Introducing *BS 9251 (2021)* "*Fire sprinkler systems for domestic and residential occupancies. Code of practice*"

Background

BSI generally aims to review and if necessary, update its standards publications approximately every five years. The current (2014) edition of *BS 9251 Fire sprinkler systems for domestic and residential occupancies. Code of practice* has recently been the subject of a major review and update process. The technical work of the review was conducted by BSI committee working group FSH 18/2/1. This working group is made up of various volunteer experts from a broad range of roles in the industry. Publication of the updated standard is expected during summer 2021. This article is intended to help to inform of and explain the proposed changes.

Standards exist to solve problems. They tell us how to do things to achieve particular results. The original sprinkler standards were designed, in the event of a fire, to reliably prevent insurers from having to pay for an entire warehouse and contents (£££) and instead only pay for a small area of fire and smoke damaged goods (£). The mature and reliable technology of '*Sprinkler systems*' are of extraordinary value to insurers or those wishing to minimise property loss.

In recent decades, sprinkler system technology has been successfully adapted and optimised for the subtly different application of the protection of life *'life safety'*. Quicker response heads, by operating sooner on an exponential fire-growth curve, significantly improve compartment tenability in a fire. Highly optimised design continues to balance the equation of cost vs benefit. Smaller-scale and more aesthetically acceptable sprinkler system components have been developed to better suit applications in domestic and residential settings.

Standards capture lessons of history and experience: case-studies, research, mistakes, failures, and successes. They typically contain obviously necessary specifications e.g. the minimum density and volume of water required to fight a fire, given an expected fire loading. They also contain knowledge which is less obvious, but can nevertheless be critical to success or failure of a system e.g. not to use certain O-ring sealing elements in sprinkler heads, which are known over time to have a high likelihood of causing the system to fail to operate. These are just two examples to illustrate the types of knowledge contained within a standard. A good standard will typically contain hundreds if not thousands of nuggets of valuable knowledge. Good standards tend to be mature standards i.e. those which have been through many well-informed iterations, capturing as much relevant experience as possible. In the case of sprinkler systems, this experience spans many decades. It is important that standards are created under responsible stewardship (e.g. where a balance of stakeholders participate to give diverse experience and moderate any conflicting interests, fashions and gimmicks). Standards produced in this way tend to be most highly optimised at doing what they need to do: In the case of BS 9251; *provide a very reliable and affordable form of automatic firefighting response, primarily intended to protect life and in some case, secondarily intended to protect property*.

Good standards are critical to the success of sprinkler technology and the success of the industry. A key objective of the BS 9251 update revision was to make a good standard better.

International politics

Another factor relevant to the revision has been the creation of the European Standard *EN 16925 (2018) Fixed firefighting systems - Automatic residential sprinkler systems - Design, installation and maintenance*, by CEN (the European Organisation for Standardisation). Even though the UK has left

the EU, the UK through BSI remains a full member of CEN, and this standard is published as a British Standard; *BS EN 16925* in compliance with their obligations.

EN 16925 was created at a time when UK had a residential and domestic sprinkler standard it was largely happy with (i.e. post 2014) but many European member states did not have such a standard. A standard such as EN 16925, created with input from up to 34 CEN members states required many compromises to be made. EN 16925 is generally regarded as a good standard in some respects, however the UK BSI committee responsible for sprinkler standards expressed its continued preference for the British Standard BS 9251 to be retained for used in the UK for various reasons. For example:

- Densities and other parameters used in BS 9251 are based on research designed to suit UK building stock
- BS 9251 is and can be easily adapted to suit quirks of the UK built environment.
- EN 16925 currently offers no clear solutions for residential buildings of greater than 18m / 4 stories in height (neither does EN 12845)

However, national members of CEN (e.g. BSI for the UK) are not permitted to publish national standards which would conflict with a CEN standard. This created a further challenge for BSI and the committee working group FSH 18/2/1; the aim was to produce a standard which was *at least as good* as both BS 9251:2014 and BS EN 16925, which did not "conflict" and was updated to capture most of the *state of the art* of general UK practice and needs.

