water supply, backflow prevention device (e.g. check valve), stop valve, priority demand valve (where required), automatic alarm system and pipework to sprinkler heads. The sprinklers are fitted at specified locations, the appropriate sprinkler type being used for each location. The main elements of a typical residential sprinkler system are shown in Annex A.

Sprinklers operate at a predetermined temperature to discharge water over a known area below. The flow of water thus initiated causes the actuation of an alarm. Only those sprinklers operate which are individually heated above their operating temperature by the heat from the fire.

The provision of a sprinkler system does not negate the need for other fire precautions or practical measures, which can include structural fire resistance, escape routes, fire detectors and good fire safety management practices. Even with the installation of a sprinkler system, normal actions on the discovery of a fire need to be taken, such as immediate evacuation and the calling of the fire service. The sprinkler system is normally only to be turned off following liaison with the fire and rescue service and when it is deemed safe to do so.

Sprinkler system maintenance is not complex but is essential (see Clause **7**). It is important that owners and occupiers are provided with adequate information.

Systems installed in accordance with this standard are primarily for the purpose of reducing risk to life, and are expected to prevent flashover (i.e. total involvement) in the room of origin of the fire and thus provide increased time for occupants to escape or be rescued.

1 Scope

This British Standard gives recommendations for the design, installation, components, water supplies and backflow protection, commissioning, maintenance and testing of fire sprinkler systems in domestic and residential occupancies. These systems are primarily intended for the protection of life in case of fire and have additional benefits for property protection, environmental protection, sustainability of buildings and continuity of use, and firefighter safety.

The recommendations of this British Standard are also applicable to any addition, extension, repair or other modification to a residential sprinkler system.

2 Normative references

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.

ASTM F442, *Standard specification for chlorinated poly(vinyl chloride) (CPVC) plastic pipe (SDR–PR)*

BS 5839-1:2013, *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 5839-6:2013, *Fire detection and fire alarm systems for buildings – Part 6: Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises*

BS 8558, *Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806*

BS 9252, *Components for residential sprinkler systems – Specification and test methods for residential sprinklers*

BS EN 805, *Water supply – Requirements for systems and components outside buildings*

BS EN 806 (all parts) [1)], *Specifications for installations inside buildings conveying water for human consumption*

BS EN 1057:2006+A1:2010, *Copper and copper alloys – Seamless, round copper tubes for water and gas in sanitary and heating applications*

BS EN 10226-1, *Pipe threads where pressure tight joints are made on the threads – Part 1: Taper external threads and parallel internal threads – Dimensions, tolerances and designation*

BS EN 10226-2, *Pipe threads where pressure tight joints are made on the threads – Part 2: Taper external threads and taper internal threads – Dimensions, tolerances and designation*

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

BS EN 12259-1, *Fixed firefighting systems – Components for sprinkler and water spray systems – Part 1: Sprinklers* [2)]

BS EN ISO 9453, *Soft solder alloys – Chemical compositions and forms*

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

3.1 alarm device

device for detecting water flow in or through a sprinkler system and initiating an alarm signal

[1)] This standard also gives an informative reference to BS EN 806-2:2005.
[2)] This standard also gives informative references to BS EN 12259-1:1999.

3.2 alarm receiving centre
continuously manned premises, remote from those in which a fire detection and fire alarm system is fitted, where the information concerning the state of the fire alarm system is displayed and/or recorded, so that the fire and rescue service can be summoned

3.3 alarm test valve
valve through which water can be discharged to test the operation of an alarm device

3.4 area of operation
maximum area over which it is assumed, for design purposes, that sprinklers will operate in a fire

NOTE This is sometimes referred to as the "assumed maximum area of operation".

[SOURCE: BS EN 12845:2004+A2, **3.9**, modified – Note from BS 5306-0:2011 added]

3.5 authority having jurisdiction (AHJ)
organization, office, or individual responsible for enforcing the requirements of legislation or standards, or for approving equipment, materials, an installation, or a procedure

3.6 backflow
movement of the fluid from downstream to upstream within an installation

[SOURCE: BS EN 1717:2000, **3.5**]

3.7 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]

3.8 compartment
area completely enclosed by walls and a ceiling, where any openings are not more than 2 500 mm in width, and have either:

a) a lintel depth of not less than 200 mm; or

b) a single opening of not more than 900 mm in width without a lintel, with no other openings

NOTE This is not the same as a compartment as defined by building regulations.

3.9 competent person
person, suitably trained and qualified by knowledge, understanding and practical experience, and provided with the necessary instructions, to enable the required task(s) to be carried out correctly

3.10 concealed sprinkler
sprinkler with a cover plate that disengages when heat is applied

3.11 crawl space
area not used for storage, under a floor or roof, giving access to building services

3.12 design density
minimum density of discharge, in millimetres per minute of water, for which a sprinkler system is designed, determined from the discharge of a specified sprinkler or group of sprinklers, in litres per minute, divided by the area covered, in square metres

[SOURCE: BS EN 12845:2004+A2, **3.19**, modified – some words changed]

3.13 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

3.14 fusible link sprinkler
sprinkler which opens when an element provided for that purpose melts

[SOURCE: BS EN 12259-1:1999, **3.13**]

3.15 glass bulb sprinkler
sprinkler which opens when a liquid-filled glass bulb bursts

[SOURCE: BS EN 12259-1:1999, **3.13**]

3.16 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 pump set

3.17 hydraulically most unfavourable area
area of operation for which the system pressure, when measured at the main control valve or pump set, is required to be at its maximum to achieve the specified design density

3.18 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

3.19 maximum flow demand
stabilized flow rate discharged from those sprinklers located at the hydraulically most favourable area when balanced to a fire pump's flow/pressure performance curve

3.20 pendent sprinkler
sprinkler in which the nozzle directs the water downwards

[SOURCE: BS EN 12259-1:1999, **3.20**]

3.21 priority demand valve
valve for isolating the supply to the domestic service in the event of sprinkler operation

3.22 pump
automatically operated device that supplies water to a sprinkler system from a water storage facility or from a mains supply when the pressure in the system drops below a pre-determined value

3.23 recessed sprinkler
sprinkler in which all or part of the thermally sensitive element is set into the ceiling or wall

[SOURCE: BS EN 12259-1:1999, **3.21**, modified – location reworded]

3.24 residential pattern sprinkler
sprinkler which gives an outward and downward water discharge, designed and approved for use in domestic and residential occupancy

3.25 service pipe
pipe supplying water from a water supply to any premises that are subject to water pressure from that water supply

3.26 sidewall pattern sprinkler
sprinkler which gives an outward half paraboloid pattern of water discharge

3.27 sprinkler system
entire means of providing sprinkler protection in the premises, typically comprising, but not limited to, sprinkler heads, pipework, alarm devices and a water supply

3.28 stop valve
manually operated valve for controlling the flow of water into the sprinkler system pipework which is normally kept in the open position

3.29 stored water supply
water, apart from mains water, that is available for the sprinkler system

NOTE For example, water stored in a tank/cistern or vessel.

3.30 upright sprinkler
sprinkler in which the nozzle directs the water upwards

[SOURCE: BS EN 12259-1:1999, **3.26**]

3.31 vulnerable people
people who are at greater risk from fire because they are unable to easily evacuate without assistance, or who have a higher than average likelihood of experiencing a fire, or a combination of the two

3.32 water undertaker
company licensed to provide a public water supply

3.33 wholesome water
water suitable for human consumption

NOTE Attention is drawn to the definitions given in the Water Supply (Water Fittings) Regulations 1999 [7] and equivalents in Scotland [8] and Northern Ireland [9].

4 Preliminary work and consultation

4.1 Initial considerations

Before undertaking the design of a residential sprinkler system for a specific property, the designer should evaluate at least the following factors before starting work on the project, obtaining specialist advice where necessary:

- the risks to be protected, including the fire loading;
- the type of occupancy of the property (see **4.3**);
- the water supply requirements and availability;
- any special circumstances (see **4.5**).

*NOTE 1 In some buildings or parts of buildings, a higher level of protection might be required than that provided in BS 9251 (see also Note 2 to **4.5**).*

NOTE 2 In buildings where there is a mix of residential and commercial use (e.g. where flats are above shops), it is generally appropriate to protect the residential parts using BS 9251, and the commercial parts using BS EN 12845. This does not preclude the use of either of these standards being applied throughout such a property subject to full evaluation, consultation and agreement with AHJs.

4.2 Consultation

*COMMENTARY ON **4.2***

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

The designer should at an early stage ensure that consultation has taken place with any relevant authorities having jurisdiction (AHJs) or others who might have a direct interest in the installation, including but not limited to:

a) the water undertaker (see *Guidelines for the supply of water to automatic fire sprinkler systems* [10]) or licensed water supplier;

b) the fire authority;

c) the licensing authority;

d) the building control body;

e) the insurer(s) of the dwelling and its contents;

f) the client, to take into account further considerations of vulnerability (see Annex B).

4.3 Category of system

The designer should at an early stage determine which category of system is applicable, as this affects various design considerations, such as the water requirements for the system.

The category of system should be determined by the type of building as shown in Table 1, up to a maximum height of 45 m. If the type of building is not listed in Table 1, or for buildings over 45 m, then the AHJ(s) should be consulted to agree which type of building should apply, whether additional measures are needed (see **4.5**), or whether an alternative system (e.g. BS EN 12845) is more appropriate.

