Standard specifications, layouts and dimensions

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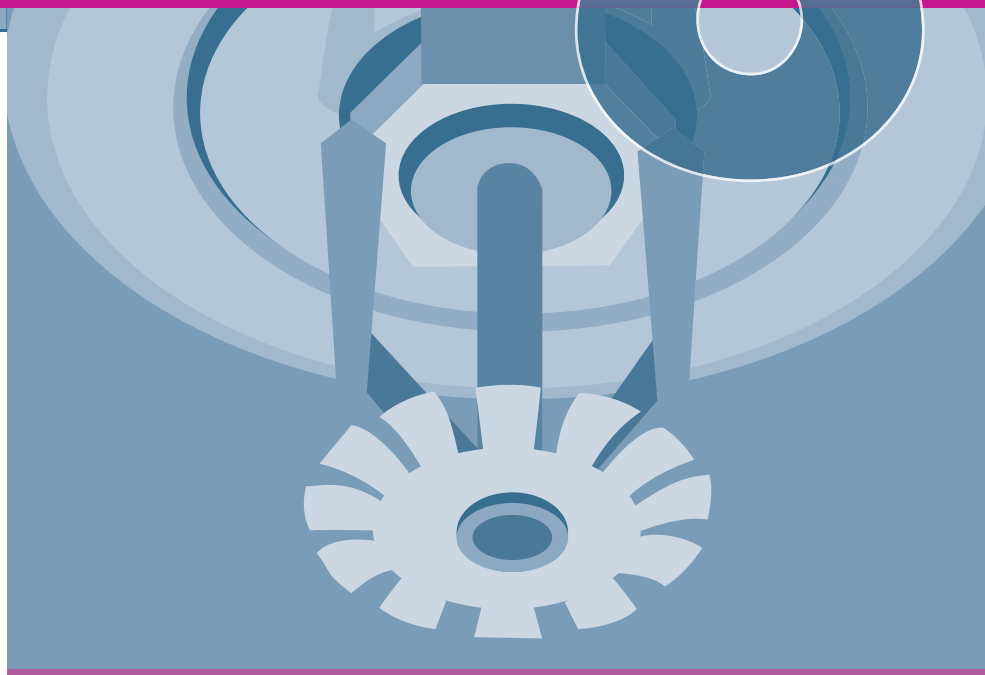

Sprinklers in schools

department for
children, schools and families

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Contents

Introduction

This guidance is one of a series of Standard Specifications, Layouts and Dimensions (SSLD) notes produced to inform the Building Schools for the Future (BSF) programme. The guidance in this document will also have direct application to other state-funded school buildings.

Policy on sprinklers in schools

Following the introduction of a new policy on sprinkler systems in March 2007, the Department for Children, Schools and Families (DCSF) now expects the majority of new state-funded schools to be fitted with sprinkler systems. However, the decision should be based on a risk analysis of the particular school concerned. To help clients, local authorities and design teams assess the level of risk and make the right decisions, DCSF has developed two new practical aids: a simple fire risk assessment tool to assess the need for sprinklers in the proposed school building; and a spreadsheet-based cost benefit analysis tool to help users decide whether sprinklers represent good value for money[1,2].

This document should be read in conjunction with DCSF's Building Bulletin 100 Design for fire safety in schools (BB 100)[3]. BB 100 shows how the requirements for life safety contained in the Building Regulations can be met in the design of a new or refurbished school. As well as covering life safety, BB 100 emphasises the importance of protecting school buildings from

1 DCSF, Risk assessment tool for fire precautions in schools, available on www.teachernet.gov.uk/fire

2 DCSF, Cost-benefit analysis for fire precautions in schools, available on www.teachernet.gov.uk/fire

3 DCSF, BB 100 Building Bulletin 100 Design for fire safety in schools, available on www.teachernet.gov.uk/fire

fire damage. It includes guidance on sprinklers, stressing their importance as a measure that can limit fire damage.

Who is this guidance for?

- Teachers and governors acting as clients for school capital projects.
- Local authority officers responsible for procuring school capital projects.
- Diocesan building officers.
- Local authority and private sector school designers and specifiers.
- Building control officers (or equivalent) and fire safety officers.
- Manufacturers and suppliers.
- Contractors.

How the guidance should be used

This guidance sets out the standards of performance for sprinkler systems for schools and shows through some examples how they might be delivered. It is one of a number of publications on various building elements within the SSLD series. The aim is to disseminate best practice and avoid 'reinventing the wheel' every time a school building is designed, so that consistently high quality environments can be delivered, offering best whole-life value for money.

School building clients, their professional advisers, contractors and their supply chains should use this guidance to inform their decisions on sprinkler systems.

To help encourage the take up of these performance specifications, this guidance will become the standard in BSF programme documentation and the Government will expect it to be adopted in the majority of situations where it is reasonable and appropriate to do so.

While we would expect projects to comply with the standards, other solutions – possibly based on new products or technologies, or reflecting local factors – may equally comply with the performance specification and could be used. We do not want to stifle innovation by being too prescriptive.

It will be for users to exercise their own skill and expertise in deciding whether a standard or example shown in this document is reasonable and appropriate for their own circumstances. This guidance does not affect obligations and liabilities under the law relating to construction and building.

Though principally aimed at secondary school building projects delivered through the BSF programme, the specifications and examples also apply to other educational buildings, for example, primary schools.

Background to Standard Specifications, Layouts and Dimensions (SSLD)

The BSF programme offers a unique opportunity over the next 10-15 years to transform our secondary schools, providing innovative learning environments that will inspire pupils to achieve more. High quality, modern school buildings will help to raise standards and play a crucial part in the Government's programme of educational reform.

With the huge increases in funding associated with this programme, there is considerable scope for using standardised specifications, layouts and dimensions to speed up design and construction, reduce whole-life costs and deliver consistently high quality and better value school buildings. Standardisation will support the use of more off-site fabrication and modern methods of construction, which should help to improve health and safety performance, reduce waste and deliver more sustainable solutions. For the supply industry, being involved in standardisation will help to demonstrate market leadership – and help firms reduce risk and increase sales, profitability, and market size.

The examples in this document and the others in the SSLD series have been developed based on extensive consultation under the auspices of the SSLD Forum. Set up by the Department for Children, Schools and Families (DCSF), this forum represents key stakeholders in the building design, research, contracting, and supply industry communities, as well as local authority construction client bodies. In addition, a specialist Steering Group has been involved with this sprinkler specification.

Aims and scope of this guidance

This document provides standard performance specifications for sprinkler systems in schools and some design examples.

It is structured as follows:

Section 2: The performance requirements for sprinkler systems in schools.

Section 3: Design examples for school sprinkler systems.

Section 4: References to relevant DCSF, sprinkler standards and other design guidance.

This specification is concerned with sprinklers for property protection and/or life safety purposes to meet any recommendations in BB 100 intended to satisfy the requirements of the Building Regulations.

Sprinkler systems can be property protection systems or life safety systems or both. The designer should decide which purpose they serve and specify this at an early stage in the project development. The purpose should be clarified at the earliest stage with the relevant authorities having jurisdiction.

At present, most schools require property protection sprinkler systems, which are used to meet insurers' requirements. More than 100 years of experience with property protection sprinkler systems have shown that they protect life as well as property. However, in recent years it has been felt beneficial to require an increased provision of assurance for life safety in achieving continuity of performance, largely in connection with water supplies, valves and the extent of available protection in certain circumstances.

Life safety systems have additional features, intended to increase the reliability of the system and its ongoing availability, and are used to meet Building Regulations' requirements or to meet requirements of the Regulatory Reform (Fire Safety) Order 2005.

Where sprinkler systems are selected as a compensatory feature to other fire protection systems in BB 100, life safety sprinkler systems should be used.

Definitions

For the purposes of this guidance, the following applies:

Area of operation: the maximum area over which it is assumed for design purposes that sprinklers will operate in a fire.

Arm pipe: a pipe less than 0.3 m long, other than a last section of a range pipe, feeding a single sprinkler.

Authorities having jurisdiction: the organisations responsible for approving sprinkler systems, equipment and procedures, e.g. the fire and building control bodies, the fire insurers, the local water authority or other appropriate public authorities.

Cavity barrier: for property protection purposes, a separating element which resists the passage of flame, smoke and/or heat for a period of 30 minutes.

Design density: the minimum density of discharge, in mm per minute of water, for which a sprinkler installation is designed, determined from the discharge of a specified group of sprinklers, in litres per minute, divided by the area covered, in m^2.

Distribution pipe: a pipe feeding either a range pipe directly or a single sprinkler on a non terminal range pipe more than 0.3 m long.

k factor: the sprinkler orifice coefficient.

Range pipe: a pipe feeding sprinklers directly or via arm pipes.

School: a place of education for children older than 2 and younger than 19 years. Includes nursery schools, primary schools and secondary schools as defined in the Education Act 1996.

Key performance requirements

UK fire statistics[4] show that fire deaths in schools are rare. From 1994 to 2002, only one person died in approximately 14,700 reported fires in schools. These statistics also show that the number of injuries in school fires is small. Note that 'injuries' in these fire statistics includes precautionary checks. From 1994 to 2002, 461 people were injured, an average of 51 per year. In 2002, there were 46 injuries, of which 19 were people referred to hospital for precautionary checks. These statistics indicate that the risk of injury or death from fires in schools is very low but the risk can never be eliminated.

Background

Currently, the main problem with fires in schools is property losses, which are large and rising. An analysis of large fires (involving a fatality and/or a loss greater than £100,000)[5] found that the total estimated fire damage reported by insurers was £46.9 million for 24 school fires in 2004. This is the direct loss of insurance claims; the true cost is higher than this as there will be associated losses that are hard to quantify, such as loss of education, loss of facilities, loss for the community.
See Cost comment, page 26.

To put the above into a context, schools have the greatest financial fire losses compared with other building occupancies[5]. In 2003 and 2004, educational fire losses were twice those of the next highest occupancy type, which is retail. In 2004, educational fire losses were 60 times those of office fires, the occupancy often referred to for benchmarking.

4 UK Fire Statistics, 1994-2002.

5 A Lewis, FPA Large Loss Analysis 2004, Fire Engineers Journal and Fire Prevention, February 2007.

Automatic fire sprinkler systems are a well established technology and have demonstrated their effectiveness in protecting life and property in industrial and commercial applications over many years. In the UK currently, sprinklers are increasingly being considered and installed in school buildings.

Sprinklers can be installed in schools for a number of reasons, including:

- property/asset protection to follow DCSF policy guidelines;
- property/asset protection to meet insurers' requirements;
- property/asset protection to preserve the continuity of education and facilities for the community;
- life safety recommendations intended to meet the Building Regulations;
- life safety, as an alternative solution to satisfy recommendations intended to meet the Building Regulations; and
- life safety, additional to the Building Regulations.

Automatic sprinkler systems are part of the overall package of fire safety measures in a school and should not be considered in isolation. For example, there would generally be a fire detection and alarm system installed and passive fire protection measures in place. A complex school building may also have a smoke and heat exhaust ventilation system.

Consideration of the costs of a sprinkler system in a cost benefit analysis does not simply include the costs of installation and provision of water supplies, but also includes the costs of inspection, testing and ongoing system maintenance.

The benefits of sprinklers in a cost benefit analysis include:

- reduced insurance premium;

and in the event of a fire:

- reduced risk of deaths and injuries;
- reduced property damage;
- reduced environmental impact;
- preservation of education and other facilities to the community; and
- reduced fire brigade costs.

If a sprinkler system is being proposed as an alternative solution, there may also be indirect cost reductions due to building design changes. See Sprinklers as a compensatory feature, page 25 and Cost comment, page 26.

School fire hazard scenarios

Examples of school fire hazard scenarios are:

- Accidental electrical fire due to faulty electrical equipment placed close to furniture, fabrics or papers in a classroom, causing a fire which then spreads.
- Deliberate ignition of school bags or notice boards and papers in a corridor, causing a fire which then spreads.
- External deliberate fire close to the exterior of a school building, spreading into the school. Examples of fire sources are wheelie bin rubbish, pallets, a vehicle, or vegetation. Note: fires external to the school are not a design scenario for a sprinkler system, see External fires, page 22.
- Accidental ignition of waste paper by an illicit smoker's smoking materials in washroom/toilet areas, causing a fire which then spreads.
- Accidental electrical overload causing ignition of combustibles in ceiling void or roof space, resulting in a fire which then spreads.
- Accidental fire involving a naked flame inside a laboratory.