BS 9251:2021 - the updates

This section gives a summary of the proposed updates contained within BS 9251:2021. The remainder of the article provides discussion of some of the updates. The reader's attention is drawn to the Disclaimer at the end of this article.

Summary of some of the notable changes:

- BS 9251:2021 is intended to be suitable for use in domestic and residential buildings of any height
- New category "Cat 4" added (for taller, higher risk buildings)
- Allowance made for commonly encountered limited areas of non-residential occupancy (e.g. bin stores, concierge offices, very small car parking areas, etc); design criteria akin to OH (Ordinary Hazard) to be used.
- Significantly clarified recommendations for alarm and fault conditions. Newly recommended system monitoring functionality (e.g. correct valve positions)
- Improved recommendations and guidance in relation to alignment of a buildings' fire strategy (e.g. "stay put" or "defend in place") and the implementation of sprinkler fire alarm functionality
- Further recommendations made in relation to self-testing pumps (e.g. weekly test interval and a move more towards fail-safe design principles)
- Improved recommendations and guidance on power supply configurations
- References to BS 9252 for Sprinkler heads removed (superseded and replaced in BS 9251 by BS EN 12259-14)
- Recommendation that flow switches should be to BS EN 12259-5
- Method of determining building height aligned with AD-B (Approved Document B)
- Clarification and better definition of roles and responsibilities

- Recommendations and limits for shadow areas, bay windows and other similar features added
- Clarification that Cat 1 was never intended to apply to every dwelling in a block of flats (Cat 2, 3 or 4 as applicable should be used).
- Guidance on vulnerable people consolidated (was fragmented to various locations of the document in BS 9251:2014)
- Recommendations for orifice plates (which can be used to achieve more efficient hydraulic design)
- Reference to remote pressure / flow test points (optional) is now made (useful to verify pipework is connected and not blocked)
- Recommendations and limitations placed on the use of Pressure Reducing Valves
- Recommendations and limitations placed on the use of Priority Demand Valves
- Annex F "Long-term inspection and testing of pipework and sprinklers" added (e.g. like BS EN 12845 Annex K; 25 years)
- Significantly more detail on how to size water supplies; which can be quite complex, particularly where they are shared with domestic supplies
- Several new figures and illustrations added (low water levels, tank volumes, power supply configurations, head coverage areas, shadow areas, architectural features, etc)
- Reference to *BS 5306-0:2020 Guide for the selection of installed systems and other fire equipment* added
- Foreword: Acknowledgement of *BS EN 16925 Automatic residential sprinkler systems. Design, installation and maintenance* added; along with cautions and remarks to the effect that the use of BS 9251 is considered preferable in the UK.

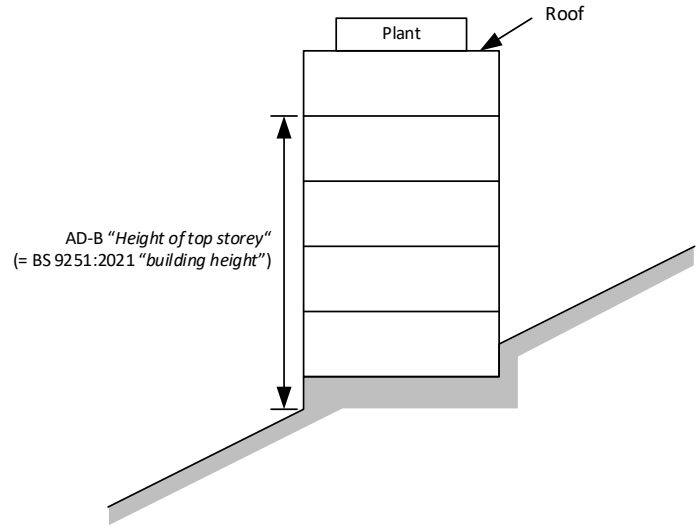
Building height and risk profile

One area in need of improvement was identified as being that BS 9251:2014 is unclear on whether and how it should be applied to tall buildings. Building height can be one approximation of risk profile (i.e. in taller buildings, greater reliance may be placed upon safety measures).