4.4 Use of sprinklers as a compensatory feature

*COMMENTARY ON **4.4***

There are occasions when a suppression system is used as a means of demonstrating compliance with building regulations or to compensate for, or overcome, circumstances where a building is unable to achieve compliance with guidance issued in support of building regulations. For example:

- *an older building where the existing construction cannot achieve the required fire resistance appropriate to the use of the premises;*
- *a new build that cannot meet the necessary access requirements for fire appliances;*
- *loft conversions where it is either not practical or not possible to secure adequate means of escape.*

As previously stated, it would be impractical for this standard to cover all circumstances. It is therefore essential that consultation take place, and where deemed appropriate to the circumstances there might be a need to increase the category of system, the design density and/or the resilience of the system. It is not implied that in all cases that there is necessarily a need to upgrade the category or increase resilience.
It would be beneficial to justify any proposals by means of a fire safety strategy in such cases to support the proposals for the specific case.

Where sprinklers are proposed as a compensatory feature, the following recommendations should be met.

- There should be consultation between the designer and any necessary or relevant AHJs, and the category of system (see Table 1) and design density (see Table 2) should be agreed and recorded on the compliance certificate (see **6.2.5**).
- Where necessary, proposals should be supported by a fire safety strategy. This should set out how the sprinkler system and any appropriate resilience measures (see Note 1 to **4.5**) would provide equivalence to guidance in support of building regulations.
- System resilience measures, where deemed necessary, should be appropriate to the risk and be agreed and recorded on the compliance certificate (see **6.2.5**).

Table 1 **Category of system**

Category of system	Description of building/occupancy
1	Single family dwellings such as: [A)] - Individual dwelling house - Individual flat - Individual maisonette - Transportable home Houses of multiple occupation (HMOs) [A), B)] Bed and breakfast accommodation [A), B)] Boarding houses [A), B)] Blocks of flats 18 m or less in height and with a maximum total floor area of 2 400 m^2 [A), C)]
2	Blocks of flats greater than 18 m in height [D)] Small residential care premises with ten residents or fewer Sheltered and extra care housing [D)]
3	Residential care premises with more than ten residents Dormitories (e.g. attached to educational establishments) Hostels

A) If any of these buildings permanently house vulnerable people (see **3.31**), this should be taken into account in determining the building category (see **4.5**).

B) Buildings with more than two floors and five or more lettable bedrooms should be treated as Category 2.

C) Where the fire strategy requires the communal rooms and corridors to be sprinkler protected, or where the total floor area is greater than 2 400 m^2, then the building should be treated as Category 2.

D) Where the fire strategy requires the communal rooms and corridors to be sprinkler protected, then the building should be treated as Category 3.

4.5 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, back-up electrical supplies, or a fire service infill connection to a stored water tank;*
- *increasing the design discharge density or design area of operation.*

NOTE 2 Situations where this might be necessary include:

- *dwellings with a fire loading greater than that which would normally be found in a domestic or residential living room, kitchen or bedroom, or if the fire hazard is greater than that of a conventional domestic or residential occupancy;*
- *buildings where the time for firefighters to commence firefighting in the fire compartment might exceed the duration of water supply of the expected category of sprinkler system, e.g. buildings over 45 m in height or complex buildings;*
- *older buildings with hidden voids and/or where compartmentation might not meet current standards;*
- *buildings with atria;*
- *buildings with adjacent unsprinklered areas;*
- *buildings housing vulnerable people (see Annex B);*
- *buildings with fire engineered design solutions;*
- *mixed use buildings (see Note 2 to **4.1**);*
- *premises providing secure accommodation, asylum centres or similar premises (specialist heads are available for institutional situations where ligature or malicious tampering are a concern).*

5 Design

5.1 General

A residential sprinkler system should be designed by a competent person and in accordance with the components manufacturers' instructions.

*NOTE In residential tower blocks and other multi-storey residential buildings, it is often appropriate to design the sprinkler system so that most maintenance functions (see Clause **7**) can be carried out from the common parts.*

Where a sprinkler system is divided into zones, e.g. for ease of maintenance or reinstatement after a fire, each zone should:

a) not cover more than one floor;

b) have a lockable full-bore stop valve;

c) have a quarter turn drain valve.

5.2 System type

A residential sprinkler system should be a wet pipe system, i.e. one that is permanently charged with water.

5.3 Design density and duration of supply

5.3.1 General

The minimum design density and duration of the supply should be determined in accordance with the category of system as given in **4.3**, Table 1 and the minimum design parameters for that category of system given in **5.3.2**, Table 2.

*NOTE The design density might need to be increased if sprinklers are to be used as a compensatory feature (see **4.4**), in special circumstances (see **4.5**), on sloped ceilings or when using sidewall heads.*

5.3.2 Minimum design parameters

The minimum design discharge densities, number of design sprinklers that should be capable of operating simultaneously in a compartment, and duration of supply should be in accordance with Table 2. The number of design sprinklers should be determined by the maximum number of sprinklers in any compartment (see **5.5**), up to the maximum given in Table 2.

Table 2 **Minimum design parameters**

Category of system (see Table 1)	**Minimum design discharge density** mm/min	**Number of design sprinklers (see 5.5)**	**Minimum duration of supply** min
1	2.04 [A]	1 or 2	10
2	2.80 [B]	1 or 2	30
3	2.80 [C]	2 to 4 [D]	30

[A] Where a sprinkler system is installed as a compensatory feature (see 4.4), the minimum design discharge density should be increased to either:
a) 2.80 mm/min for a single head operation, or 2.04 mm/min through each sprinkler operating simultaneously up to a maximum of two sprinklers in a single area of operation; or
b) 4 mm/min for single head operation, or 2.80 mm/min through each sprinkler operating simultaneously up to a maximum of two sprinklers in a single area of operation.
The increased level of discharge density needed [a) or b) above] should be agreed with the AHJ prior to installation, based on the risk identified.

[B] Where a sprinkler system is installed as a compensatory feature (see **4.4**), the minimum design discharge density should be increased to 4 mm/min for single head operation, or 2.8 mm/min through each sprinkler operating simultaneously up to a maximum of two sprinklers in a single area of operation.

[C] Where a sprinkler system is installed as a compensatory feature (see **4.4**), the minimum design discharge density should be increased to 4 mm/min for single head operation, or 2.8 mm/min through each sprinkler operating simultaneously up to a maximum of four sprinklers in a single area of operation.

[D] Where communal areas/corridors are managed areas and considered to be sterile within a fire strategy report or with agreement by the AHJ, the number of design sprinklers may be limited to two in these areas only.

5.3.3 System flow rate

The system flow rate should be not less than the greater of:

- flow determined by multiplying the discharge density (see Table 2) by the maximum area of operation; or
- flow from the sprinkler operation at 0.5 bar [3]; or
- approved flow rate specified by the manufacturer for that area of operation.

[3] 1 bar = 10^5 N/m^2 = 100 kPa.

5.4 Extent of sprinkler protection

Sprinkler protection should be provided in all parts of the premises. However, unless required by a fire strategy or risk assessment, the following may be excluded:

- bathrooms with a floor area of less than 5 m^2;
- cupboards and pantries with a floor area of less than 2 m^2 or where the least dimension does not exceed 1 m;
- attached buildings such as garages and boiler houses without direct access from within the protected building;
- crawl spaces;
- ceiling voids;
- external balconies permanently open to the outside;
- uninhabited loft/roof voids.

NOTE A fire strategy or risk assessment might demonstrate that extensive spread of fire or smoke, particularly between rooms and compartments, is likely to take place and therefore the fire risk in the area is such that sprinkler coverage is necessary.

5.5 Sprinkler coverage and positioning

Residential sprinkler spacing and positioning should meet the following recommendations.

a) The maximum area protected by each sprinkler should be in accordance with its approved listing performance or 25 m^2, whichever is the lesser.

b) Sprinklers should be not more than 5.5 m apart nor more than half the design spacing from any wall or partition.

c) The distance between sprinklers within a compartment should be not less than 2.4 m, except where there is an intervening constructional feature preventing adjacent sprinklers wetting each other.

d) Pendent and upright sprinklers should have heat-sensitive elements, not more than 100 mm below the ceiling and under no circumstances exceeding the manufacturer's approval listing.

e) Sidewall pattern sprinklers should have the top of the deflector within 100 mm to 300 mm below the ceiling and under no circumstances exceeding the manufacturer's approval listing.

f) The whole of the floor area and the walls from the floor up to 0.7 m below the ceiling should be wetted when the sprinklers are operated.

g) For sloping ceilings, sprinklers should be positioned in accordance with the manufacturer's instructions.

h) Sprinklers should be positioned such that the sensitivity and discharge pattern are not adversely affected by obstructions such as constructional beams, smoke alarms, light fittings or other sprinkler heads (refer to manufacturers' instructions for guidance).

i) Sprinklers should be positioned a sufficient distance from any heat sources (e.g. fireplaces, stoves, ovens, kitchen ranges, hot air flues, hot water pipes, hot air diffusers, water heaters, heat generating light fixtures) in accordance with the sprinkler head manufacturer's instructions.

j) The potential for a shielded fire to develop should be taken into account.

k) Sprinklers should be not less than 50 mm or the manufacturer's recommended distance, whichever is greater, from any wall or partition.