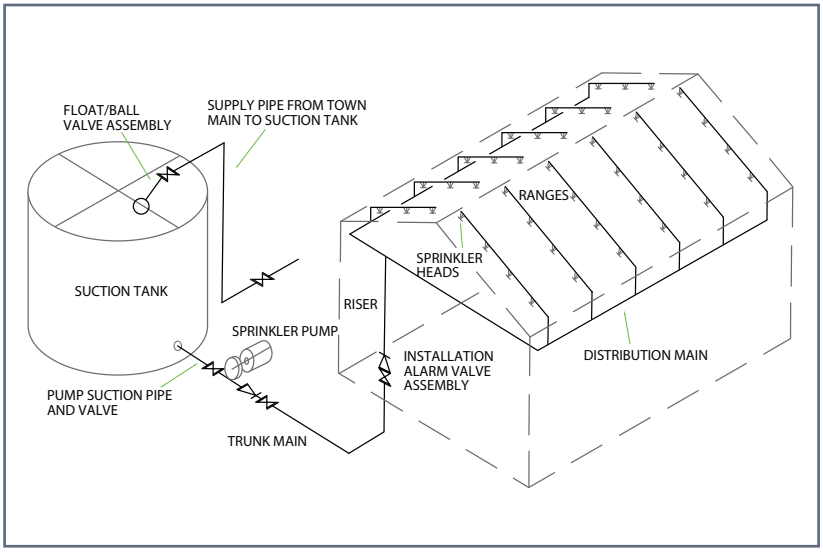
Description of sprinkler systems

A typical school sprinkler system consists of a water supply, valves, an alarm and an array of pipework (distribution and range pipes) fitted with individual sprinkler heads. The sprinkler heads are fitted at specific locations, normally at ceiling level and in concealed spaces.
The pipework is normally permanently filled with water and if the sprinkler system is for life safety purposes, it should be permanently charged with water.

The main purpose of an automatic fire sprinkler system is to provide water to suppress and control and, in some cases, extinguish a fire.

There are three stages to consider with sprinkler system performance in a fire:

- Detection of the fire.
- Operation of the system and raising the alarm.
- Fire suppression and control.



Schematic showing main elements of a sprinkler system

Detection of the fire

The sprinkler system detects the fire if there is a fire in the vicinity of a sprinkler head. Each sprinkler head has a heat sensitive device holding a sprinkler sealing assembly closed against the installation water pressure. The heat sensitive device is a fluid-filled glass bulb or a fusible link. This heat sensitive device will operate at a predetermined temperature when heated by the fire gases. The thermal response characteristics of the sprinkler head will determine when and under what conditions the sprinkler will operate. These characteristics are the sprinkler thermal response rating and nominal operating temperature. Sprinkler thermal response can be classified as quick, special, standard response A and standard response B[6].

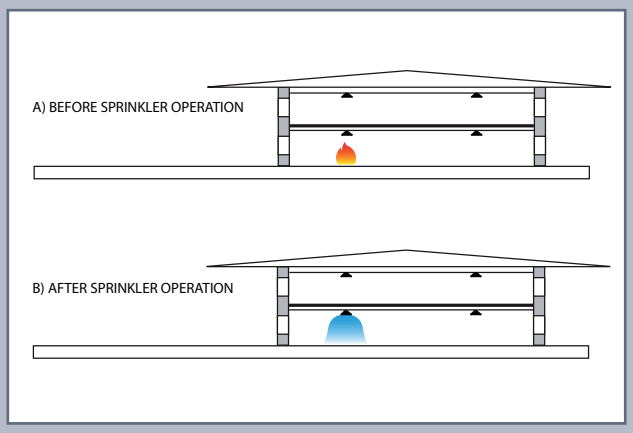
Operation of the system and raising the alarm

Sprinklers operate by the release of a sprinkler sealing assembly when the glass bulb shatters due to the expansion of the liquid or when the solder link has melted. Then a water flow is released and a spray is discharged onto the fire. The flow of water initiates an alarm. The number of sprinklers that operate in a fire will depend on a variety of factors, such as where the fire occurs, the nature of the burning materials and the severity of the fire. School sprinkler systems are designed so that only sprinkler heads in the vicinity of the fire are intended to operate.

Fire suppression and control

The sprinkler water spray should reduce the intensity and size of the fire and suppress and control it. In some cases, the fire may be extinguished. The characteristics of the water spray, combined with the sprinkler positioning and spacing, have been proved to suppress fires. The water spray inside a room will directly be involved in suppressing and controlling the fire, will wet surrounding combustible materials so they do not ignite, will wet surfaces to cool the building structure, will cool the smoky gases and reduce the likelihood of flashover.

The sprinkler spray characteristics are created by the design of the sprinkler head (the shape of the frame and deflector plate), the water flow rate, the bore size and the location of the head relative to the ceiling and other structures. A number of suppliers provide sprinkler head products, each with their own range of models.



Schematic showing sprinkler head operating to control the fire

6 British Standards Institution, BS EN 12259-1 Fixed firefighting systems, components for sprinkler and water spray systems Part 1 Sprinklers, 1999.

Approvals and certification

Sprinkler installers

It is important that sprinkler systems for schools are designed, installed and maintained by specialist sprinkler contractors who are suitably qualified and experienced to ensure the effective performance of the system in the event of a fire and to satisfy insurers and/or approving bodies.

Third party accreditation of installers of sprinkler systems provides a means of ensuring that installations have been conducted by knowledgeable contractors to appropriate standards, thereby increasing the reliability of the anticipated performance in fire.

Insurers usually require independent schemes of certification or accreditation of installers of automatic sprinkler systems for the purposes of property protection.

Building control bodies may accept the certification of the installation or maintenance of sprinkler systems as evidence of compliance with the relevant standard. Nonetheless, a building control body will wish to establish, in advance of the work, that any such scheme is adequate for the purposes of the Building Regulations.

In the UK, there are two third party certification schemes for sprinkler installers that are applicable to school buildings.

One is operated by the Loss Prevention Certification Board (LPCB) and known as the LPS 1048 scheme. Certificated installers are listed in the LPCB List of Approved Fire and Security Products and Services, known as the Red Book[7].

Under this scheme, a third party Certificate of Conformity is issued by the sprinkler contractor for each system installed. This certificate states that the sprinkler system complies with all the appropriate requirements of BS EN 12845 and, where applicable, lists details of any accepted minor departures. Major non compliances are not permitted.

The other is operated by Warrington Certification Limited and comes under the FIRAS certification scheme[8].

Sprinkler products

Components of sprinkler systems should be suitable for use to ensure the effective performance of the system in the event of a fire and to satisfy insurers and/or approving bodies.

Third party accredited sprinkler product conformity certification schemes not only provide a means of identifying sprinkler products which have demonstrated that they have the requisite performance in fire, but additionally provide confidence that the products actually supplied are provided to the same specification as that tested/assessed.

Insurers usually require sprinkler products which are approved and listed to a recognised and appropriate third party certification scheme and comply with appropriate British/European standards, where available, for the purposes of property protection.

Building control bodies may accept the certification of sprinkler products as evidence of compliance with the relevant British/European standards, where available.

7 The Loss Prevention Certification Board, List of Approved Fire and Security Products and Services, Red Book, BRE Global, available on www.redbooklive.com

8 FIRAS Scheme for Installers of Commercial and Industrial Sprinkler Systems, Warrington Certification Limited, available on www.firas-register.co.uk

Nonetheless, a building control body will wish to establish, in advance of the work, that any such scheme is adequate for the purposes of the Building Regulations.

In the UK, the Loss Prevention Certification Board (LPCB) operates various certification schemes for sprinkler products. Certificated sprinkler products are listed in the LPCB List of Approved Fire and Security Products and Services, (the 'Red Book'[9]).

Design, installation and maintenance of sprinklers in schools

Standards for sprinkler systems

Sprinkler systems should be designed, installed and maintained to a recognised standard to ensure the effective performance of the system in the event of a fire and to satisfy insurers and/or approving authorities.

In the UK, the recognised principal standards that are relevant to the design, installation and maintenance of sprinklers in schools are:

- British/European Standard BS EN 12845: Fixed firefighting systems – automatic sprinkler systems – Design, installation and maintenance[10].
- The LPC Sprinkler Rules, BS EN 12845 version[11] – these Rules are for property protection purposes and contain the text of BS EN 12845 and a series of Technical Bulletins, which amplify the requirements of the standard or cover additional requirements for insurers. BS EN 12845 in conjunction with Technical Bulletin TB 221, Sprinkler protection of schools[12] and other relevant Technical Bulletins contain insurers' requirements for sprinkler protection of schools.

Note: British Standard BS 5306 Part 2: Specification for sprinkler systems[13] became obsolescent in August 2007.

Where a sprinkler system is required to meet any recommendations in BB 100, it should be designed and installed in accordance with either:

- for property protection, the recommendations of LPC Sprinkler Rules, principally BS EN 12845 and all applicable Technical Bulletins, with particular reference to TB 221; or
- for life safety, the recommendations of BS EN 12845, including the relevant hazard classification, together with the special requirements for life safety systems in Annex F of BS EN 12845 and water supply requirements in Approved Document B[14].

Standards for sprinkler components

British/European standard BS EN 12259[15] is a series of companion standards to BS EN 12845 and covers requirements for components of sprinkler systems.

9 The Loss Prevention Certification Board, List of Approved Fire and Security Products and Services, Red Book, BRE Global, available on www.redbooklive.com

10 British Standards Institution, BS EN 12845, Fixed Firefighting systems – Automatic sprinkler systems – Design Installation and maintenance, 2004.

11 LPC rules for automatic sprinkler installations incorporating BS EN 12845, The Fire Protection Association.

12 Technical Bulletin TB 221: 2005: 1 Sprinkler protection of schools, The Fire Protection Association, 2005.

13 British Standards Institution, BS 5306 Part 2: Specification for sprinkler systems, 1990 (obsolescent).

14 Communities and Local Government, The Building Regulations 2000, Approved Document B, Fire Safety, volume 2 – buildings other than dwellinghouses, 2006 edition, available on www.planningportal.gov.uk

15 British Standards Institution, BS EN 12259 (various parts), Fixed firefighting systems, components for sprinkler and water spray systems.

Key elements

Fire protection and sprinklers need to be considered at an early stage of the design process so that the impact of different design choices on the design of fire protection/sprinkler systems can be considered.

The key elements that need to be considered for the design, installation and maintenance of school sprinklers are:

- Documentation.
- Extent of sprinkler protection (including permitted exceptions).
- Classification of occupancies and fire hazards (including protection of special hazards).
- Hydraulic design criteria (including design density and area of operation).
- Water supplies and type (including type of water supply).
- Pumps.
- Installation type and size.
- Spacing and location of sprinklers.
- Pipe sizing and layout.
- Sprinkler design characteristics and uses.
- Valves.
- Alarms and alarm devices.
- Pipework.
- Signs, notices and information.
- Commissioning and acceptance tests and periodic inspection (the importance of).
- Maintenance (regular).
- Special requirements for property protection.
- Special requirements for life safety systems.

Annex A contains a table relating these key elements to the clause number in BS EN 12845, Technical Bulletins, Recommendations, Briefing Notes and Guidance documents.

A full specification that covers all these aspects of design, installation and maintenance cannot be reproduced in this specification – the relevant standards and companion documents will need to be consulted. Instead, attention is drawn to selected key elements and where these can be found in the standards and/or companion documents, as follows.

Consultation and planning

Where a sprinkler system is being considered for a school, the following relevant authorities should be consulted at an early stage:

- The water supply company.
- The fire authority.
- The building control body.
- The insurer(s) of the school building and school building contents.

Other parties who also need to be involved when considering a sprinkler system for a school include:

- School building clients.
- Local authority officers responsible for procuring school capital projects.
- Local authority and private sector school designers and specifiers.
- Specialist sprinkler contractors who design and install the sprinkler system.

Details that influence the design and cost of the sprinkler system and that need to be provided by the specifier to the sprinkler contractor at an early stage include the following:

- Timeframe for the project.
- Details of the school building:
  - number of storeys;
  - dimensions of rooms, corridors and other spaces;
  - dimensions and details of concealed spaces: ceiling and floor voids; and roof spaces;
  - details of fire-resisting elements of construction; and
  - details of ceiling penetrations/obstructions;
- Purpose of system (whether life safety and/or property protection).
- Details of hazards and risks to be protected and any future changes.
- Details of sprinkler standard(s) to be used.
- Provision and route of water supply.
- Route of electrical supply.
- Any requirements for sprinkler head type(s), finishes and metal guards, flexible connectors.