With careful reading, BS 9251:2014 does appear to say that where a building is taller than 45m *something* different should happen, but it is not very clear *what should happen*. It does say that for buildings taller than 45m the "AHJ" (Authority Having Jurisdiction) should be consulted and additional measures of Clause 4.5 might be applied or a system to BS EN 12845 might be used. Typical problems with this are: The AHJ often does not know how to address this point (it is not reasonable to expect them to have the necessary expertise in fixed firefighting system design and performance). Clause 4.5 contains several possible system enhancements; it is not clear which should be applied. Some of these system enhancements feature variables (e.g. use an *'increased density'* of water), but the text does not state what value should actually be used. Whilst BS EN 12845 can be adapted for residential use, it is not written for this purpose. For example, no guidance is given on how *'residential'* pattern sprinkler heads should be used in such applications.

Definition of building height

As building height is a critical parameter, it is important to have an agreed convention for determining building height. The Approved Document B (AD-B) method as depicted in AD-B Diagram D5 (as illustrated in the following figure, an adaptation of AD-B Diagram D5) has been adopted.



Enhanced design criteria for taller buildings

In a properly designed, built and maintained residential building, a fire should not behave differently on a low floor as compared to a high floor. The design ambition is that a fire in one dwelling will not affect the neighbouring properties. However, we know this is not always the reality of the built environment today; many buildings in the UK are known to contain fire safety defects, some of which are very serious. There is near-universal agreement that taller buildings constitute a higher risk to the occupants – and to firefighters.

The increased risk arises from:

- The increased difficulty escaping from a taller building, should it be necessary to do so.
- The increased difficulty in fighting a fire in a taller building, particularly at the higher floors.
- Scale and complexity: Proximity of dwellings, interdependence of the various construction elements, safety components and systems.

Sprinkler technology has proven to be a very effective method of mitigating some of these risks in residential tall building fires. Note that sprinkler systems should not be used as a primary mitigation measure for serious fire safety defects; the defects should be remedied.

The BS 9251:2021 drafting committee have carefully considered how sprinkler systems should be designed for tall buildings. A new Category 4 has been added to better accommodate the specific needs of taller buildings.

The new recommendations of BS 9251:2021 are based upon: experience, case studies, stakeholder input (e.g. Fire and Rescue Service (F&RS) advice on their response capability), wider input from public consultation (a process which involved very active engagement), and a review of current global best-practice. Effort has been made to ensure the new recommendations are as cost-effective as they can be; for example, see the exceptions allowed below.

BS 9251:2021 Category 4 buildings (residential buildings taller than 18m) should have:

- 60 minute water supply duration. This is to allow F&RS more time to mount an effective response in taller buildings. An exception is allowed; where there are areas of a building with

high hydraulic demand at the base of the building (e.g. limited non-residential areas), as it will be easier for the F&RS to reach these areas, a 30 minute water supply duration may be considered for these areas.

- An enhanced water supply; a service (towns') main fed from both ends or split capacity tanks feeding two or more pumps
- Duplicate electricity supply (for new-builds, which will generally have a duplicate power supply already e.g. for firefighting lifts). An exception is allowed that for retrofit applications this recommendation is not made until building height exceeds 45m.

Even with these enhancements, it may be worth a reminder that a sprinkler system to BS 9251, which uses relatively light water densities and other design criteria, is primarily a "life safety" system. That is to say that it is intended to help facilitate protection of occupants and allow safe evacuation and not necessarily intended to protect the fabric of the building (although experience shows it often will). Where there is a higher than usual degree of reliance upon the sprinkler system for any particular reason, even greater enhancement may be appropriate. It remains the duty of the entity with design responsibility to address this complex issue on a case-by-case basis.

Limited non-residential areas

Residential buildings often include areas of non-residential occupancy. For example: bin stores, car parks, garages, offices, plant rooms, stores (e.g. tenants' cubicles or store rooms), food banks, community resource centres, small retail concessions, commercial kitchens and laundries, etc.

Compared to *'commercial and industrial'* sprinkler heads (heads to BS EN 12259-1), *'residential'* sprinkler heads (heads to BS EN 12259-14) deliver a relatively flat parabola of water spray discharge. This is intended to wet walls, the perimeter of rooms (where furniture/fuel loading is often found in dwellings) and curtains. Only a limited proportion of the water will be directed downwards. Also noteworthy, these heads generally operate at quite low water discharge densities (typically ≥ 2.8 mm/min), to allow efficient sizing of the water supply and pipework (larger supplies are often a costly and impractical system element).