5.6 Residential pattern sprinkler heads

5.6.1 General

Only sprinkler heads in accordance with BS 9252 (or other standard as agreed with the AHJ) with quick-response temperature-sensing elements should be used in the inhabited parts of the building.

Sprinkler heads should be of pendent, upright or sidewall spray pattern types suitable for flush, recessed or concealed installation.

Only new sprinkler heads should be used. Any sprinkler head removed from a system should be discarded.

NOTE In uninhabited parts of the building (e.g. garages), or in habitable parts with sloped ceilings where residential sprinkler heads are not appropriate, sprinkler heads conforming to BS EN 12259-1 may be used.

5.6.2 Minimum operating pressure and flow

The minimum nominal *k*-factor should be not less than 40 L/min/bar$^{0.5}$.

The minimum operating pressure at any sprinkler head should not be less than 0.5 bar [4)].

5.6.3 Temperature rating of sprinklers

Sprinkler heads should have a thermal sensitivity rating in accordance with BS 9252.

Fusible link sprinklers should be colour coded on the frame or sprinkler body; glass bulb sprinklers should be colour coded by the bulb liquid in accordance with BS 9252 or BS EN 12259-1.

The temperature rating of the sprinklers should be:

a) the closest to but at least 20 °C greater than the highest anticipated ambient temperature of the location;

b) within the range of 79 °C to 107 °C when installed under glazed roofs.

NOTE For normal climatic conditions in the United Kingdom, the sprinkler temperature ratings are in the range of 57 °C to 77 °C.

5.6.4 Sprinkler connection

Sprinkler heads should be suitable for use with fittings threaded in accordance with BS EN 10226-1 and BS EN 10226-2.

5.7 Hydraulic calculations

NOTE Full hydraulic calculations need to be carried out for each system to determine the required pressure and flow, which in turn determines the required water supply. The calculations may be carried out using computer software provided that the results can be shown to be accurate.

The hydraulic calculations should be carried out in accordance with Annex C to determine the hydraulically most unfavourable area for the system, based on the maximum number of heads assumed to be operating, the pipe configuration, head selection and classification of risk.

If the system uses stored water then an additional set of calculations should be undertaken to find the most favourable demand area, to determine the effective capacity of the stored water supply.

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

All possible locations for the most unfavourable and favourable areas of operation should be assessed, to determine the maximum required system pressure and system flow.

5.8 Water supplies

5.8.1 General

The design should identify water supply requirements (pressure, flow and duration) for the sprinkler system.

NOTE 1 Where water is drawn from a public mains supply, attention is drawn to the legal requirement for water undertaker approval to be sought.

A suitable water supply should be identified at an early stage to avoid unnecessary work at a later stage. The water supply should be able to provide the system design requirements identified in Table 2.

NOTE 2 For information on Legionella and fire-fighting systems, see Legionella and fire-fighting systems – A technical briefing note *[11].*

5.8.2 Types of supply

Sprinkler systems should be connected to a reliable and sustainable supply, for example:

- mains water supply:
  - mains pressure only;
  - mains water supply boosted by a pump;
- stored water supply:
  - pump supplied from a water tank;
  - regulated pressurized vessel;
  - gravity-fed stored water system.

5.8.3 Mains water supply

5.8.3.1 General

When planning to use a mains water supply, the minimum mains dynamic pressure and flow should be ascertained at a time of peak demand at the earliest opportunity to ensure that there will be sufficient pressure and flow available to allow the system to perform as designed.

NOTE 1 Where there is concern with regard to a mains water supply, a data logger may be used to establish a record of the standing pressure.

If the mains dynamic pressure at the design flow rate is insufficient, a pump may be attached to the mains (with permission from the water undertaker or licensed water supplier) to boost pressure. It should not be used to increase flow rates. Only pumps which are designed to increase pressure should be used (see **5.9**).

NOTE 2 Although an in-line booster pump increases pressure, it has minimal effect on increasing flow.

When the lowest pressure and flow characteristics from the mains water supply do not meet the sprinkler system design requirements, an alternative supply should be provided, e.g. a stored water supply (see **5.8.4**).

5.8.3.2 Design flow rate for mains water supply connections

Where the mains water supply connection serves only the sprinkler system, the system should be capable of providing flow rates at the sprinkler heads as determined by **5.3.3**.

Where the mains water supply connection serves both the sprinkler system and the domestic or residential occupancy supply, the sprinkler system should be capable of providing flow rates at the sprinkler heads by:

a) the operation of an automatic priority demand valve; or

b) locating the domestic occupancy branch connection immediately adjacent to and in close proximity to the incoming water supply; or

c) for category 1 systems (see **4.3**), the flow rate determined by **5.3.3** plus at least 25 L/min;

d) for category 2 and 3 systems (see **4.3**), the flow rate determined by **5.3.3** plus the design demand for the residency plus at least 50 L/min.

Where the connection to the mains water supply serves more than one dwelling, the system should be capable of providing the flow rates at the sprinkler heads as determined by **5.3.3** at times of simultaneous peak domestic demand from all of the dwellings concerned.

5.8.3.3 Supply pipe sizing

The diameter of the water supply pipe to the sprinkler system should be large enough to accommodate the system flow requirements identified in **5.3.3**.

The diameter of the service pipe for the sprinkler system fed by mains water supplies should be agreed with the water undertaker or licensed water supplier.

Losses in the service pipe between the connection point to the water supplier's main and the system design point should be taken into account when designing a town mains fed installation.

5.8.4 Stored water supply

5.8.4.1 General

Where stored water supplies are used, the most appropriate location for the storage volume should be identified.

An alarm to indicate low water levels should be provided for a stored water supply. The alarm should be situated in such a place or of sufficient decibels to ensure that the alarm can be noticed and acted upon.

Storage tanks should be sited such that they can be inspected and maintained.

5.8.4.2 Stored water capacity

To establish the correct effective water storage capacity, the hydraulically most favourable area calculation should be balanced with the pump's performance curve to find the system's maximum flow demand. The maximum flow demand should then be multiplied by the system duration for the classification of risk to establish the minimum effective tank capacity. The maximum flow demand calculation should be carried out in accordance with Annex C.

NOTE 1 The flow requirements at the most hydraulically favourable location are dictated by the performance of the pump selected for the system.

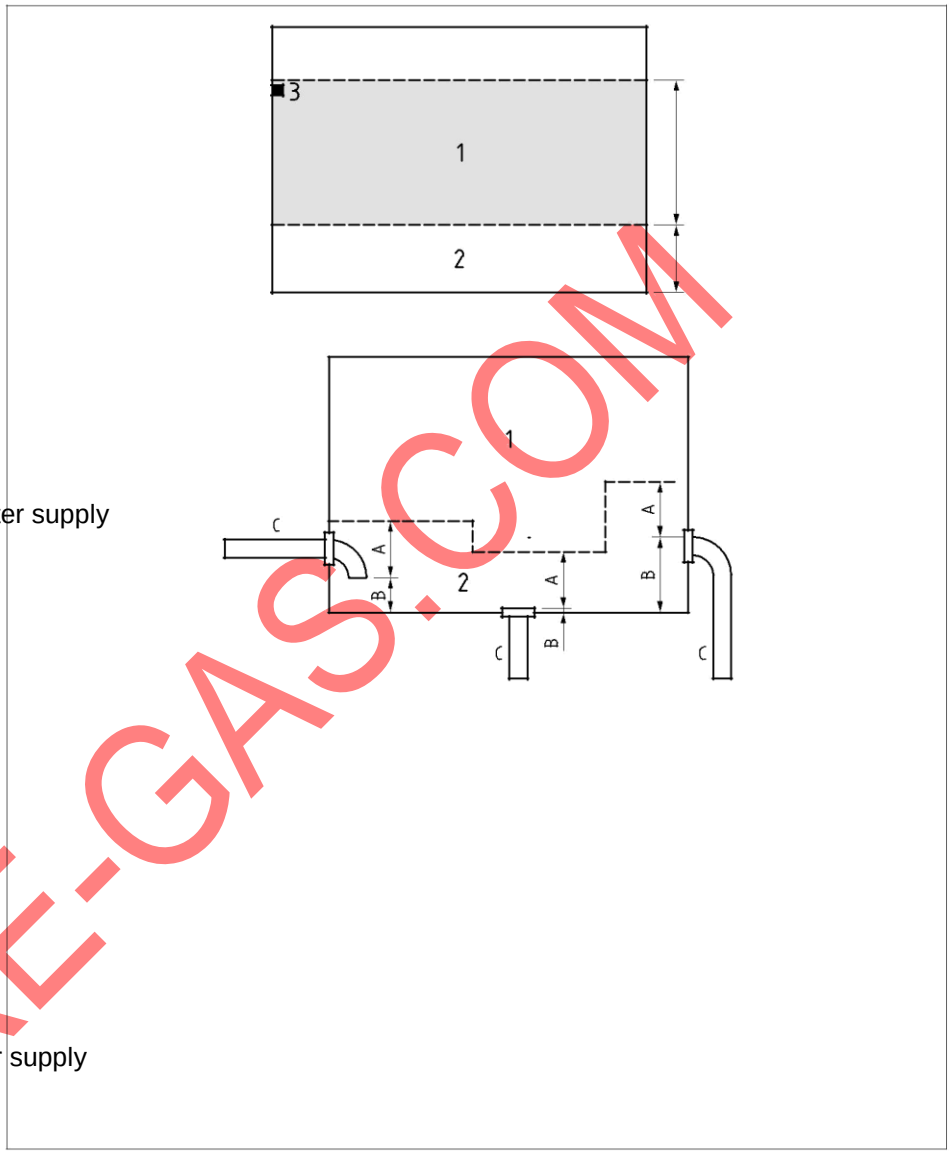
The volume of a stored water supply should be large enough to ensure that the effective capacity of the stored supply [see Figure 1a)] is sufficient for the duration for the category of system as determined in Table 2, or any increased capacity required for an agreed enhanced duration. The air gap at the top and

unusable water at the base [see Figure 1b)], which is affected by a vortex letting air into the pump suction, should be taken into account.