Extent of sprinkler protection

Sprinkler protection should be provided throughout the building, so that if a fire starts at any location in the building it is suppressed and controlled and/or extinguished quickly and efficiently, preventing fire spread to other parts of the building. Optional permitted exceptions are:

- enclosed staircases and enclosed vertical shafts (i.e. which cannot contain combustible materials);
- selected concealed spaces, see Void sprinkler protection, page 22;
- rooms protected by other automatic extinguishing systems (designed, installed and maintained to recognised British/European standards);
- rooms containing electric power distribution apparatus such as switchgear and transformers; **Note:** If sprinkler protection is omitted, then the walls, ceiling and floors should have at least 120 minutes of fire resistance or an alternative fire suppression system.
- rooms containing industrial/laboratory processes where water discharge might present a hazard;
- communicating buildings or storeys separated from the sprinklered building by walls of appropriate fire resistance. See BB 100 Appendix A, TB 206 and TB 221; and
- outbuildings separated from the sprinklered building by at least 10 m, such as sheds.

Ideally, outbuildings that are school buildings should be sprinkler protected.

All exceptions to sprinkler protection should be agreed with the insurer and other authorities having jurisdiction.

The exact details of the permitted exceptions are given in BS EN 12845 and TB 221.

Classification of occupancies and fire hazards

Sprinkler systems are designed to provide an appropriate level of protection for the occupancy and the hazard. In BS EN 12845, occupancies are classified in hazard groups, 'Light' (LH), 'Ordinary' (OH) and 'High' (HH). OH and HH are subdivided into groups. For example, OH is divided into OH1, OH2, OH3 and OH4. The hazard classification takes into account the properties, dimensions, arrangements, quantities and locations of combustible materials that are likely to be found in schools and the expected rate of growth of the fire in the early stages.

A fire hazard review should be carried out a) to identify all the fire hazards that could be present in the school, including any special hazards and b) to determine the appropriate hazard classification of the school for the sprinkler design.

The sprinkler fire hazard classification is the responsibility of the specifier for the development of the sprinkler system tender documentation. This classification should be carried out by a suitably qualified person.

The sprinkler fire hazard classification should be confirmed with the relevant authorities having jurisdiction at the earliest stage, for example, to meet insurers' requirements.

In BS EN 12845 section 6.2 and Annex A, schools are classified as:

- LH: for schools with low fire loads and low combustibility and with no single compartment greater than 126 m^2 with a fire resistance of at least 30 minutes.
- OH1: for schools with combustible materials and a medium fire load and medium combustibility.

Technical Bulletin TB 221 states that schools should be classified as at least OH1 and not LH.

For sprinklers for property protection and life safety purposes, schools should be classified as at least OH1.

The fire hazard review will determine whether a higher hazard category should be applied.

The fire hazard review will also determine whether there are any special hazards that need separate consideration.

For OH1 systems, it is generally assumed that a fire will be controlled by six sprinkler heads or less. The standard specification for OH1 is:

- Area per sprinkler = 12 m^2 maximum.
- Area of operation = 72 m^2 maximum.
- Design density = 5 mm/min minimum, i.e. 5 litres per m^2 per minute over a specific proportion of the area of operation.

Hazard classifications higher than OH1 may be required if the area of operation (and therefore a water supply limited to six sprinkler heads) could be exceeded.

The minimum requirements for design density and areas of operation for LH, OH1, OH2, OH3 and OH4 for wet systems are shown in the following table.

Hazard class	Design density* (mm/min)	Area of operation (m^2)
LH	2.25	84
OH1	5	72
OH2	5	144
OH3	5	216
OH4	5	360

*for a specific proportion of the area of operation

For tall and large spaces, there may be fire scenarios where more than six sprinkler heads could operate, because:

- the increased height introduces a time delay for sprinkler operation (and hence larger fires can develop);
- the increased height reduces the efficiency of the water delivery; and
- large plan areas increase the number of sprinklers that will be exposed to the fire gases (and potentially more sprinklers could operate).

For spaces with multiple uses, events such as clothes sales and theatre productions can introduce a large quantity of combustibles and have the potential for large fires.

Method of determining correct hazard classification

The hazard classification can be determined using the following steps:

1. For each room in a school building:
   - use the table overleaf to identify the room type (and size where applicable); and
   - use the table overleaf to determine the appropriate hazard classification for that room and tick the appropriate cell.

Where a room type could have a range of possible hazard groups, the hazard group should be determined by a suitably qualified person.

2. Once the hazard classifications for all the rooms in the school building have been determined, find the overall appropriate hazard classification for the building (which will be the highest hazard reached for any of the rooms), i.e. the column that the furthermost right hand tick is in.

3. Repeat this for all the school buildings.

Rooms	Hazard Group				Notes
	OH1	OH2	OH3	OH4	
Classrooms and seminar rooms					OH1
Basic teaching rooms for: ICT, general teaching, practical work, design and technology, art, music, drama					OH1 when the fire load is typical of a basic teaching room. OH2 should be considered for rooms that are > 72 m^2 and < 144 m^2 and contain fire loads comparable to commercial laboratories, photographic film rooms, broadcasting studios, museum, cinema, theatre, concert hall or department stores.
Learning resources areas					OH1
Libraries					OH1 when the fire load and book/shelf layout are typical of a library. OH2 should be considered for libraries that are > 72 m^2 and < 144 m^2 and contain a fire load and book/shelf layout comparable to a book store. OH3 should be considered for libraries that are > 144 m^2 and contain a fire load and book/shelf layout comparable to a book store.
Halls: main, sports, activity studio					OH1 when: • the storage of combustible equipment, e.g. foam mats, is in a separate dedicated store room; and • in halls of multiple use, additional fire protection measures may be required to address the property protection and life safety fire hazards presented by particular events such as sales, which can introduce a large quantity of combustibles and have the potential for large fires. OH2 should be considered for halls of multiple use, that are > 72 m^2 and < 144 m^2 containing fire loads similar to those found in a cinema, theatre, concert hall, department store, commercial book store, museum. OH3 should be considered for halls of multiple use that are > 144 m^2 and < 216 m^2 containing fire loads similar to those found in a cinema, theatre, concert hall, department store, commercial book store. OH4 should be considered for halls of multiple use that are > 216 m^2 containing fire loads comparable to a cinema, theatre or concert hall.
Theatre					OH1 when the fire load is typical of other areas of the school and the stage is small. OH4 should be considered for theatres that have stages where there is a safety curtain between the stage and auditorium – see BS EN 12845 Annex F.

Staff and administration rooms					OH1
Storage (teaching and non-teaching)					Storage hazard classification needs to be in accordance with BS EN 12845, which accounts for height, material, and shelving. In addition: OH1 when the room size is less than 72 m^2. OH2 should be considered for store rooms that are > 72 m^2 and < 144 m^2. OH3 should be considered for store rooms that are > 144 m^2 and < 216 m^2. OH4 should be considered for store rooms that are > 216 m^2.
Dining and social areas					OH1
Kitchens (and stores)					OH1
Toilets (and personal care)					OH1 when they can be used to store combustible materials. These may be optional permitted exceptions – see Extent of sprinkler protection, page 13.
Circulation and corridors					OH1
Stair enclosure					OH1 when they can be used to store combustible materials. These may be optional permitted exceptions – see Extent of sprinkler protection, page 13.
Cloakroom					OH1
Plant rooms					OH1 when the room size is < 72 m^2. OH2 should be considered for plant rooms that are > 72 m^2 and < 144 m^2. OH3 should be considered for plant rooms that are > 144 m^2.
Chemical store					OH1 when the room size is < 72 m^2. OH2 should be considered for chemical stores that are > 72 m^2. and < 144 m^2. OH3 should be considered for chemical stores that are > 144 m^2.
Swimming pool					OH1 when it cannot be used as a dual purpose space. For swimming pools that can be used as a dual purpose space, e.g. covering the pool and using the space for another use, the hazard group will be that of the relevant room type.
Sleeping accommodation					OH1

Water supplies

Sprinkler system water supplies should be reliable and provide sufficient flow and pressure to satisfy the system design requirements.

At the earliest stage, prior to selection of the water supply, the town main at the site should be performance tested to determine its pressure and flow characteristics and the minimum available pressure. This could occur at peak demand or at night when pressure levels are reduced.

The results of the performance test will determine whether the town main can be used as a water supply for the sprinkler system.

If the town main is used as a water supply, regular maintenance will include further performance tests to check the pressure and flow characteristics and the minimum available pressure.

The sprinkler system should fully comply with the Water Regulations and permission for a water supply connection to the sprinkler system should be sought from the relevant water supply company.

A number of types of water supplies can be used for school sprinkler systems.

Water supplies for property protection

Water supplies for sprinklers for property protection are detailed in BS EN 12845, TB 221 and TB 224[16]. These should be:

- Single town main complying with BS EN 12845 clause 9.2.1.
- Single automatic suction pump drawing from a water source, i.e. pump suction tank, gravity tank or reservoir, complying with BS EN 12845 clause 9.3.
- Single automatic booster pump, drawing water from a town main complying with BS EN 12845 clause 9.2.2.
- Technical Bulletin TB 221 introduces the additional option of using a reduced water supply duration for OH1 sprinkler systems, i.e. 30 minutes reduced from 60 minutes. These sprinkler systems require automatic transmission of fire and fault alarms to a central station for alarm signalling, approved by LPCB or equivalent and assumes fire brigade attendance times being appropriate to the level of risk. This option can result in reduced: tank size, tank housing size and groundworks for the tank. Where the hazard exceeds OH1, this option should not be used.

A fire brigade inlet should be provided for all stored water applications.

Hydrant water supplies are for fire brigade use and need manual intervention. Sprinkler systems need to be automatic and self contained.

Sprinkler system water supplies should be separate from hydrant supplies, hose reels and risers.

For further information on pumps, see BS EN 12845 clause 10 and TB 210[17]. For power supplies for sprinkler pumps, see TB 220[18] and TB 210.

16 Technical Bulletin TB 224: 2005: 1 Sprinkler water storage tanks (cisterns), The Fire Protection Association, 2005.
17 Technical Bulletin TB 210: 2007: 1 Automatic sprinkler pump installation, The Fire Protection Association, 2007.
18 Technical Bulletin TB 220: 2004: 1 Power supplies for sprinkler pumps, The Fire Protection Association, 2004, until September 2008.

Photograph showing external tank and pump house

Photograph showing the electric pump and valve set inside the pump house

Water supplies for life safety

For systems designed and installed to BS EN 12845, water supplies for sprinkler systems for life safety for non-residential applications, including schools, are detailed in Approved Document B Volume 2, section 018 b)[19]. These should consist of either:

- two single water supplies complying with BS EN 12845, clause 9.6.1, where each is independent of the other; or
- two stored water supplies, where:
  - gravity or suction tanks should satisfy all the requirements of BS EN 12845 clause 9.6.2 b) other than capacity; and
  - any pump arrangements should comply with BS EN 12845 clause 10.2; and
  - the capacity of each tank is equivalent to half the specified minimum water volume of a single full capacity tank, appropriate to the hazard; or
  - one tank should be at least equivalent to half the specified water volume of a single full capacity tank and the other should not be less than the minimum volume of a reduced capacity tank BS EN 12845 clause 9.3.4, appropriate to the hazard; and

    Note 1: The requirement for inflow should be met.

    Note 2: Where two half capacity tanks are being used, as stated in third and fourth dashed bullet point above, it is normally accepted practice for the two 'half tanks' to be formed as two sections of a single tank. The relevant authorities having jurisdiction should be consulted for agreement.

  - whichever water storage arrangement is used at third and fourth dashed bullet point above, the total 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 complying with BS EN 12845, Table 9, Table 10 or clause 9.3.2.3, as appropriate, to the hazard and pipework design.

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

19 Communities and Local Government, The Building Regulations 2000, Approved Document B, Fire Safety, volume 2 – buildings other than dwellinghouses, 2006 edition, available on www.planningportal.gov.uk

The sprinkler water supplies should generally not be used as connections for other services or other fixed firefighting systems.