The concern is that *'Residential'* sprinkler protection to non-residential areas containing a higher hazard than typically found in a dwelling might not be effective. In such areas, it is likely that a more uniform sprinkler discharge spray pattern, at a higher density (e.g. similar to Ordinary Hazard OH1 or OH2 criteria; typically ≥ 5.0 mm/min)) would be more reasonable and effective as a firefighting measure. Currently, in BS 9251:2014 no such provisions are made and BS 9251:2014 recommends BS EN 12845 be used for areas of higher hazard. This can be a significant jump in equipment, requirements and cost. The use of two systems and design approaches to serve one building can create complications (e.g. two sets of related plant, two or more separate systems, etc).

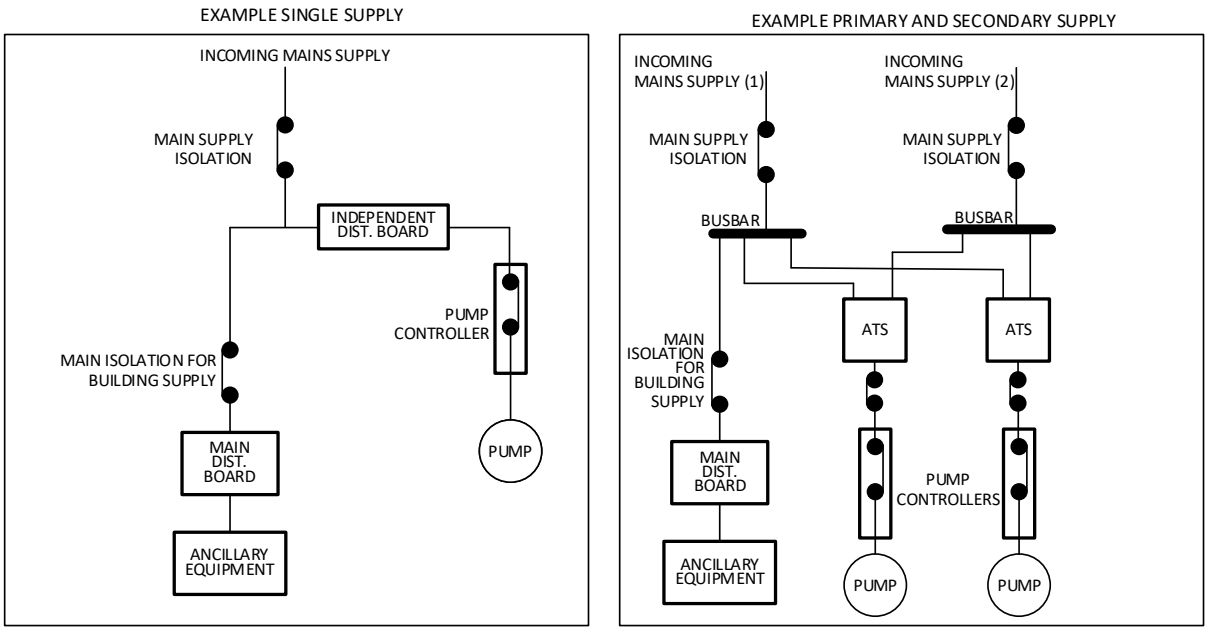
EN 16925 Automatic residential sprinkler systems - Design, installation and maintenance provides a neat solution to this problem. It allows limited areas of "OH" protection within a residential building. BS 9251:2021 intends to follow suit and build upon the example of EN 16925. BS 9251:2021 does so by introducing recommendations and greater detail on situations where sprinkler design akin to OH protection can be used in a residential building and within the scope of BS 9251:2021. The proposed parameters include: qualifying occupancy types, use of EN 12259-1 sprinkler heads, 12m^2 max coverage, 3m x 4m max spacing, design density 5mm/min minimum, AMAO (assumed maximum area of operation) of the compartment size or 72m^2 or 100m^2, for limited non-residential areas (up to 100m^2).