NOTE 2 An anti-vortex device can be installed to increase the amount of usable water at the base of the tank.

The storage tank should have a cover.

Figure 1 **Stored water supply**



a) Effective capacity of stored water supply

b) Unusable water of stored water supply

Key

1 Effective capacity

2 Unusable water

3 Low level alarm

A Distance from suction outlet to lowest level of effective capacity (see Note)

B Distance from suction outlet to base of stored water supply (see Note)

C Suction pipe to pump

NOTE The depth of unusable water is calculated as measurement A + measurement B, and varies depending on:

a) *the diameter of the suction outlet;*

b) *the location and type of the suction outlet.*

Measurement A is identified from either:

1) the manufacturer's recommendations; or

2) at least 2.5 times the suction pipe diameter.

5.8.4.3 Dedicated stored water supply

Where the stored water supply is used exclusively for a sprinkler system, the effective capacity should be at least that determined by the sprinkler system design requirements.

NOTE Typically the effective capacity of stored water supplies for sprinkler systems is:

- *category 1 systems: 1 m^3 to 1.5 m^3;*
- *category 2 systems: 3 m^3 to 4.5 m^3;*
- *category 3 systems: 6 m^3 to 9 m^3.*

*However, it is important to calculate the stored water supply capacity (see **5.8.4.2**), which is greater than the typical values for effective capacity given above.*

5.8.4.4 Shared stored water supply

Where the stored water supply is used to supply both the sprinkler system and the domestic system (hot and cold water), the stored volume should be capable of providing:

- the building's peak demand for the required duration of the sprinkler system's run time; and
- the sprinkler system maximum demand.

NOTE 1 Where shared storage is to be considered, the stored water supply needs to be designed to avoid stagnation and ensure sufficient turnover (water usage) to maintain water quality.

*NOTE 2 Where any proposed combined volume of stored water exceeds that required for domestic purposes, as set out in BS EN 806-2:2005, **19.1.4**, it is likely that separate storage arrangements will be required by the water undertaker or licensed water supplier.*

Where the sprinkler water is derived from the building's stored water supply and the domestic pump set, the following recommendations should be met.

a) The water low level alarm should be set to operate at a point which is:
   - well above the low level mark; and
   - below the expected normal operational low water level, e.g. the range of top water levels the cistern is likely to experience throughout the day created by fluctuations in water supply (infill) and user demand (draw off).

b) All draw-off points from the tank should be at the same level, and they should be taken from the base of the tank.

NOTE 3 The peak flow demand of the building is not the same as the peak demand over a period of 10 min or 30 min.

NOTE 4 If the sprinkler system is being supplied from the domestic cold water tank and booster pump with a dedicated sprinkler riser, the tank size can be that required for the sprinkler system only as long as the domestic draw is via a demand valve that closes on sprinkler activation.

5.8.4.5 Reduced capacity of stored water supply

The stored volume may be reduced if there is a proven rate of automatic infill from the water main. Only 80% of the proven infill may be used for reduction. The proven infill rate should be measured at peak demand.

The reduced capacity should be not less than 60% of the effective capacity without infill.

5.8.5 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 Supply (Water Fittings) Regulations 1999 [7] and equivalents in Scotland [8] and Northern Ireland [9], 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 *[12] or obtained from the water supplier.*

5.9 Pumps

5.9.1 General

*COMMENTARY ON **5.9.1***

The volume of the stored water supply is dictated by the flow performance of the pump selected at the most hydraulically favourable location.

The pumps can be dedicated or can supply both the sprinkler water and domestic water.

Only pumps suitable for use in sprinkler systems should be used. They should be installed and used according to the manufacturer's instructions.

The pump should be able to supply the sprinkler system design pressure and flow requirements at the hydraulically most unfavourable and favourable location as identified in **5.7** and Annex C. The suction pipe diameter should be not less than the pump's inlet diameter, and the velocity in the pump suction should be less than 1.8 m/s.

Where a pump is used to boost pressure, it should be selected to ensure that it will meet the sprinkler system design requirements. These pumps should be used on mains water-fed systems only for the purpose of boosting pressure.

Where a pump is used, it should be:

a) located such that it is unlikely to be affected by a fire or protected in the event of fire;

b) located where the temperature can be maintained above freezing, or trace heating or lagging applied;

c) protected electrically by suitable fusing. Circuit breakers are not suitable;

d) protected against the effects of fire;

e) of sufficient capacity to ensure that the recommendations given in **5.3.3** are met;

f) operated automatically on demand;

g) continuously rated;

h) constructed from corrosion-resistant material;

i) located such that it is unlikely to be affected by flooding.

To ensure ease of maintenance, stop valves should be installed immediately upstream and downstream of the pump (see Annex A).

The electrical supply to the pumps should be installed in such a way as to minimize the risk of electrical supply failure by having a separately fused connection taken after the meter and from the supply side of the fuse box, using approved fire-resistance cabling.

5.9.2 Combined sprinkler and domestic supply pump

NOTE In many situations, a combined sprinkler and cold water pump is more robust than a dedicated sprinkler pump, as the pump is in constant use and therefore a fault becomes apparent and can be fixed extremely quickly.

Where the pump is installed with a priority demand valve to shut off the supply to the domestic draw, the pump should be of sufficient capacity to ensure that the recommendations of **5.3.3** are met.

Where the pump is not installed with a priority demand valve to shut off the supply to the domestic draw, the pump should be of sufficient capacity to ensure that the recommendations of **5.3.3** and the peak domestic draw of the building are met simultaneously.

5.9.3 Dedicated sprinkler pump

Where a dedicated pump is used, in addition to the recommendation in **5.9.1** it should be:

a) designed to include an automatic test cycle where the pump is activated at least monthly;

b) operated automatically on demand but requiring manual shut down.

A fault alarm should be raised if the electrical power fails or the automatic test cycle fails. The alarm should be situated in such a place or of sufficient decibels to ensure that the alarm can be noticed and acted upon.

5.10 Pipes and fittings

All pipes and fittings should be supplied, stored, handled, used and installed in accordance with the relevant British Standard, or other nationally recognized standard, appropriate for the particular material being used.

Capillary fittings should be joined by soldering or brazing with alloys with a melting point of not less than 230 °C as specified in BS EN ISO 9453.

Copper tube conforming to BS EN 1057:2006+A1 used in underground locations should be R220 (annealed), thick walled, factory plastic coated tube. In this case, fittings should be manipulative Type B. Brass fittings in underground locations should be immune to de-zincification.

Other metallic and non-metallic pipes and fitting systems should be suitable for sprinkler systems and be installed in accordance with the manufacturer's instructions.

5.11 Valves

Valves should be suitable for sprinkler systems and be installed in accordance with the manufacturer's instructions.

The system should have the following (see Annex A):

a) a suitable backflow prevention device (see **5.8.5**);

b) a lockable full bore stop valve. The valve should normally be locked in the open position to prevent accidental or deliberate interruption of the water supply to the sprinkler system;

c) where appropriate, a priority demand valve;

d) an alarm test valve;

e) a quarter turn drain valve facility fitted at the lowest point of the sprinkler pipework to allow the complete draining of the sprinkler system;

f) a quarter turn test valve facility fitted downstream of the flow switch to allow testing of the switch, suitably sized to check the appropriate maximum system flow rate;

NOTE The drain and test valves can be combined if suitably located to serve both functions.

g) an installation pressure gauge;

h) measures to prevent tampering with components of a sprinkler system that would isolate the water supply from the rest of the sprinkler system.

5.12 Frost protection

*COMMENTARY ON **5.12***

Freezing can lead to burst pipes, inhibiting the movement of water through the sprinkler system and preventing discharge from the sprinklers.

Normal methods of protection against freezing include:

- *installing pipework within the heated envelope of the dwelling;*
- *the use of lagging and trace heating;*
- *antifreeze.*

Unlike water in domestic water systems, water in sprinkler systems is not replenished by warmer water in normal circumstances. Therefore the water in a sprinkler system continues to lose heat until it reaches ambient air temperature and can therefore easily freeze, despite being lagged. Exposed pipework, unless adequately protected, can also be affected by wind-chill leading to the freezing of the contents, even when ambient temperatures are above 0 °C.

Any water-filled pipework, pump(s) or container(s) used in the sprinkler system, which might be subjected to temperatures below 4 °C, should be protected against freezing.