Duplicate pumps can be one electric pump using mains power from a public electricity supply and one diesel pump. Two electric pumps can be used provided their power supplies are independent of each other, for example, one using mains power and the other using power from an onsite diesel generator.

For further information on pumps, see BS EN 12845 clause 10, TB 210 and TB 220.

Sprinkler system type

For property protection and life safety, sprinkler systems should be of the wet pipe type, i.e. a system in which the pipework is always charged with water, provided the system is adequately protected from freezing. See Frost protection, page 24.

A) PENDENT, QUICK RESPONSE, 68°C, SPRAY SPRINKLER

A) PENDENT, CONCEALED SPRINKLER

Photographs showing different sprinkler heads

Sprinkler design characteristics and applications

Sprinklers should detect the fire and operate at an early stage.

Thermal sensitivities of sprinklers used in schools for property protection should be 'quick', 'special' or 'standard'. Unrated sprinkler heads, such as concealed and recessed, can be used if they have a 'quick' temperature sensitive element. See BS EN 12845, BS EN 12259-1[20] and TB 207[21].

Thermal sensitivities of sprinklers for life safety should be 'quick' response, except for rooms less than 500 m^2 and less than 5 m high, where standard 'A' and special response can be used. Concealed and recessed sprinklers should not be used for life safety applications as they are currently thermal sensitivity unrated.

Sprinkler patterns can be selected for design characteristics that produce water sprays that will be suitable for different applications.

BS EN 12845 and TB 221 detail the selection of sprinkler head types covered by EN 12259-1 or BS DD 252[22] suitable for different applications in the school building.

The types of sprinkler patterns should be used for different applications, as follows:

- Spray, ceiling or flush pattern sprinklers with a k factor of 80 can be used for general room protection.
- Spray pattern sprinklers with a k factor of 80 can also be used for protection of floor, ceiling or roof spaces > 2.4 m high.

20 British Standards Institution, BS EN 12259-1 Fixed firefighting systems, components for sprinkler and water spray systems Part 1 Sprinklers, 1999.

21 Technical Bulletin TB 207: 2005: 1 The selection of sprinkler heads, The Fire Protection Association, 2005.

22 British Standards Institution, BS DD 252, Draft for Development Components for residential sprinkler systems – specification and test methods for residential sprinklers, 2002 (under revision).

- Ceiling or flush pattern sprinklers with a k factor of 80 are not suitable for the protection of floor, ceiling or roof spaces.
- Sidewall pattern sprinklers with a k factor of 80 can be used in corridors, passageways or narrow rooms.
- Conventional pattern sprinklers can be used to protect floor, ceiling or roof spaces not exceeding 2.4 m in height.
- Residential sprinklers described in BS DD 252 can be used in small rooms not requiring more than two sprinklers where life safety is a consideration. These should be installed in accordance with the manufacturer's data sheet but should comply with the requirements of BS EN 12845 as a minimum. Where residential sprinklers are used, the design criteria should meet the requirements of BS EN 12845 Table 3 OH hazard class. **Note:** Residential sprinklers should not be used at LH design densities or in HH class applications.

However, it is also important that sprinklers are not damaged or deliberately operated when there is no fire.

In addition:

- Where the sprinkler patterns above may be subject to accidental mechanical damage, they should be fitted with a metal guard.
- Where exposed sprinklers could be subject to accidental damage or tampering, recessed pattern sprinklers with a k factor of 80 can be used for general room protection.
- Where it is considered essential to conceal the presence of sprinklers from school occupants, concealed pattern sprinklers with a k factor of 80 can be used for general room protection.
- Concealed and recessed pattern sprinklers should not be used for the protection of floor, ceiling or roof spaces.

Maintenance

A sprinkler system should be regularly serviced, maintained and periodically inspected so that it will work properly in the event of a fire.

Sprinkler systems have an extensive service, maintenance and inspection programme covering the whole of their design life, including weekly, monthly, quarterly, yearly, three-yearly, up to ten-yearly checks and tests.

Regular service and maintenance should be carried out in accordance with BS EN 12845 and Technical Bulletin TB 203[23] by a sprinkler contractor for all but the monthly and weekly checks.

Special requirements for life safety systems

Special requirements for life safety sprinkler systems are contained in BS EN 12845 Annex F and Approved Document B. BS EN 12845 requires:

- increase in number of zones;
- system type to be wet type;
- quick response sprinkler heads (except for rooms < 500 m^2 in area and < 5 m high, where standard 'A' and special response can be used);

23 Technical Bulletin TB 203: 2004: 1 Care and maintenance of automatic sprinkler systems, The Fire Protection Association, 2004.

- duplicate control valve sets;
- at least one superior single water supply;
- specific requirements for theatres that have stages where there is a safety curtain between the stage and auditorium; and
- additional precautions for maintenance.

Approved Document B includes the life safety requirements for sprinkler water supplies.
See Water supplies for life safety, page 19.

Special considerations

External fires

External fires are not design scenarios within the sprinkler standards. Prevention and protection from these fires should be dealt with by housekeeping measures to prevent accumulation of combustibles outside and close to the school buildings and additional external passive fire protection measures for property protection purposes. See BB 100.

Water-based systems, not sprinklers, for example, drenchers and window 'sprinklers', are available and could be applied but a number of practical issues would need to be addressed. Practical issues include: adequate exposure of heat sensing element to flames for system activation, adequate water delivery to all of the exposed areas of the school façade that need to be protected, extent of area of façade to be protected, and frost protection of the water delivery system. These systems are not covered by standards and technical evidence should be provided to prove these are fit for their intended purpose.

Void sprinkler protection

The height of a concealed space (for example, ceiling and floor voids and roof spaces) and the contents of the concealed space in a school building will affect the extent of sprinkler protection required.

Custom and practice in the UK is different from the requirements in BS EN 12845.

Technical Bulletin TB 230[24] is in consultation. This will allow some unsprinklered floor and ceiling voids over 0.8m, if they are of non-combustible construction and contain no combustible materials, or contain electrical cables with a voltage less than or equal to 250 volts, with a low load for normal lighting or a voltage greater than 250 volts, enclosed within steel conduits or mineral insulated cable.

Void sprinkler protection should be in compliance with TB 230 (in consultation).

Sprinkler protection is required for:

- roof spaces that are greater than 0.8 m in height; or
- roof spaces and concealed spaces between floors that are 0.8 m or less in height and greater than 250 m^2 in area and are formed of combustible construction or contain combustible materials; or
- concealed spaces between floors that are between 0.8 m and 2 m in height and have some combustible construction or contain combustible materials; or
- concealed spaces between floors that are greater than 2 m in height.

24 Technical Bulletin TB 230 2007: 1 Protection of floor voids, ceiling voids and roof spaces, The Fire Protection Association (in consultation).

Sprinkler protection is not required for:

- roof spaces and concealed spaces between floors that are 0.8 m or less in height and wholly of non-combustible construction and contain no combustible materials; or
- roof spaces and concealed spaces between floors that are 0.8 m or less in height, which are formed of combustible construction or contain combustible materials where there are vertical cavity barriers installed enclosing areas 250 m^2 or less; or
- concealed spaces between floors that are between 0.8 m and 2 m in height and wholly of non-combustible construction and contain no combustible materials; or
- concealed spaces between floors that are between 0.8 m and 2 m in height and wholly of non-combustible construction and contain electrical wiring with a voltage less than 250 volts with a low load for normal lighting; or
- concealed spaces between floors that are between 0.8 m and 2 m in height and wholly of non-combustible construction and contain electrical wiring with a voltage greater than 250 volts enclosed within steel conduits or if mineral insulated cable is used.

The selection of the sprinkler head type for use in concealed spaces is important. See Sprinkler design characteristics and applications, page 20.

Sprinkler protection of atria

Atrium spaces require sprinkler protection. New schools may include tall (>10 m) glazed atria that may need non-standard sprinkler protection. These systems are not covered by standards, and technical evidence should be provided to prove they are fit for their intended purpose.

Sprinkler protection of theatres

School theatres should be sprinkler protected. An appropriate hazard classification category should be selected. See Classification of occupancies and fire hazards, page 14.

Sprinkler protection of sleeping accommodation

Some schools include sleeping accommodation. Sleeping accommodation areas or buildings as part of a school should be sprinkler protected. Residential sprinklers can be used in conjunction with the design requirements of BS EN 12845. See Sprinkler design characteristics and applications, sixth bullet point, page 21.

Protection from legionella

Legionnaires' disease is a form of pneumonia that can be contracted by inhaling water droplets or aerosols containing bacteria from the genus legionella. Legionella grows in tepid stagnant oxygenated water with a supply of nutrients. For human infection to occur from a sprinkler system, any legionella present in the system would have to grow to an infectious level, be present in an aerosol and be inhaled by a susceptible individual.

The risk of being infected by legionella from a properly installed and maintained sprinkler system is negligible. The likelihood of being exposed to legionella from a discharging sprinkler during a fire or from a sprinkler system supplied from the town main is equally small. The likelihood of a school employee being exposed to legionella during maintenance/testing work involving sprinklers is very small, although there is a slightly higher risk in the case of sprinkler contractors who have to remove sprinkler heads supplied by poorly maintained private water tanks.

The Technical Briefing Note in the LPC Sprinkler Rules on legionella and firefighting systems[25] gives further information on this subject and recommends control measures.

All water supplies and pipework should be protected from legionella.

Frost protection

Water leakage and burst pipes could occur if water in the sprinkler system freezes, causing water damage and/or an ineffective sprinkler system.

All water supplies and pipework should be adequately protected from freezing. See BS EN 12845, Technical Bulletin TB 221 and Recommendations RC38[26].

Trace heating systems or a subsidiary dry pipe or alternate extension can be used in areas where there is a possibility of freezing.

Trace heating systems should be in accordance with BS EN 12845 clause 11.1.2.2.

Subsidiary dry pipe and alternate extensions should be in accordance with BS EN 12845 clause 11.5 and limited to ten sprinklers on any subsidiary extension.

Security

Security measures should be taken to prevent tampering with components of a sprinkler system that would isolate the water supply from the rest of the sprinkler system, including:

- The control valves and any pump sets should be located in a secure location.
- Each stop valve should be provided with a tamper-proof device to monitor its status. Each of the monitoring devices should be electrically connected to a control and indicating panel, installed at an accessible location on the school premises.
- Signs for the sprinkler stop valve and the sprinkler control valves may be omitted, provided the fire authority agrees.

Use of specialised sprinkler types

Specialised sprinkler types that are not yet included in BS EN 12845 or BS EN 12259-1 may be suitable for use in sprinkler systems for school applications. Technical evidence should be provided to prove these are fit for their intended purpose and should be confirmed with the relevant authorities having jurisdiction at the earliest stage.

One example is the EPEC (Enhanced Protection Extended Coverage) sprinkler. See Technical Bulletins TB 222[27] and TB 223[28].

25 Technical Briefing Note Legionella and firefighting systems, The Fire Protection Association.

26 Loss Prevention Recommendations RC38: Recommendations for frost protection measures for sprinklers, The Fire Protection Association.

27 Technical Bulletin TB 222: 2004: 2 Ordinary Hazard Group 3 protection using enhanced protection extended coverage sprinklers, The Fire Protection Association, 2004.

28 Technical Bulletin TB 223: 2004: 2 Sprinkler protection of concealed spaces in OH3 EPEC sprinklered buildings, The Fire Protection Association, 2004.

Use of plastic pipe

Plastic pipe is not specified in BS EN 12845. There are a number of types of plastic, all with their own properties. Plastic pipe seems an attractive alternative to metallic pipe where cleanliness and/or ease of installation are important. However, there are several issues with plastic pipe that restrict its use. For example, plastic pipe can weaken after prolonged exposure to sunlight, can deform or melt on exposure to heat, is less rigid than metallic pipe and needs more support, and cementing of joints needs sufficient curing time to prevent water leakage and/or a weakening of the structure. Therefore, care and caution are needed to ensure that a particular type of plastic pipe is suitable and only used in appropriate circumstances as part of a school sprinkler system.

Plastic pipework should not be painted unless the paint is stated to be suitable for use by the manufacturer.

When plastic pipe is used in sprinkler installations in schools it should be approved to LPS 1260 (under revision)[29] or equivalent and should be installed in accordance with TB 211[30] and TB 227[31].

The use of exposed and unprotected plastic pipe is not allowed.