Power supplies

BS 9251:2014 provides very limited information on sprinkler system power supply configuration. Clearly this is an important aspect of system design as, unlike a BS EN 12845, diesel and electric configuration (two fully independent arrangements), in a BS 9251:2014 system the electrical power supply often constitutes a potential single point of failure in a residential system.

In BS 9251:2021, it is intended that significantly greater detail will be given on preferred electrical power supply designs (both for single and duplicate supplies) and features for resilience. Exemplar general arrangement circuit diagrams (see below) will be provided along with key components and their locations.

The following figures are examples (a single power supply and primary and secondary power supply arrangement) of the type of detail which will be included in BS 9151:2021. Also to be included: mains/UPS (uninterruptable power supply) backup battery arrangement example and a mains/generator arrangement.



Sprinkler system fire and fault alarm functionality

Improved guidance is proposed for both sprinkler fire alarm functionality and system fault condition monitoring. It is recognised that there can be many ways to implement these functions in a residential building, depending on the circumstances and requirements (e.g. stay-put vs full or phased evacuation policy, onsite staff or not, etc). The new standard aims to better accommodate this variability. While doing so, it aims to specify more clearly key system states that must trigger audible and/or visual alarms, and highlight the pertinent points for consideration in this aspect of system design. It is recommended that in Category 2, 3 and 4 systems at least the following should be monitored, and signals sent to a location (local or remote) where they are most likely to be acted upon appropriately:

- Fire
- Pump self-test failure (the revised standard will more tightly describe how this is to be achieved)
- Pump power failure

- Pump running
- Tank low water level
- Critical valve incorrect position
- Trace heating system fault
- Supervised circuit fault*.

*The standard also recommends that supervised circuits (i.e. with built-in circuit failure detection) should be used.

Improved guidance on hydraulic calculation methods

New material is included intended to assist users understand the requirements and conventions of performing the necessary hydraulic calculation design tasks. For example, clarification is made on a point of common confusion: whether a head design density achieved in an actual installation should be calculated as per the area of coverage specified by the head manufacturers datasheet, or the actual coverage area as found in the application. Explanation and worked examples are to be included in the revised standard.

Conclusion

At the outset of the project a relatively minor revision of BS 9251:2014 was anticipated. A great deal of attention to detail has been paid by a team of volunteer experts who are passionate about the subject and share the common objective of promoting safety. The revision took far more effort than expected. The authors of the standard hope and believe that the BS 9251:2021 edition will provide very many beneficial, incremental improvements. They hope it will be of great value to the sprinkler industry and society and will continue to provide the high-performing and cost-effective fire safety systems.

DISCLAIMER: those potentially affected by the changes discussed in this article should wait until the document is confirmed, agreed, and published (publication being the only definitive confirmation) before relying upon any of this write-up of the proposed changes. Prior to publication, the document remains subject to change.

References

BSI (2020). BS 5306-0 Fire extinguishing installations and equipment on premises. Guide for the selection of installed systems and other fire equipment. London, UK, BSI.

BSI (2014). BS 9251 Sprinkler systems for residential and domestic occupancies. Code of practice. London, UK, British Standards Institution.

BSI (2021) [draft]. BS 9251 Sprinkler systems for residential and domestic occupancies. Code of practice. London, UK, British Standards Institution.

BSI (1999). BS EN 12259-1 Fixed firefighting systems. Components for sprinkler and water spray systems. Sprinklers. London, UK, British Standards Institution.

BSI (2002). BS EN 12259-5 Fixed firefighting systems. Components for sprinkler and water spray systems. Water Flow Switches. London, UK, British Standards Institution.

BSI (2020). BS EN 12259-14 Fixed firefighting systems. Components for sprinkler and water spray systems. Residential Sprinklers. London, UK, British Standards Institution.

BSI (2015 + A1:2019). BS EN 12845 Fixed firefighting systems — Automatic sprinkler systems — Design, installation and maintenance. London, UK, BSI Group.

BSI (2018 + C1:2020). BS EN 16925 Fixed firefighting systems - Automatic residential sprinkler systems - Design, installation and maintenance. London, UK, BSI Group.

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