If antifreeze is used, it should meet the following recommendations.

a) Antifreeze is flammable. It should therefore be sufficiently diluted and thoroughly mixed. Only approved premixed solutions that can be evidenced as suitable for sprinkler systems should be used.

b) The use of antifreeze solutions in water systems connected to wholesome water supplies should have appropriate backflow protection.

c) Only glycerine-based anti-freeze solutions may be used with plastic pipe and fittings. Glycol-based anti-freeze solutions should not be used in CPVC systems as it can damage the plastic.

d) The use of antifreeze solutions in water systems connected to wholesome supplies requires a level of backflow protection which is greater than for systems without antifreeze (see **5.8.5**). The water provider (e.g. water undertaker) should be consulted regarding the fluid categorization and the suitability of backflow prevention arrangements prior to installation.

5.13 Alarm system

5.13.1 General

Alarm devices suitable for residential sprinkler systems should be installed in accordance with the manufacturer's instructions.

5.13.2 Alarm devices

*COMMENTARY ON **5.13.2***

Because sprinklers have a high level of reliability in fire situations, coupled with very few unwanted actuations, the sprinkler alarm needs to be treated as a confirmed fire signal.

Owing to the burden caused by false alarms, many fire and rescue services have introduced measures to reduce attendance to alarms generated by automatic fire alarm systems. Therefore to ensure an emergency response to a sprinkler alarm, consideration needs to be given to clearly distinguishing a sprinkler-initiated alarm from a signal generated by automatic fire detection. Early consultation with the local fire and rescue service can assist in developing an appropriate solution.

Whilst in some domestic and residential buildings the actuation of the fire alarm triggers immediate and total evacuation of the premises, other residential buildings are designed so that the initial alarm is sounded only in the dwelling where the fire starts, as only this dwelling needs to evacuate immediately. It is important that the configuration of the sprinkler alarm is matched to the building's fire evacuation strategy.

If a building or dwelling has comprehensive automatic fire detection and alarm provision that provides adequate fire alarm and warning arrangements to initiate evacuation, additional sprinkler alarms to initiate evacuation might be unnecessary.

A sprinkler system may be interfaced with the fire detection and fire alarm system (e.g. by means of a flow switch), so that a fire alarm signal is given by the building's fire alarm system when a sprinkler head operates.

Alarm system designers need to take account of the fact that the sprinkler alarm might have more than one function, e.g. to initiate evacuation, to alert management and/or to alert the fire and rescue service.

In some cases there can be benefits for reducing property damage, especially in unoccupied areas, if an external sprinkler alarm is installed in a prominent location where people can be alerted to a sprinkler actuation.

All systems should have an alarm device, consisting of an electrically operated flow switch that should be initiated by the flow of water to a single head with the lowest flow rate.

The alarm device should initiate a sprinkler alarm signal that should instigate the appropriate emergency procedures.

NOTE 1 These procedures may be determined, where necessary, by a fire strategy for the building.

The alarm device should be either:

a) connected to an internal audible alarm; or

b) interfaced with an automatic fire detection and alarm system. Where the property is fitted with an automatic fire detection and alarm system to at least the minimum grade and category recommended in BS 5839, the sprinkler alarm device may be interfaced with this system. Any such interface should be in accordance with the recommendations given in BS 5839-1:2013 or BS 5839-6:2013 as appropriate.

   NOTE 2 BS 5839-1:2013, Table A.1 and BS 5839-6:2013, Table 1 provide guidance on the category of system for the relevant property types.

When the alarm device is interfaced with automatic fire detection and warning systems, actuation of the sprinkler alarm should be clearly distinguishable on any fire alarm control and indicating equipment.

5.13.3 Multi-storey blocks of flats

In multi-storey blocks of flats, the sprinkler alarm device may be configured to serve an alarm zone, rather than each individual dwelling, provided the following recommendations are met.

a) The alarm zone should cover no more than a single floor.

b) The individual dwellings should be fitted with an LD1 automatic fire detection and alarm system with a minimum of a grade D power supply, designed, installed and maintained in accordance with BS 5839-6:2013.

c) The sprinkler alarm device should be connected to suitable control and indicating equipment so that management are alerted and the emergency action plan can be initiated.

In multi-staircase buildings, the control equipment should clearly indicate the floor level and appropriate staircase.

5.13.4 Transmission of alarm signals to alarm receiving centres

*COMMENTARY ON **5.13.4***

Where a sprinkler system has been installed for the protection of vulnerable people, it is essential that the sprinkler alarm is also transmitted to an alarm receiving centre or a place where people are tasked with responding on a 24/7 basis, so that management action can be initiated and the fire and rescue service mobilized.
*BS 5839-6:2013, Clause **20** provides more detailed guidance and recommendations.*

In buildings housing vulnerable people (see Annex B), the sprinkler alarm should be transmitted as a confirmed fire signal to a permanently staffed location.

5.13.5 Electrically operated alarm devices

All electrically operated alarm devices should be capable of carrying out their function in the event of a complete failure of the mains electrical power supply.

6 Installation, commissioning and documentation

6.1 Installation

6.1.1 General

Sprinkler systems should be installed by a competent person and in accordance with the designer's specification.

6.1.2 Pipework

6.1.2.1 General

All pipework should be stored, handled and installed in accordance with the manufacturer's instructions.

Where appropriate, sprinkler system pipework should be installed in accordance with BS EN 805, BS EN 806 and BS 8558.

NOTE See also the WRAS Water Regulations guide *[12].*

6.1.2.2 Pipework support

Pipework supports should meet the following recommendations.

a) Supports should be fixed directly to the structural elements or primary supports of the building.

b) Supports should not be used to support any other services.

c) Supports should be able to resist high temperatures without loss of strength.

d) Supports should prevent the pipe from being dislodged.

e) Supports should be secured in accordance with the manufacturer's instructions.

f) Supports should not be glued, welded or soldered to the pipe or fittings.

g) Where necessary, supports for pipes should be suitably lined to prevent corrosion and abrasion.

h) Supports should be fitted as close as practically possible to the sprinkler heads in order to ensure that no movement occurs which would recoil heads into the ceiling or loft voids.

i) Supports should be no closer than 0.15 m to an upright sprinkler.

j) The maximum pipework support spacing should be in accordance with the manufacturer's installation instructions. Where no instructions are available, the maximum spacing should be in accordance with Annex D.

6.1.2.3 Pipework through structural timbers

Structural timbers should not be notched or bored in such a way that the integrity of the structure is compromised.

6.1.3 Sprinkler heads

Sprinkler heads should be stored, handled and installed in accordance with the manufacturer's instructions.

Particular care should be taken to ensure that:

a) vent holes are not obstructed, e.g. through the use of insulation, concreting or boxing in;

b) the sprinkler heads are not damaged in any way prior to fitting; especially the glass bulb or fusible link and the deflector;

c) the sprinklers are installed using the appropriate wrench supplied by the sprinkler manufacturer.

Protective covers should be left in place until the installation has been completed and the system is about to be commissioned (see **6.2**).

6.2 Commissioning

6.2.1 General

In addition to a full visual inspection, all of the tests described in **6.2.2**, **6.2.3** and **6.2.4** should be passed for the system to become operational.

6.2.2 Leakage test

The sprinkler system should be pressurized to a minimum pressure of 8 bar [5)], or to 1.5 times the maximum working pressure, whichever is the greater, for 1 h. If the sprinkler system fails to maintain pressure, the leak should be found and corrected and this test repeated.

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

6.2.3 Hydraulic test

The sprinkler system should be tested to check that at least the design flow rate can be achieved at the design pressure when measured at the combined drain and alarm test valve. If this flow rate at the required pressure cannot be achieved, the system should not be approved for use until the system has been corrected and the test has been passed.

NOTE An example of a suitable test is given in Annex E.

6.2.4 Alarm test

The alarm device should be tested by opening the alarm test valve to ensure a flow of water and checking that the alarm operates as designed (see **5.13**). Where the alarm is configured for remote monitoring, the signal to the monitoring station should be checked.

NOTE It is essential that any alarm receiving centre to which alarm signals are relayed is notified before, and immediately after completion of, any tests that could result in an alarm signal.

6.2.5 Compliance certificate

On satisfactory completion of the commissioning tests, a compliance certificate should be issued by the competent person in accordance with **6.3.3**a), which attests that the sprinkler system has been designed, installed and commissioned in accordance with this British Standard (see Note).

NOTE The design element of the certificate may be provided by another party.

Any variations from this standard should be agreed with the AHJ and should be clearly stated on the compliance certificate.

6.3 Documentation

6.3.1 Presentation

For new and extended systems all drawings and documents should bear as a minimum details of the system which should include:

a) the address and location of the premises or, in the case of transportable homes, the chassis or reference number;

b) the name, address and contact details of the competent person;

c) the name and address of the designer if different to the competent person;

d) the date of installation.

6.3.2 Log book

A log book should be provided to the occupier, and owner if appropriate, for each system containing all of the documentation listed in **6.3.3**.