Use of flexible connectors

One type of flexible connector connects a range pipe to a single sprinkler. This type of flexible connector, unlike rigid pipe, has a susceptibility to deformation and kinking, which would detrimentally affect system performance, so caution and care are needed in its installation and continued use.

Any flexible connectors connecting range pipes to single sprinklers should be approved to LPS 1261 (under revision)[32] or equivalent and installed in accordance with all the requirements of TB 227[33].

Use of unusual materials

Whenever unusual materials or designs are used, for example, ETFE for roofs, a fire engineering solution should be used. See BB 100. It should be determined that the material, for example, ETFE, does not detrimentally affect the performance of the sprinkler system when exposed to a fire.

Sprinklers as a compensatory feature

For a sprinkler system being proposed as a compensatory feature to other fire protection systems to meet the requirements of the Building Regulations or other Regulatory requirements, see BB 100.

29 Loss Prevention Certification Board, LPS 1260 Requirements for testing plastic pipes for sprinkler systems, BRE Global, available on www.redbooklive.com (under revision).

30 Technical Bulletin TB 211: 2004: 1 CPVC plastic pipe, The Fire Protection Association, 2004.

31 Technical Bulletin TB 227: 2006: 1 Pipework, The Fire Protection Association, 2006.

32 Loss Prevention Certification Board, LPS 1261 Requirements for testing flexible hoses for sprinkler systems, BRE Global, available on www.redbooklive.com (under revision).

33 Technical Bulletin TB 227: 2006: 1 Pipework, The Fire Protection Association, 2006.

Cost comment

The cost figures in this section have been taken from recent work by EC Harris for DCSF[34]. These figures were adjusted by EC Harris to the third quarter of 2006.

Capital costs

The capital cost of a new sprinkler system in a secondary school ranges between 1.7% and 3.0% of the total construction cost (in a primary school ranges between 1.4% and 4.5%).

The capital cost ranges from £23/m^2 to £37/m^2 for secondary schools (£29/m^2 to £68/m^2 for primary schools)[35]. These figures include the total sprinkler construction costs and the additional associated works but do not include professional fees. The design details that influence the cost variability the most are water supplies (see Water supplies, page 18) and ceiling void sprinkler protection (see Void sprinkler protection, page 22).

The addition of sprinklers during a school refurbishment can be significantly more expensive than for a new school. To date, there have been a few cases where refurbishments have been undertaken which have involved installing sprinkler protection. The total costs could be more than 50% higher than for a new building.

Capital cost savings are a possibility with the addition of a sprinkler system as a compensatory feature. Consideration can be given to other fire protection provisions, such as structural fire resistance and compartment sizes. See BB 100 and BS DD 9999[36] for further details.

Whole-life costs

It is important to consider whole-life costs of sprinkler systems rather than capital costs alone.

Sprinkler systems have an extensive service, maintenance and inspection programme covering the whole of their design life. Typically, a well maintained sprinkler system will still be available for operation in 50 years.

The annual cost associated with regular servicing, maintenance and inspection of the sprinkler system is approximately £1,100. This comprises internal and external costs. Annual indicative internal costs are £180 for inspection and checking work by a trained school caretaker. Annual indicative external costs are £180 for off-site sprinkler alarm monitoring, £500 for six-monthly sprinkler contractor maintenance, £120 for water costs and up to £120 for fuel costs.

The fire insurance costs that need to be considered are the premium and the deductible (excess). The fire insurance premium costs are likely to be reduced if a school is sprinklered. This reduced premium reflects the improved property protection afforded by the sprinkler system. Also, the insurance deductible (excess) for an unsprinklered school can typically be £100,000 based on a school valued at £10,500,000 for insurance purposes, in an insurance application for a group of schools. This excess is likely to be reduced or removed for a sprinklered school.

34 EC Harris LLP, A cost analysis of sprinklers in schools, report prepared for DCSF, January 2007, available on www.teachernet.gov.uk/fire

35 All costs at third quarter 2006 prices.

36 British Standards Institution, DD 9999 Draft for Development Code of Practice for fire safety in the design, construction and use of buildings, 2005 (under revision).

However, each case is considered on its merits and any fire insurance cost savings will include an appraisal of a) the number of sprinklered schools in the group of schools and b) for the individual school, the incidence of fire, environment and buildings, fire safety and fire protection measures, consequences and impact of fire. See[37,38] for further details.

In unsprinklered schools, there have been cases where a large fire has completely destroyed a large part of the school and this has led to displaced education and a re-build programme. The many associated losses that are not covered by insurance are hard to quantify and include:

- the loss of education (loss of coursework, teaching materials, etc), loss of specialised facilities (hall, sports, music/drama, laboratories), time wasted travelling to alternative sites, head teacher and staff distracted from key roles, time wasted in planning temporary accommodation, planning rebuilding, re-scheduling lessons, etc);
- a loss of facilities (temporary accommodation may not be suitable for all activities, problems with site planning/access, planning permission required and this may be time-consuming, vulnerability to arson attack);
- loss for the community (stigma due to arson, teacher morale, loss of community facility (e.g. sports halls), blow to area regeneration efforts); and
- associated logistical problems.

In contrast, the indirect benefit of a sprinkler system in a school is that there is the opportunity for quick reinstatement of the school following a potentially large fire incident, perhaps achieved in a few days.

Detailed cost benefit calculations for installing a sprinkler system in a particular school can be performed using the DCSF CBA tool[38].

37 DCSF, Risk assessment tool for fire precautions in schools, available on www.teachernet.gov.uk/fire
38 DCSF, Cost-benefit analysis for fire precautions in schools, available on www.teachernet.gov.uk/fire

Design examples

The following design examples show typical design arrangements in parts of a sprinkler system. It is for those involved to decide what would be the most appropriate final design solution for their particular situation.

Examples 1, 2 and 3 illustrate different sprinkler/ceiling arrangements.

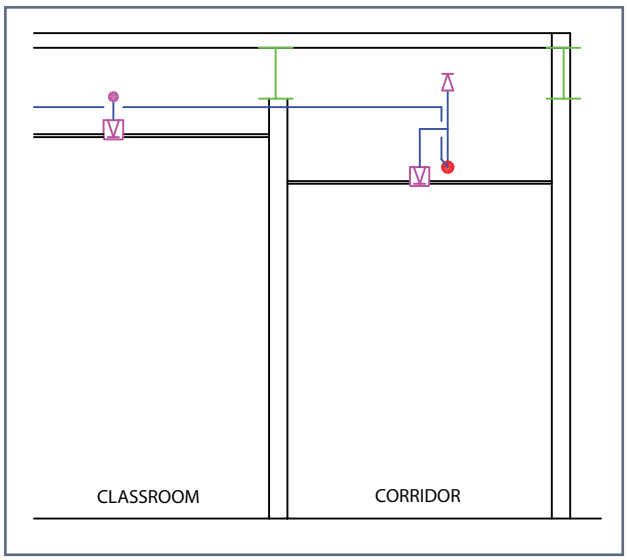
Examples 4, 5 and 6 illustrate different types of water supplies.

Example 1 Sprinklers to protect classroom and corridor for property protection

Sprinklers are installed at ceiling level to protect the classroom and corridor and in the void above the corridor. The ceilings in both cases are constructed from non-combustible materials. Sprinklers are installed in the corridor void as the depth of the void exceeds 0.8 m and the corridor void is likely to contain combustible materials in the future. Sprinklers are not installed in the classroom void as it contains no combustibles. The two voids are separated by non-combustible construction.

Sprinkler system specification:

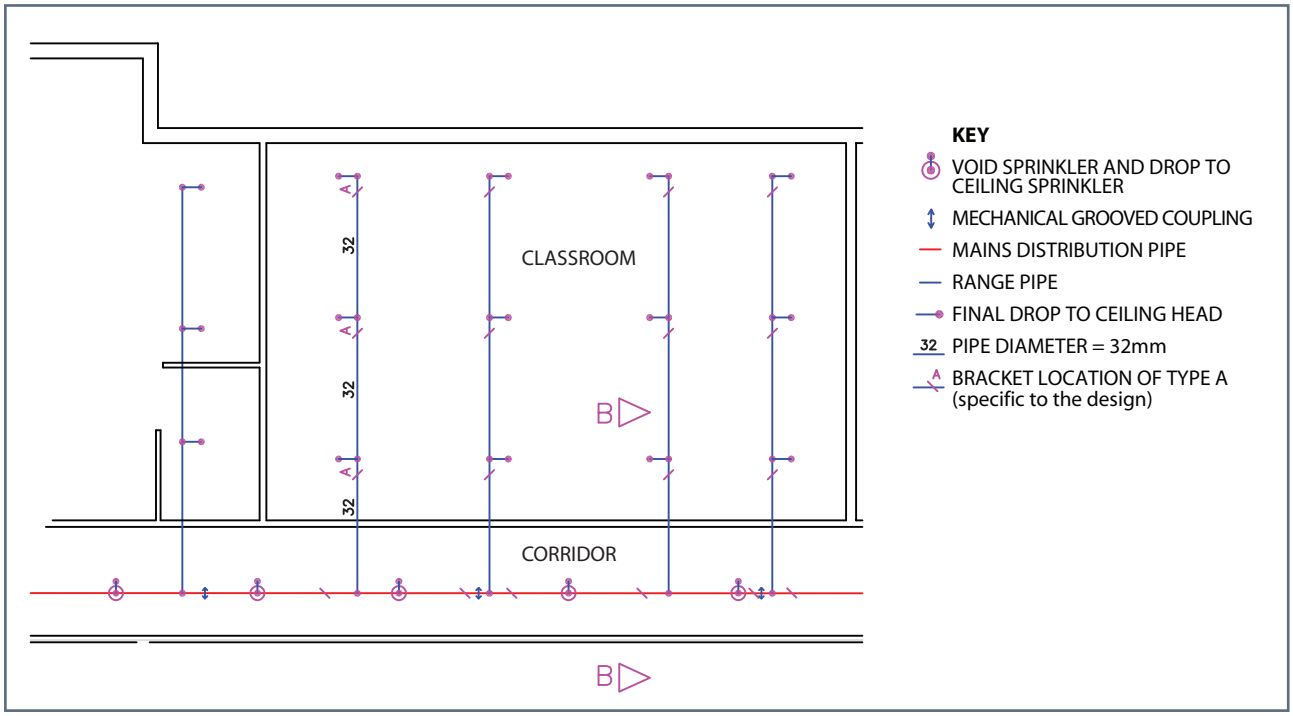
- Standards = BS EN 12845, TB 221, TB 207, TB 230.
- The hazard classification is OH1.
- Pipework = wet pipe system, steel pipe, pre-calculated tables used for pipe sizes.
- Ceiling sprinklers = concealed type, 68°C, k80, 'unrated' response sprinkler with 'quick' response bulbs.
- Void sprinklers = conventional type, 68°C, k80, 'quick' response sprinkler.



A side view of sprinklers and pipework in a classroom and corridor, section B-B.

This design has:

- sprinkler protection of the classroom and no sprinkler protection in the classroom ceiling void; and
- sprinkler protection of the corridor and sprinkler protection in the corridor ceiling void.



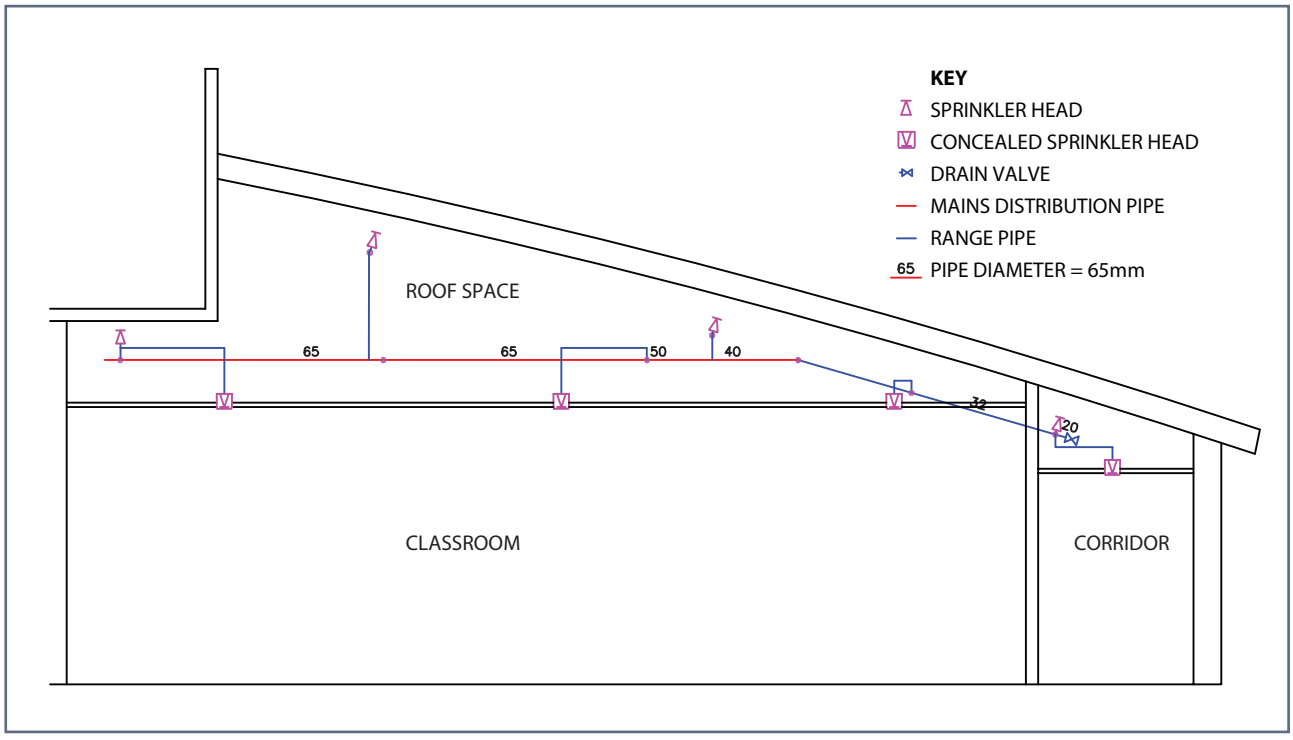
A plan view of sprinklers and pipework in a classroom and corridor, showing the location of section B-B

Example 2 Sprinklers to protect roof space for property protection

Sprinklers are installed at ceiling level to protect the roof space, classroom and the corridor. The roof space is protected as it is greater than 0.8 m deep.

Sprinkler system specification:

- Standards = BS EN 12845, TB 221, TB 207, TB 230
- The hazard classification is OH1
- Pipework = wet pipe system, steel pipe, pre-calculated tables used for pipe sizes
- Ceiling sprinklers = concealed type, 68°C, k80, 'unrated' response sprinkler with 'quick' response bulb
- Void sprinklers = conventional type, 68°C, k80, 'quick' response sprinkler



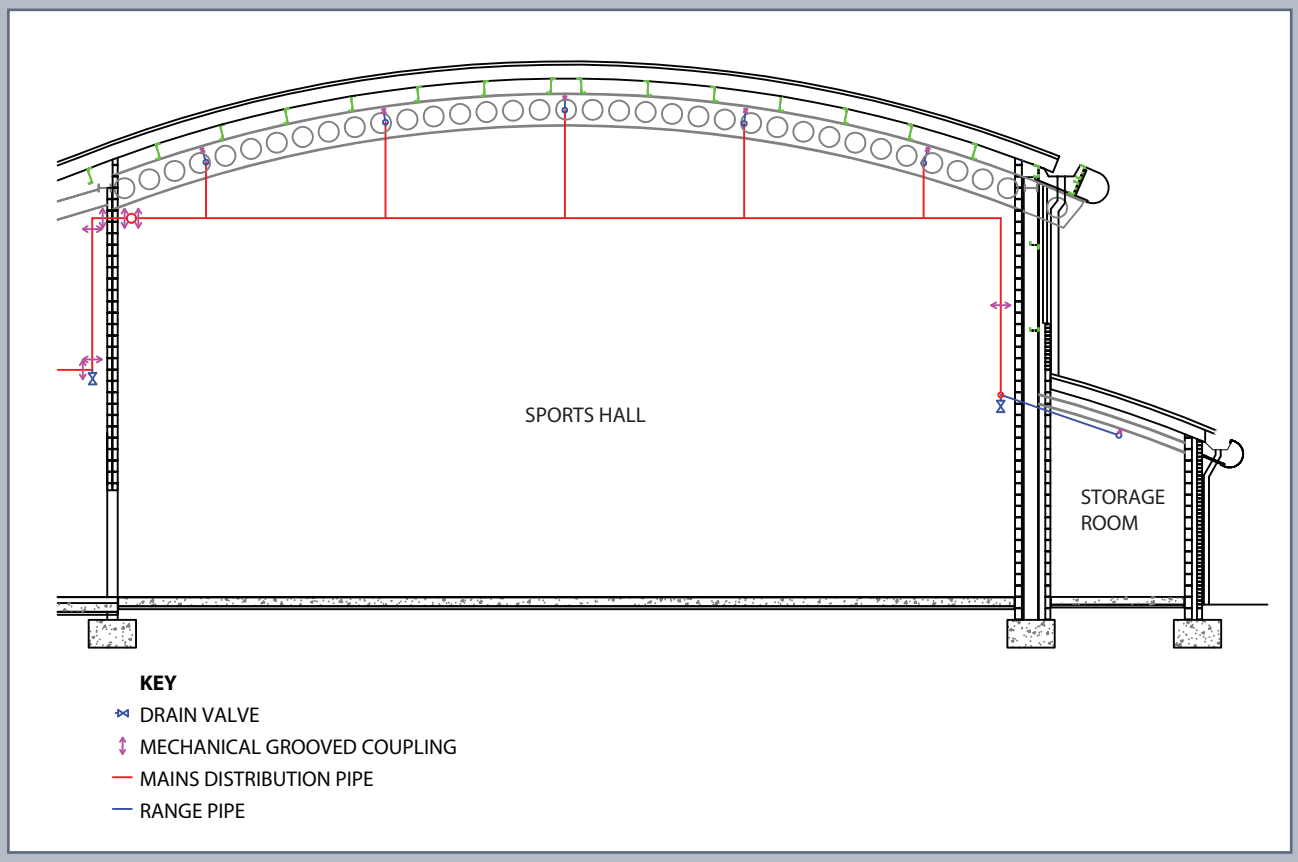
A side view of sprinklers and pipework in roof space, classroom and corridor

Example 3 Sprinklers to protect sports hall and storage room for property protection

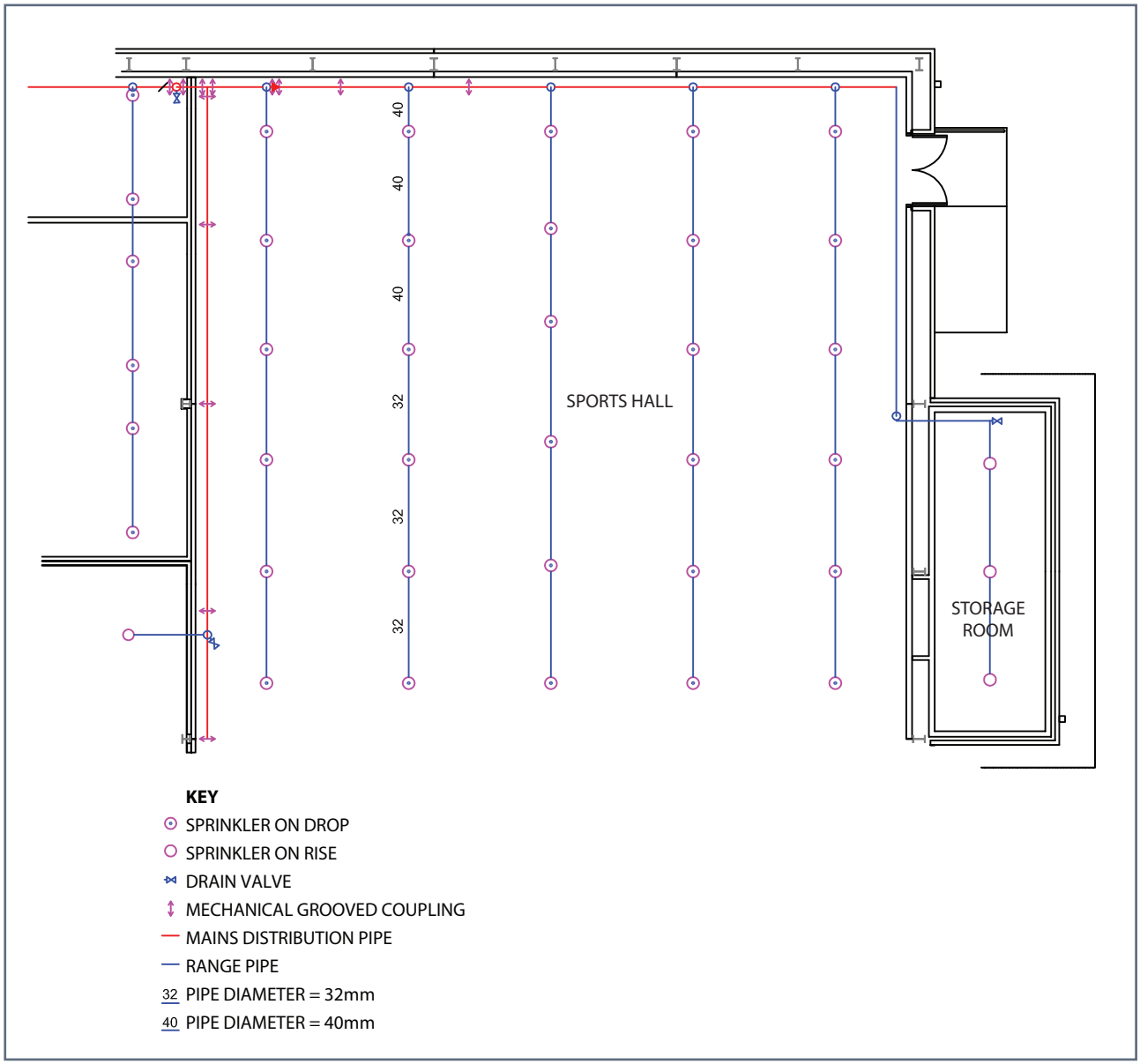
Sprinklers are installed at ceiling level to protect the sports hall and storage room. The sports hall is a large, tall space with multiple use. The shape of the roof requires the installation of sprinkler range pipes at varying height to comply with standard sprinkler locations.

Sprinkler system specification:

- Standards = BS EN 12845, TB 221
- The hazard classification is OH1, OH2 or OH3
- Pipework = wet pipe system, steel pipe, pre-calculated tables used for pipe sizes
- Ceiling sprinklers = conventional type, 68°C, k80, 'quick' response