6.3.3 Documents

The following information should be provided and be contained in the log book (see **6.3.2**):

a) a statement of compliance with this British Standard in the form of a signed compliance certificate (see **6.2.5**) [6)], together with any variations agreed with the AHJ and justification for the variation;

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6) Such a certificate represents an installer's declaration of conformity, i.e. a claim by or on behalf of the installer that the system 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.

b) category of system and number of design sprinklers;

c) a general description of the system and a layout drawing of the premises, which should include as-fitted details, showing the extent of the installation, together with a set of the hydraulic calculations, including the system pressure and flow requirements;

d) results of the commissioning tests;

e) a list of components used, identifying the supplier's name and parts reference number;

f) details of the authorities consulted and any response to consultation;

g) details of the water supplies which, if a town main, should include pressure and flow rate data at a specified location for the commissioned installation, with the time and date of the test;

h) a routine inspection and maintenance programme for the system;

i) instructions on the actions to be taken in respect of operation of the system, faults, etc.;

j) a 24 h emergency contact which can be used to obtain assistance;

k) essential information for the user, e.g. "do not paint, cover or in any way impede the operation of a sprinkler head", "no modification should be made to any sprinkler equipment except in accordance with BS 9251:2014".

6.4 System data label

A label or notice should be attached or fixed adjacent to or on the sprinkler riser next to the main sprinkler stop valve as a permanent record of a system's design data.

NOTE 1 An example is given in Annex F.

*NOTE 2 This is not the same as the compliance certificate (see **6.2.5**).*

7 Maintenance

7.1 Inspecting and testing

The sprinkler system should be subject to an annual inspection and test by a competent person, as follows.

a) The system should be inspected to determine whether all components are functioning as designed.

b) The system should be inspected for leaks.

c) The system should be inspected to determine whether any or all modifications have been carried out in accordance with this standard.

d) Where there has been a material alteration to the building, an increase in fire loading or a change to include vulnerable occupants, an assessment should be made as to whether the category of system is still appropriate.

e) The sprinklers and cover plates should be inspected to determine whether they have been tampered with or whether their spray pattern has been impeded.

f) Valves should be exercised to ensure free movement and any locking mechanism should be checked and reinstated.

g) The test valve should be operated to determine whether the system's design flow rate and pressure, as hydraulically calculated, is achieved.

NOTE 1 An example of a suitable test is given in Annex E.

h) Alarms should be tested to determine whether they function as designed.

i) Backflow prevention devices should be maintained in accordance with the manufacturer's recommendations or BS EN 806-5.

j) Any remote monitoring arrangements should be tested to determine whether they are being transmitted and received correctly.

NOTE 2 It is essential that any alarm receiving centre to which alarm signals are relayed is notified before, and immediately after completion of, any tests that could result in an alarm signal.

k) Where trace heating is installed, its operation should be checked.

NOTE 3 Maintenance of the system might be a legal requirement in some circumstances. It might also be a requirement of the building fire strategy.

The person carrying out the inspection should complete and sign the log book as recommended in **7.3**.

7.2 Reinstatement of the system

Reinstatement of the system following maintenance or actuation should be undertaken by a competent person and the log book (see **7.3**) should be annotated to indicate the reason for reinstatement and any actions taken.

7.3 Log book

The log book referred to in **6.3.2** should be completed giving details of:

a) the date of inspection;

b) details of all tests conducted and their results;

c) confirmation or otherwise of the sprinkler system's operational status;

d) confirmation or otherwise of the alarm system's operational status;

e) the time, date and location of any actuation, and details of subsequent reinstatement of the system;

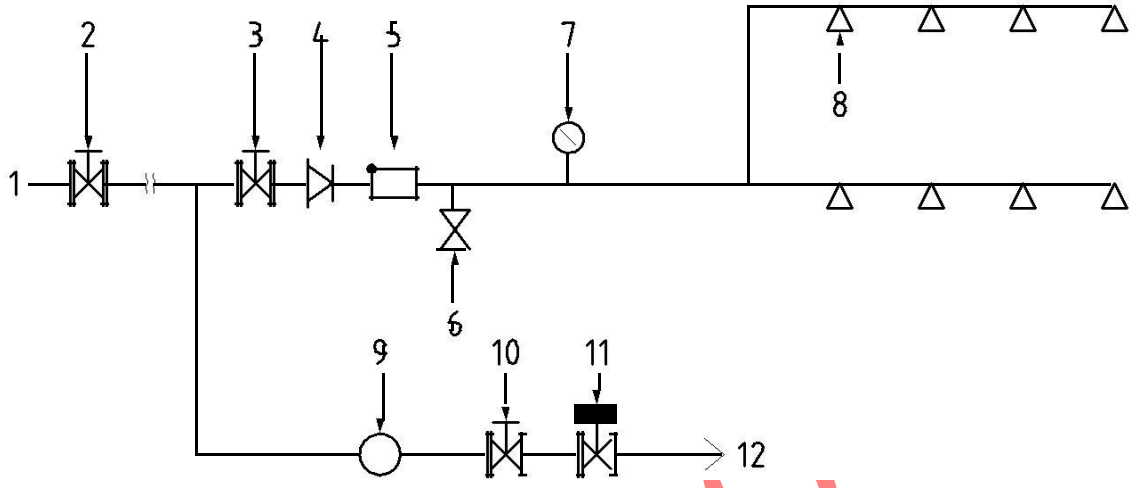
f) details of any recommendations or comments.

Any serious system faults should be relayed to the occupants or owners as soon as possible, and confirmed in writing within 24 h.

Annex A (informative) Elements of a typical residential sprinkler system

The main elements of a typical residential sprinkler system are shown in Figure A.1 for mains-fed systems and Figure A.2 for pump and tank systems.

Figure A.1 **Elements of a typical mains-fed sprinkler system**

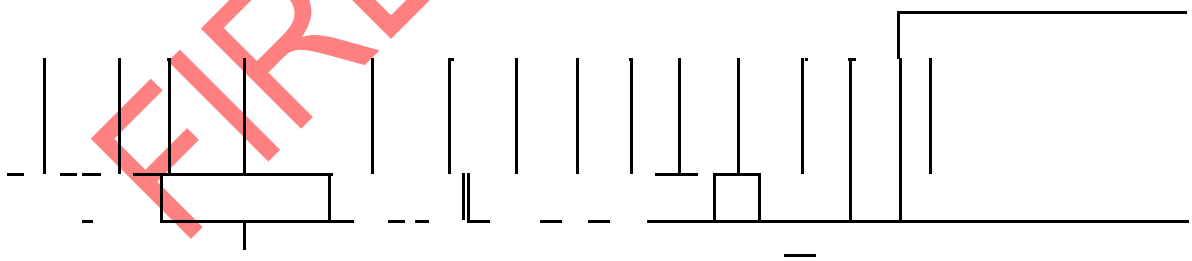


Key

1 Mains water supply
2 Water provider's stop valve
3 Lockable sprinkler stop valve
4 Backflow prevention device
5 Electrical water flow switch
6 Drain and test valve
7 Installation pressure gauge
8 Sprinkler head
9 Domestic water supply meter
10 Domestic water stop valve
11 Optional priority demand valve
12 Domestic system

NOTE In some areas, the water provider might require the whole of the supply to be metered.

Figure A.2 **Elements of a typical pump and tank sprinkler system**



Key

1 Mains water supply
2 Water provider's stop valve
3 Lockable tank isolation valve
4 Float valve with suitable backflow prevention device
5 Tank overflow
6 Water storage tank
7 Tank lid
8 Lockable tank suction stop valve
9 Lockable pump isolation valves
10 Pump
11 Non-return valve
12 Pump controller (see **5.9.1**)
13 Electrical water flow switch
14 Test and drain valve
15 Installation pressure gauge
16 Sprinkler head

Sprinkler performance, reliability and resilience for systems installed in the homes of vulnerable people

Annex B (informative)

COMMENTARY ON ANNEX B

In some situations the risk profile of the resident(s) might justify additional performance, reliability or resilience measures over and above the minimum recommendations in the main standard. This annex gives guidance on some of these situations.

It is the responsibility of the building owners, building management, and/or the responsible person for the building, to advise the sprinkler systems designer/installer whether this annex is applicable and to agree/approve any increased reliability requirements.

Identifying the most vulnerable from fire

It is important to consider vulnerability as a combination of hazard and likelihood and therefore a matter of risk.

B.1 In simple terms this can be thought of as:

- hazard: the ignition source for a fire and materials to aid combustion (the fire itself);
- likelihood: the likely occurrence of a fire starting (the hazard being realized);
- risk: the person being unable to escape in sufficient time to avoid injury or death from fire.

People who are vulnerable from fire can be considered as those with a higher than average likelihood of having a fire or with poor reaction or realization of the danger presented by fire, or a combination of both.

UK fire casualty trends indicate that many victims are older people who live alone, with mental and/or physical health issues. These trends have resulted in an increasing call, from housing and care providers and fire and rescue services, for suppression systems to be installed in the homes of identified vulnerable people.

B.2 Vulnerability: significant factors

The factors below are not a definitive list, but might be primary indicators for concern:

a) likelihood:
   - high fire risk activities or habits, such as careless disposal of smoking materials or leaving cooking unattended;
   - history of fire-setting behaviour;
   - history of previous fires or evidence of near misses, such as scorch marks on clothing or furniture;
   - threats of arson;

b) inability or willingness to escape:
   - impaired mobility affecting ability to escape;
   - impaired reaction to fire or warning devices;
   - impaired senses affecting ability to respond to alarm;
   - poor situational awareness;

- alcohol or drugs, increasing the likelihood of a fire and lowering reaction to alarm.

Evidence for the first group [a)] can be through observation: these are factors affecting the likelihood of a fire occurring. The remainder [b)] might require confirmation from a medical or social care agency and are, importantly, linked with the matter of ability to escape.

The most vulnerable persons are influenced by factor(s) from both groups and are therefore at greater risk.

B.3 Additional performance, reliability and resilience measures

In order to address concerns with a higher than average risk profile, additional measures might be needed as part of the system design, including but not limited to any of the following:

- increasing the duration of application and/or the resilience of the water supply;
- upgrading the system to a higher category or to BS EN 12845;
- arrangements to maintain system integrity during maintenance or repair;
- provision of a back-up power supply to pump(s);
- additional pumps to provide redundancy;
- remote monitoring of critical system components;
- automatic test facilities;
- installation of a fire and rescue service inlet to supplement the water supply.

Annex C (normative) Hydraulic calculations

C.1 Static pressure

The static pressure difference between two inter-connecting vertical points in a system should be calculated from:

$$p = 0.098h$$

where:

p is the pressure, in bar;

h is the vertical distance between the two points, in metres (m).

NOTE If the calculations are undertaken by hand then the value of p may be rounded to 0.1.

C.2 Flow from a sprinkler head

The flow from a sprinkler head should be determined by the following formula:

$$Q = kp^{0.5}$$

where:

Q is the flow, in litres per minute (L/min);

k is the constant, sprinkler head nominal k-factor; p is the pressure, in bar.

C.3 Pipe friction loss

The pressure loss at a given flow through the pipework should be calculated using the Hazen–Williams formula:

$$p = \frac{6.05 \times 10^5}{C^{1.85} \times d^{4.87} \times L \times Q^{1.85}}$$

where:

- p is the pressure, in bar;
- C is a constant for the type and condition of the pipe (see Table C.1);
- d is the mean internal diameter of the pipe, in millimetres (mm);
- L is the equivalent length of pipe and fittings, in metres (m);
- Q is the flow, in litres per minute (L/min).

The pressure loss in the pipework for any given flow should be calculated using the appropriate K value from Table C.2a, Table C.2b or Table C.2c and by using the following formula:

$$p = K \times Q^{1.85} \times L$$

where:

- p is the pressure, in bar;
- K is a constant for the pipe type given in Table C.2a, Table C.2b and Table C.2c;
- Q is the flow, in litres per minute (L/min);
- L is the equivalent length of pipe and fittings, in metres (m).

C.4 Pressure loss through fittings and valves

The pressure loss due to friction in valves and fittings should be calculated using the Hazen–Williams formula in **C.3** for the appropriate equivalent length.

The fitting or valve equivalent length should be taken from:

a) the manufacturer's instructions, when available; or

b) Table C.3a, Table C.3b and Table C.3c for the appropriate material; and

c) equivalent lengths of pipe for pulled bends in copper tube (in metres of pipe).

The frictional pressure loss in copper pipework bends where the direction of water flow is changed through 45° or more should be calculated using the formula:

$$L = 7.65 \times 10^{-3} Q^{0.15} d^{0.87}$$

where:

- L is the equivalent length, in metres (m);
- Q is the flow, in litres per minute (L/min);
- d is the mean internal diameter of the pipe, in millimetres (mm).

Table C.1 ***C* values for various type of pipes**

Type of pipe	Value of *C*
Carbon steel	120
Copper	140
CPVC	150

NOTE This list is not exhaustive. Other values are given in BS EN 12845.

Table C.2a ***K* values for carbon steel tube conforming to BS EN 10255, Medium series**

Nominal diameter (mm)	Internal diameter (mm)	Value of *K*
20	21.70	2.67×10^{-5}
25	27.35	8.66×10^{-6}
32	36.05	2.25×10^{-6}
40	41.95	1.08×10^{-6}
50	53.05	3.44×10^{-7}
65	68.75	9.72×10^{-8}
80	80.75	4.44×10^{-8}

Table C.2b ***K* values for CPVC conforming to ASTM F442**

Nominal diameter (mm)	Internal diameter (mm)	Value of *K*
20	22.20	1.58×10^{-5}
25	28.00	5.11×10^{-6}
32	35.40	1.63×10^{-6}
40	40.60	8.36×10^{-7}
50	50.90	2.78×10^{-7}
65	61.50	1.11×10^{-7}
80	75.00	4.21×10^{-8}

Table C.2c **K values for copper tube conforming to BS EN 1057:2006+A1, half-hard, R250 designation**

Nominal diameter (mm)	Internal diameter (mm)	Value of *K*
22	21.10	2.30×10^{-5}
28	27.10	6.81×10^{-6}
35	33.50	2.42×10^{-6}
42	40.80	9.92×10^{-7}
54	52.80	2.64×10^{-7}
67	62.70	1.14×10^{-7}

Table C.3a **Typical equivalent lengths for steel fittings and valves**

Fittings and valves	Equivalent length in metres						
	20 mm [A]	25 mm [A]	32 mm [A]	40 mm [A]	50 mm [A]	65 mm [A]	80 mm [A]
90° elbow	0.76	0.77	1.00	1.20	1.50	1.90	2.40
45° elbow	0.34	0.40	0.55	0.66	0.76	1.00	1.30
Tee or cross	1.30	1.50	2.10	2.40	2.90	3.80	4.80
Gate or full bore ball valve	0.20	0.30	0.30	0.30	0.38	0.51	0.63
Butterfly valve	1.00	1.10	1.50	1.80	2.20	2.90	3.60
Globe valve	7.30	8.80	11.30	12.80	16.00	21.00	26.00
Non-return valve (swing type)	1.00	1.30	1.70	2.00	2.40	3.20	3.90
Non-return valve (mushroom or spring assisted disc type)	7.00	8.00	10.00	11.00	12.00	19.00	19.70
Flow switch [B]	1.60	2.05	2.65	3.11	4.04	5.30	6.70

NOTE The values given are based on a C-value of 120.

[A] Nominal diameter.

[B] Flow switch equivalent lengths have been derived on the basis of a maximum loss of 0.207 bar, at a flow rate equivalent to a velocity of 4.6 m/s.

Table C.3b **Typical equivalent lengths for CPVC fittings and valves**

Fittings and valves	Equivalent length in metres						
	20 mm [A]	25 mm [A]	32 mm [A]	40 mm [A]	50 mm [A]	65 mm [A]	80 mm [A]
90° elbow	2.13	2.13	2.44	2.84	3.35	3.66	3.96
45° elbow	0.30	0.30	0.61	0.61	0.61	0.91	1.22
Tee branch	0.91	1.52	1.83	2.44	3.05	3.66	4.57
Tee run or coupling	0.30	0.30	0.30	0.30	0.30	0.61	0.61
Gate or full bore ball valve	0.30	0.45	0.45	0.45	0.57	0.77	0.94
Butterfly valve	1.51	1.66	2.26	2.72	3.32	4.38	5.36
Globe valve	7.30	10.00	13.00	16.00	22.00	24.10	38.74
Non-return valve (swing type)	4.23	5.13	6.04	6.95	8.76	10.12	12.00
Non-return valve (mushroom or spring assisted disc type)	6.49	8.46	9.06	11.93	18.12	28.69	38.74
Flow switch [B]	2.42	3.10	4.00	4.70	6.10	8.00	10.00

NOTE The values given are based on a C-value of 150.

[A] Nominal diameter.

[B] Flow switch equivalent lengths have been derived on the basis of a maximum loss of 0.207 bar, at a flow rate equivalent to a velocity of 4.6 m/s.

Table C.3c **Typical equivalent lengths for copper fittings and valves**

Fittings and valves	Equivalent length in metres					
	22 mm [A]	28 mm [A]	35 mm [A]	42 mm [A]	54 mm [A]	67 mm [A]
90° elbow	0.80	1.00	1.40	1.70	2.30	3.00
45° elbow	0.45	0.53	0.73	0.88	1.01	1.33
Tee	1.00	1.50	2.00	2.50	3.50	4.50
Gate or full bore ball valve	0.27	0.40	0.40	0.40	0.51	0.68
Butterfly valve	1.33	1.46	2.00	2.40	2.93	3.86
Globe valve	11.02	13.29	17.06	19.33	24.16	31.71
Non-return valve (swing type)	3.60	4.52	5.32	6.12	7.71	8.91
Non-return valve (mushroom or spring assisted disc type)	5.72	7.45	7.98	10.51	15.96	25.27
Flow switch [B]	2.00	2.50	3.20	4.00	5.50	6.40

NOTE The values given are based on a C-value of 140.

[A] Nominal diameter.

[B] Flow switch equivalent lengths have been derived on the basis of a maximum loss of 0.207 bar, at a flow rate equivalent to a velocity of 4.6 m/s.