A side view of sprinklers and pipework in a sports hall and storage room



A plan view of sprinklers and pipework in a sports hall and storage room

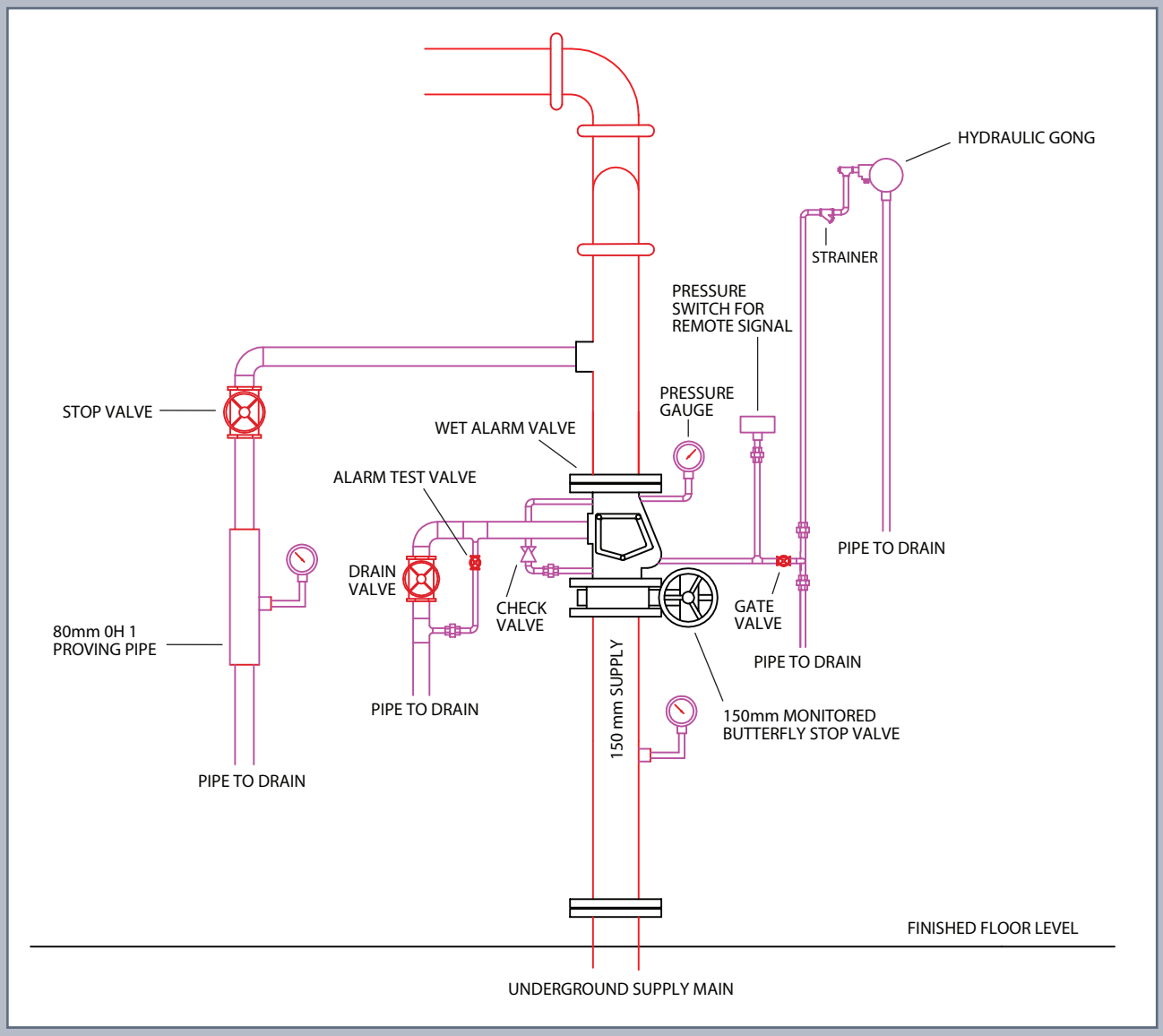
Example 4 Single town main water supply for property protection

In this example, the school requires sprinklers for property protection and therefore a single water supply is sufficient.

The water supply to the sprinklers is from the town main. Prior to selection of the water supply, the town main at the site is tested – its pressure and flow characteristics are found and the minimum available pressure and flow is determined. See Water supplies, page 18.

In this example, the tested water is found to be sufficient for the system design requirements at the valve set. The system design requirements are calculated by taking account of the highest sprinkler, friction loss (due to pipe lengths, bends, height) and pressure/flow requirements at the most remote sprinklers.

For this example, a 150 mm water supply is required. A new connection to the town main is made, a trench is dug and new pipe installed to the site of the sprinkler valve room.



An example town main water supply and sprinkler valve arrangement

Sprinkler system specification:

- Standards = BS EN 12845, TB 221
- The hazard classification is OH1
- Pipework = wet pipe system, steel pipe, pre-calculated tables used for pipe sizes
- Water supply = 150 mm underground water supply main, single supply, wet alarm valve

The town main water supply may be subject to change and therefore consultation with the water supply company is essential to ensure continuity of supply. In many cases, contingency plans are necessary for alternative water supplies (such as pump and tank) if there is a possibility that the available water pressure/flow could be reduced in the future.

Currently, few secondary schools have town main supplies as the system design requirements are often greater than the available pressure/flow.

Example 5 Pump and tank water supply for property protection

In this example, the school requires sprinklers for property protection and therefore a single water supply is sufficient.

The water supply to the sprinklers is from a tank via an electric pump. The tank is sized to deliver water for 30 minutes. The highest sprinkler is less than 15 m so the minimum tank size is 27.5 m^3. The electric pump is selected to meet the system design requirements of water pressure and flow, at the valve set. The system design requirements are calculated by taking account of the highest sprinkler, friction loss (due to pipe lengths, bends, height) and pressure/flow requirements at the most remote sprinklers.

For this example, a new connection to the town main is made for the water infill, a trench is dug and new pipe installed to the site of the sprinkler tank.

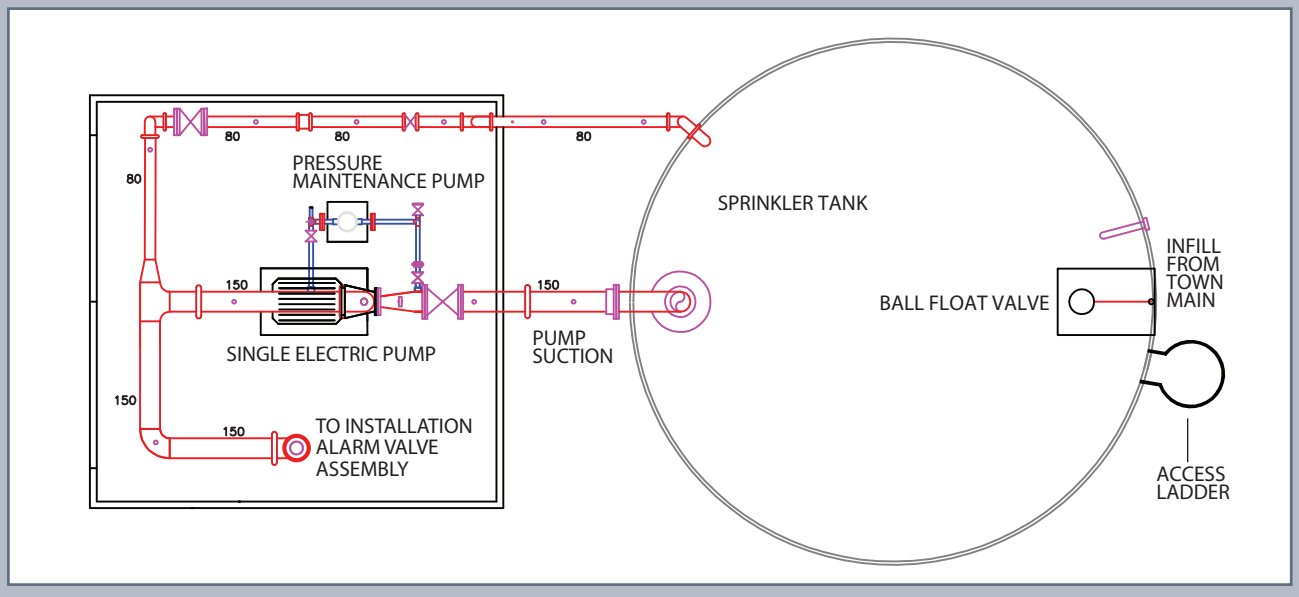
Sprinkler system specification:

- Standards = BS EN 12845, TB 205, TB 220, TB 221
- The hazard classification is OH1
- Pipework = wet pipe system, steel pipe, pre-calculated tables used for pipe sizes
- Water supply = inflow water supply from main, single tank 27.5 m^3, one electric sprinkler pump, 150 mm wet alarm valve

A single electric pump and single tank are employed for property protection sprinklers designed to comply with TB 221.

A 30 minute water supply is only acceptable to the insurance industry if the hazard classification is OH1, the local fire service can arrive and attack the fire in 30 minutes and there is full compliance with the requirements of TB 221 (for example, provision should be made to transmit fire and fault alarm automatically to a central station for fire alarm signalling approved by a nationally accredited, independent, third party approvals organisation).

Most secondary schools have pump and tank supplies.



An example pump and tank water supply

Example 6 Pump and tank water supply for life safety

In this example, the school requires sprinklers with additional life safety features and therefore requires duplicate water supplies.

The water supply to the sprinklers is from a tank via two electric sprinkler pumps from two separate and independent electricity supplies. See Water supplies for life safety, page 19.
The tank is sized to deliver water for 60 minutes. The highest sprinkler is over 15 m high, therefore the minimum tank size is 70 m^3. The tank is divided into half and the electric pumps can draw water from each half tank. The electric pumps are selected to meet the system design requirements of water pressure and flow, at the valve set. The system design requirements are calculated by taking account of the highest sprinkler, friction loss (due to pipe lengths, bends, height) and pressure/flow requirements at the most remote sprinklers.

For this example, a new connection to the town main is made for the water infill, a trench is dug and new pipe installed to the site of the sprinkler tank.

Sprinkler system specification:

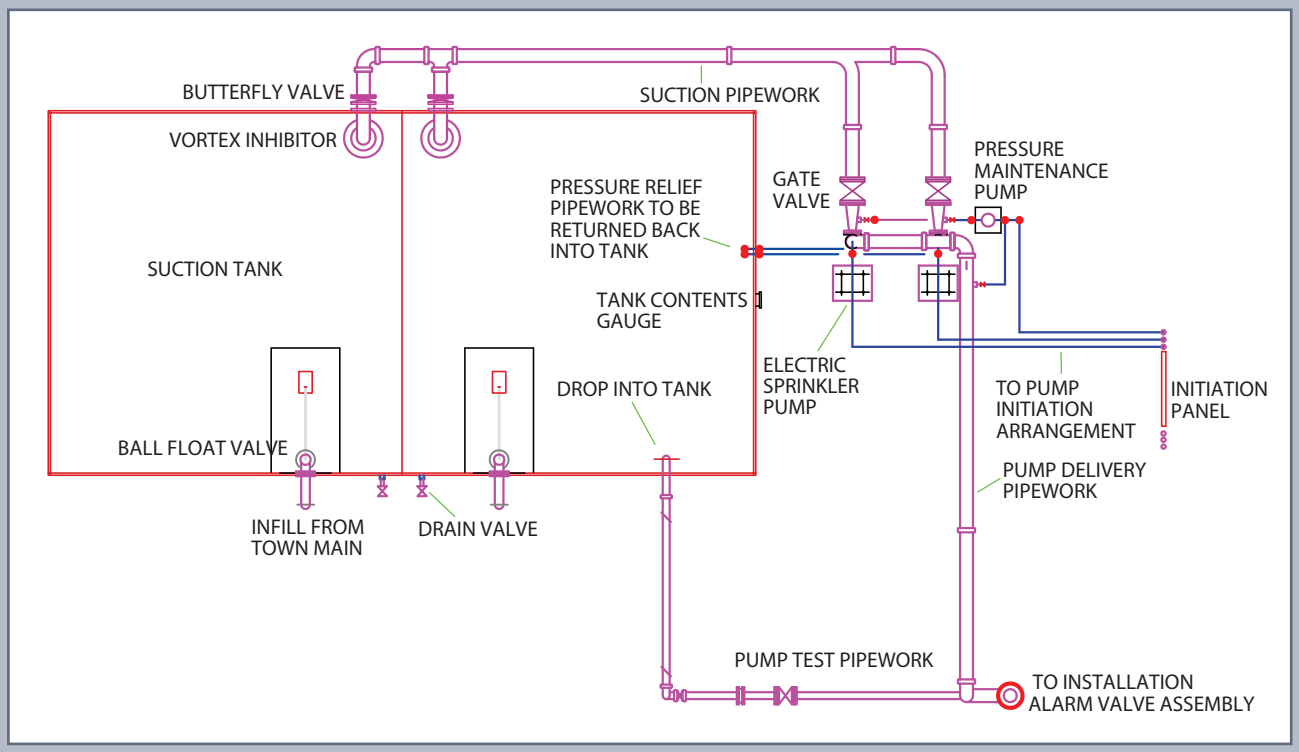
- Standards = BS EN 12845, TB 205, TB 220, TB 221
- The hazard classification is OH1
- Pipework = wet pipe system, steel pipe, pre-calculated tables used for pipe sizes
- Water supply = inflow water supply from main, 70 m^3 tank divided into two, two electric pumps, two independent electrical supplies, 150 mm wet alarm valve

Duplicate electric pumps and duplicate tanks are employed for life safety sprinklers. All control/gate valves are monitored but not shown.

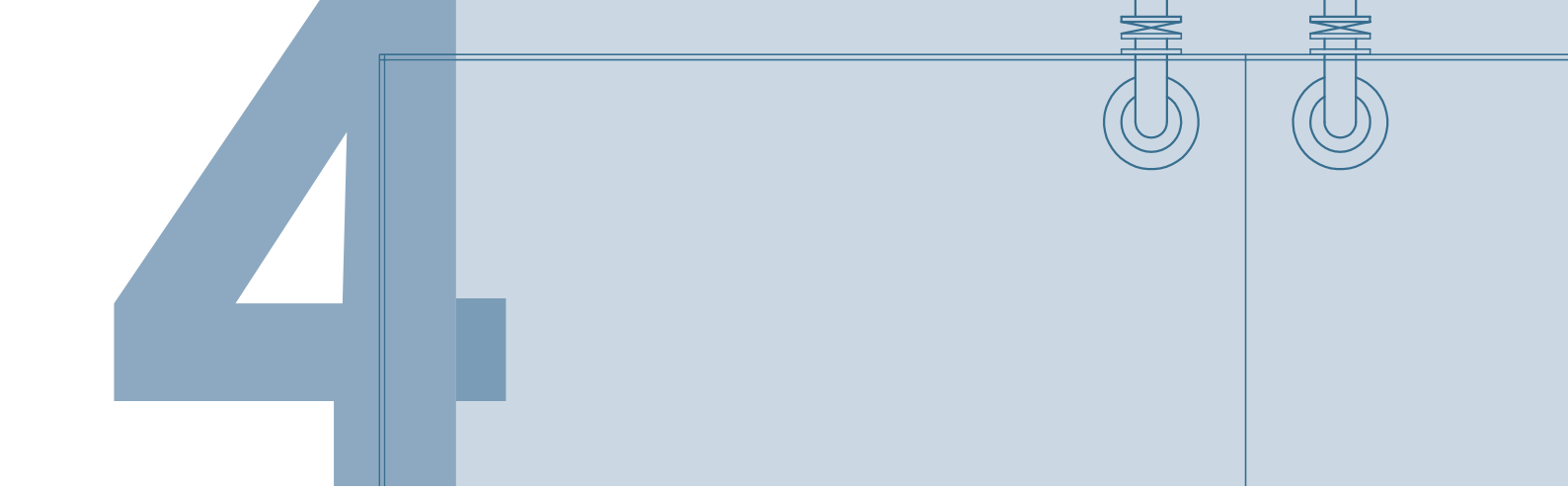
Other additional requirements for life safety systems are given in Special requirements for life safety systems, page 21.

Currently, only a few secondary schools have life safety sprinkler systems with the associated additional life safety features.

However, new schools with large open areas and multiple use facilities may include life safety sprinkler systems as part of fire engineered solutions.



An example duplicate pump and tank water supply



References

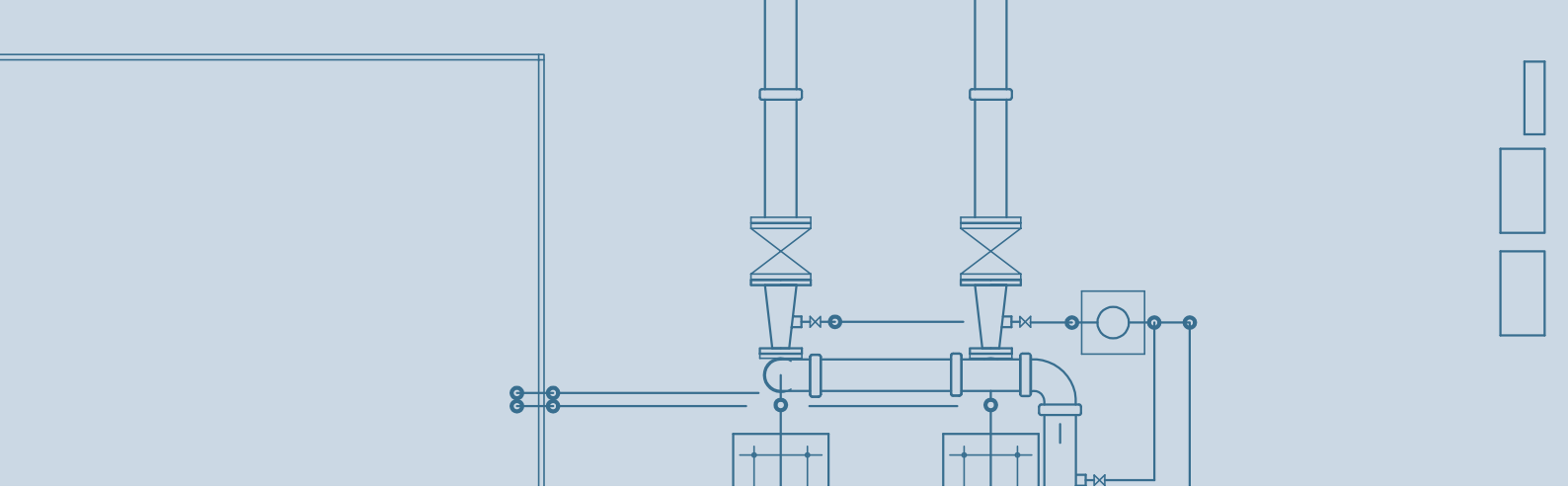
This document was published in February 2008. After this date readers should ensure they use the latest edition of all references.

Department for Children, Schools and Families

- *Risk assessment tool for fire precautions in schools*, available at www.teachernet.gov.uk/fire
- *Cost-benefit analysis for fire precautions in schools,* available at www.teachernet.gov.uk/fire
- Building Bulletin 100 *Design for fire safety in schools*, available at www.teachernet.gov.uk/fire
- EC Harris LLP, *A cost analysis of sprinklers in schools*, report prepared for DCSF, January 2007, available at www.teachernet.gov.uk/fire

The Building Regulations

- The Building Regulations 2000, Approved Document B, *Fire Safety,* volume 2 – buildings other than dwellinghouses, 2006 edition, available at www.planningportal.gov.uk



British Standards

- BS 5306 *Part 2: Specification for sprinkler systems*, 1990 (obsolescent)
- BS EN 12259 (various parts), *Fixed firefighting systems, components for sprinkler and water spray systems*
- BS EN 12259-1 *Fixed firefighting systems, components for sprinkler and water spray systems Part 1 Sprinklers*, 1999
- BS EN 12845, *Fixed Firefighting systems – Automatic sprinkler systems – Design Installation and maintenance,* 2004
- BS DD 252, *Draft for Development Components for residential sprinkler systems – specification and test methods for residential sprinklers*, 2002 (under revision)
- BS DD 9999 *Draft for Development Code of Practice for fire safety in the design, construction and use of buildings,* 2005 (under revision)

Other standards

- The Loss Prevention Certification Board LPS 1260 *Requirements for testing plastic pipes for sprinkler systems*, BRE Global, available at www.redbooklive.com (under revision)
- The Loss Prevention Certification Board LPS 1261 *Requirements for testing flexible hoses for sprinkler systems*, BRE Global, available at www.redbooklive.com (under revision)
- *LPC rules for automatic sprinkler installations incorporating BS EN 12845*, and including Technical Bulletins, Recommendations, Technical Briefing Notes and Guidance documents, The Fire Protection Association

Technical Bulletins relevant to schools

- TB 201 *Suitable sprinkler components and services*
- TB 202 *Approved sprinkler equipment*
- TB 203 *Care and maintenance of automatic sprinkler systems*
- TB 204 *Sprinkler system grading*
- TB 205 *Consultation and acceptance for sprinkler system approval by fire insurers*
- TB 206 *Passive fire protection of sprinklered buildings*
- TB 207 *The selection of sprinkler heads*
- TB 208 *Supplementary requirements for sprinkler installations which can operate in the dry mode*
- TB 209 *ESFR sprinkler protection*
- TB 210 *Automatic sprinkler pump installation*

- TB 211 *CPVC plastic pipe,* until April 2008
- TB 213 *Upkeep and testing of multiple controls*
- TB 214 *Sprinkler protection of flammable liquid stores*
- TB 215 *Sprinkler protection of idle pallet storage*
- TB 216 *Sprinkler protection of aerosols*
- TB 217 *Categorisation of goods in storage*
- TB 218 *Water supply diagrams*
- TB 219 *Sprinkler protection of cold stores*
- TB 220 *Power supplies for sprinkler pumps,* until September 2008
- TB 221 *Sprinkler protection of schools*
- TB 222 *Ordinary Hazard Group 3 protection using enhanced protection extended coverage sprinklers*
- TB 223 *Sprinkler protection of concealed spaces in OH3 EPEC sprinklered buildings*
- TB 224 *Sprinkler water storage tanks (cisterns)*
- TB 225 *BS EN 12845: 2004*
- TB 226 *Design, installation and maintenance of underground pump chambers*
- TB 227 *Pipework*
- TB 228 *Revision to BS EN 12845 Table 1*
- TB 229 *LPC Rules for automatic sprinkler installations variations to BS EN 12845: 2003 and 2004*
- TB 230 *Protection of floor voids, ceiling voids and roof spaces (in consultation)*
- TB 231 *Pipe sizing*

Recommendations

- RC19: *Recommendations for the storage of aerosol products*
- RC38: *Recommendations for frost protection measures for sprinklers*

Technical Briefing Note

- *Legionella and firefighting systems*

Guidance documents

- *Guidelines for the supply of water to fire sprinkler systems*
- FPA guide on the *management of fire water in sprinkler-protected properties*
- FPA guide on *working in confined spaces*

Other publications

- British Automatic Fire Sprinkler Association, *Sprinklers for safety – Uses and benefits of incorporating sprinklers in buildings and structures*, 2006
- The Loss Prevention Certification Board, *List of Approved Fire and Security Products and Services*, Red Book, BRE Global, available at www.redbooklive.com
- FIRAS Scheme for Installers of *Commercial and Industrial Sprinkler Systems*, Warrington Certification Limited, available at www.firas-register.co.uk
- *UK Fire Statistics,* 1994-2002
- A Lewis, *FPA Large Loss Analysis 2004*, Fire Engineers Journal and Fire Prevention, February 2007

Annex A

Table relating key elements of sprinkler system design and installation to BS EN 12845 Clauses and LPC Technical Bulletins

Key elements of sprinkler system design	BS EN 12845 clause number and LPC Technical Bulletin number*
Contract planning and documentation	BS EN 12845 clause 4, TB 205 and TB 221 clause 5
Extent of sprinkler protection (including permitted exceptions)	BS EN 12845 clause 5, TB 206, TB 221 clause 3 and TB 230
Classification of occupancies and fire hazards (including protection of special hazards)	BS EN 12845 clause 6, TB 215, TB 217, TB 228, TB 221 clause 8 and TB 229 clause 3
Hydraulic design criteria (including design density and area of operation)	BS EN 12845 clause 7, TB 221 clause 9 and TB 229 clause 3
Water supplies and type (including type of water supply)	BS EN 12845 clauses 8 and 9, TB 204, TB 218, TB 224, TB 226, TB 221 clauses 6 and 7 and TB 229 clause 3
Pumps	BS EN 12845 clause 10, TB 210 and TB 220
Installation type and size	BS EN 12845 clause 11, TB 208, TB 219, TB 221 clause 4, TB 229 clause 3 and RC 38.
Spacing and location of sprinklers	BS EN 12845 clause 12 and TB 229 clause 3
Pipe sizing and layout	BS EN 12845 clause 13, TB 229 clause 3 and TB 231
Sprinkler design characteristics and uses	BS EN 12845 clause 14, TB 207 and TB 221 clause 10
Valves	BS EN 12845 clause 15 and TB 229 clause 3
Alarms and alarm devices	BS EN 12845 clause 16 and TB 221 clause 11
Pipework	BS EN 12845 clause 17, TB 211 and TB 227
Signs, notices and information	BS EN 12845 clause 18 and TB 221 clause 12
Commissioning and acceptance tests and periodic inspection	BS EN 12845 clause 19 and TB 205

Key elements of sprinkler system design	BS EN 12845 clause number and LPC Technical Bulletin number*
Maintenance	BS EN 12845 clause 20, Annex F and Annex J, TB 203, TB 213, TB 219 and TB 221 clause 13
Classification of typical hazards	BS EN 12845 Annex A and TB 229 clause 3
Special requirements for life safety systems	BS EN 12845 Annex F
Protection of special hazards	BS EN 12845 Annex G, TB 214, TB 215, TB 216, TB 229 clause 3 and RC 19
Security	TB 221 clause 12
Specialised sprinkler types	TB 209, TB 222 and TB 223
Approved sprinkler equipment	TB 202
Suitable sprinkler components and services	TB 201

*Titles of LPC Technical Bulletins relevant to schools – see References.

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