C.5 Maximum flow demand calculation

The maximum flow demand should be determined by either:

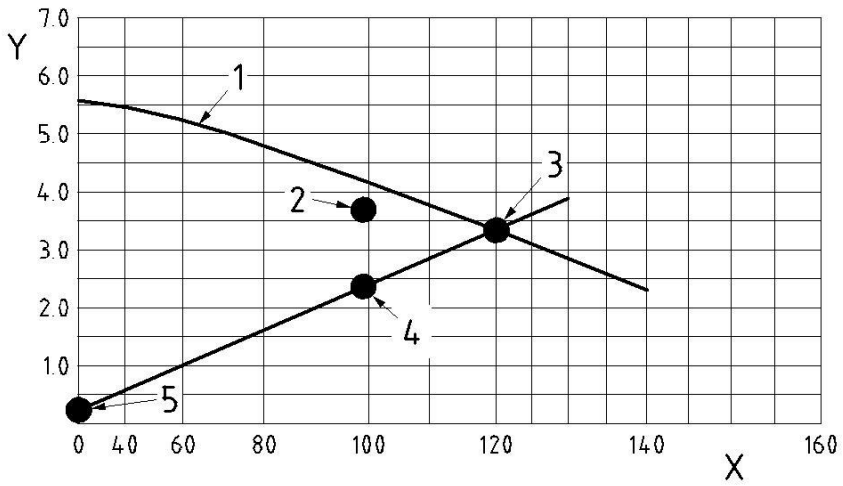
a) full calculation, referencing the available water supply flow/pressure characteristics when applied to the calculated hydraulic demand point of the most favourable area; or

b) determination of the intersect point of the available water supply flow/pressure characteristics with the calculated hydraulic demand point of the most favourable area, using a square law graduation graph referenced as an installer's pump test data sheet.

NOTE An example of using a square law graduation graph is shown in Figure C.1, and a blank template covering a range of appropriate flow rate and pressure requirements in Figure C.2. Figure C.1 indicates:

- *the pump curve performance characteristics;*
- *the most unfavourable demand point at 98 L/min at 3.6 bar;*
- *the most favourable demand point at 98 L/min at 2.4 bar;*
- *the highest operating sprinkler located within the favourable area at 2.0 m high (equivalent to 0.196 bar);*
- *the maximum flow demand of 120 L/min.*

Figure C.1 **Example of a square law graduation graph**



Key

1 Pump curve

2 Most unfavourable demand point

3 Maximum flow demand (120 L/min)

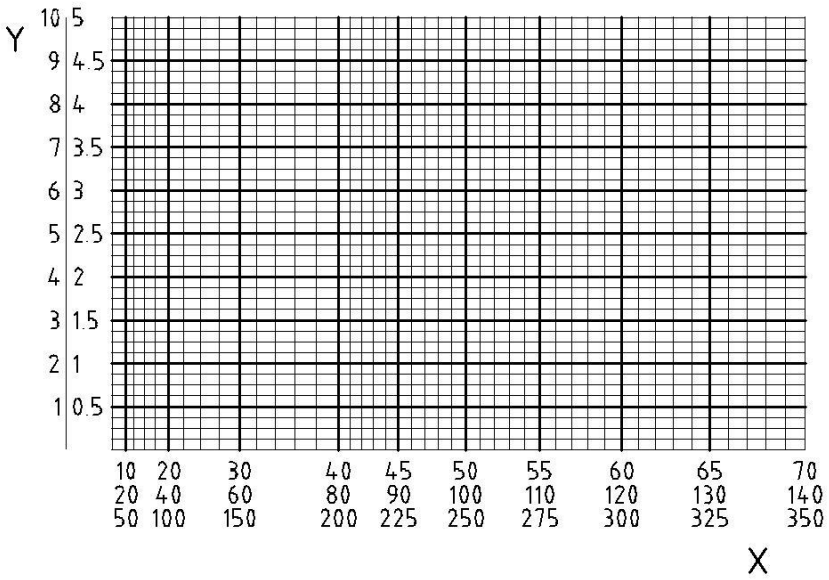
4 Most favourable demand point

5 Height of highest most favourable sprinkler, in bar X

Flow, in litres per minute (L/min)

Y Pressure, in bar

Figure C.2 **Blank template of a square law graduation graph**



Key

X Flow, in litres per minute (L/min)

Y Pressure, in bar

Annex D (normative) Pipework support

In the absence of manufacturers' instructions, sprinkler system pipework should be supported at the intervals given in Table D.1, Table D.2 or Table D.3 as appropriate for the material being used.

Table D.1 **Maximum spacing of fixings for copper and stainless steel pipework**

Nominal diameter	Horizontal run	Vertical run
mm	m	m
22	1.8	2.4
28	1.8	2.4
35	2.4	3.0
42	2.4	3.0
54	2.7	3.6
67	3.0	3.6

Table D.2 **Maximum spacing of fixings for steel pipework**

Nominal diameter	Horizontal run	Vertical run
mm	m	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 D.3 **Maximum spacing of fixings for CPVC pipework**

Nominal diameter	Horizontal run	Vertical run
mm	m	m
20	1.7	3.0
25	1.8	3.0
32	2.0	3.0
40	2.1	3.0
50	2.4	3.0
65	2.7	3.0
80	3.0	3.0

Annex E (informative) Hydraulic test

COMMENTARY ON ANNEX E

Before testing begins, the as-fitted design pressure and the design flow for the system at the test point need to be ascertained.

This is the pressure requirement of the most remote sprinkler head(s), plus the pressure loss due to elevation and the intervening pipework. Both these pieces of information can be obtained from the system designer as part of the hydraulic calculations for the system.

An example of a suitable test is as follows.

a) Connect the test rig to the sprinkler control drain and test point (see Figure E.1).

b) Connect a sufficient length of drain hose of at least equal internal bore to the end of the test rig, with the open end run to a suitable surface drain or receptacle. Ensure that the hose is as straight and level as practicably possible. Do not submerge the open end of the pipe.

c) Close valve B (see Figure E.1) and open all other valves.

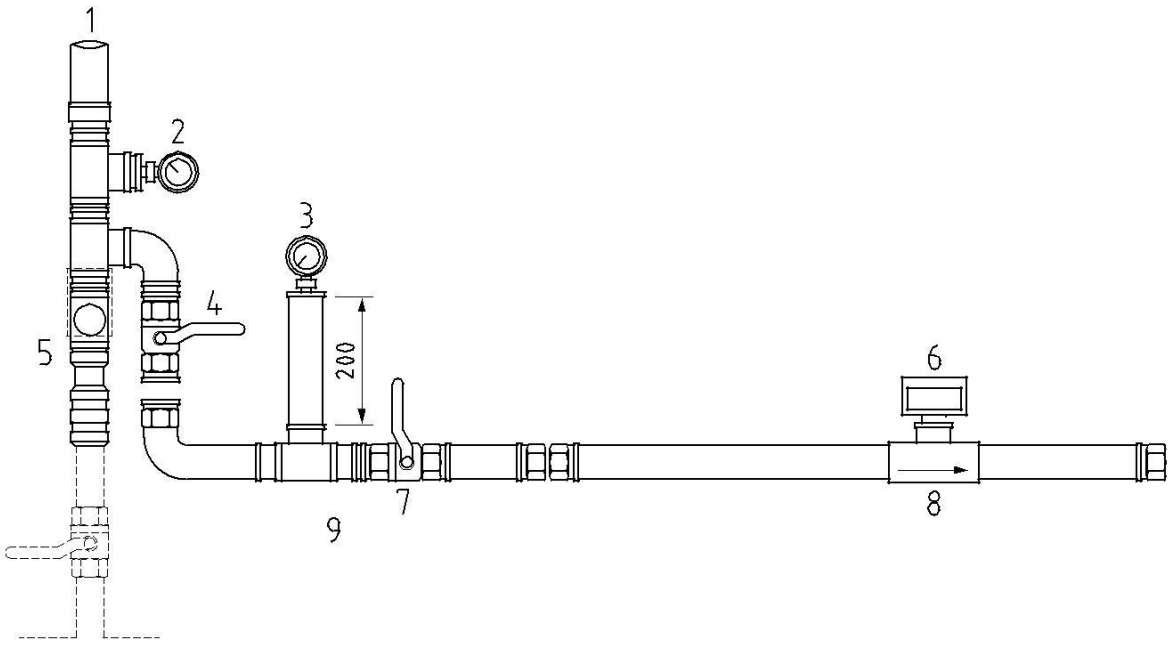
d) Slowly open valve B until the design pressure is registered on the pressure gauge B.

e) Run the system for not less than 1 min to allow residual pressures to dissipate.

f) Read off the flow on the flow gauge. If this flow equals or exceeds the design flow of the system then the system is deemed to have passed the test.

g) Record the result of the test in the system's log book.

Figure E.1 **Test rig for hydraulic test**



Key

1 Sprinkler system
2 Gauge A
3 Gauge B
4 Valve A
5 Valve set
6 Flow meter rig
7 Valve B
8 Flowmeter
9 Adaptor rig

Annex F (informative) Example of system data label

An example of a system data label is shown in Figure F.1.

Figure F.1 **Example of system data label**

Sprinkler system data	
Installed at:	*123 Main Street,* *Town,* *County,* *Postcode*
Installation date	*month/year*
Design specification	
Code of practice	*BS 9251:2014*
Category of system	*Category 1*
Hydraulic data	
Sprinklers operating	*2 No.*
Flow/pressure demand	*100 L/min @ 2.5 bar*
Installing contractor	
Name *Address* *Logo*	Contract Reference No. *AB1234*
Third party certification body, if appropriate	*Name*
Certificate URN	*CD5678*

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