BS 7974:2019

Application of fire safety engineering principles to the design of buildings

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Introduction

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Evolving from a Draft for Development, DD 240, which was issued in 1997, BS 7974 was first issued in 2001. Since then, various Published Documents have been reviewed and updated, but this 2019 Revision represents the first major appraisal and update of the suite. This document provides some background to the process and outlines the changes.

Fire safety engineering is an important discipline within the built environment, and so the process of standardisation as set out in BS 7974 and supporting Published Documents is essential for facilitating design freedoms whilst providing suitable levels of safety and resilience.

Thanks to the tireless work of the Panel leaders and members of the Technical Committee for their direction, the Content Developers for their patience and prompting, and to those who took the time to review the drafts during the DPC (Draft for Public Comment) stage, we are pleased launch the 2019 Revision, ensuring BS 7974 remains current and relevant.

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Peter is Chair of FSH/24, the Technical Committee for fire safety engineering, which oversees the maintenance and development of the BS 7974 suite of documents. FSH/24 draws representatives from a wide range of stakeholder organisations, research and teaching, as well as practicing fire engineers. It is the national committee for Fire Safety Engineering, mirroring CEN/TC 127/WG 8 Fire Safety Engineering; and many of the working groups in ISO/TC 92.

Background

So, where has fire safety engineering come from?

Fire safety engineering is defined as:

The application of scientific and engineering principles to the protection of people, property and the environment from fire

In this context, it is provision of adequate fire safety precautions in a building or structure to meet performance-based objectives, or to accommodate a departure from the prescribed methods in any specific area.

BS 7974 provides a framework for the application of fire safety engineering principles to the design of buildings.

Early recognition and acceptance

As a result of the large and rapid increase in innovative and diversified building design, prescriptive regulations became demonstrably restrictive and inflexible.

By way of example, air travel required airports to start handling large numbers of people, who were unfamiliar with the building, in a pleasant and efficient way. Designs based on the prescriptive standards of the time simply couldn't cope with this new design requirement. Some engineers and scientists saw the possibility of applying scientific research directly to the design of individual buildings. One important issue relating to airport design was the need for large compartment volumes, not permitted under Building Regulations without obtaining a relaxation. A range of data from experiments, surveys and fire statistics were collected to illustrate how various measures could compensate for lack of fire resisting construction, or compartmentation.

The commitment of the Government of the day to deregulation and to reduce the burden on industry led, in 1985, to the introduction of new functional building regulations. This set out the requirements for fire safety of buildings in the functional statements that we have already touched on, and designers were now free to provide any solution that could be shown, to the satisfaction of the enforcing authority, to fulfil these functional requirements.

Whilst formal recognition and acceptance of the use of fire safety engineering had been given in England and Wales within the 1985 edition of Approved Document B, no guidance was given. The pressure for guidance and a structure for the application of fire engineering principles to the design of buildings came from designers, and an initiative by BSI to provide a Code of Practice on the subject was begun.

DD 240 code of practice

In 1989 a format and list of contents for a comprehensive Code of Practice was presented to BSI. It was intended that the proposed code would cover general principles, life safety considerations, property safety considerations, mitigation of socially unacceptable events and reduction of economic loss.

By the end of 1990, a small panel of fire safety engineers was formed with the support of Warrington Fire Research Centre, to undertake a three-year contract, administered by BSI, which would culminate in a Code of Practice giving a framework for the fire engineering design of buildings. The panel first met in March 1991. BSI published the draft Code of Practice as a Draft for Development DD 240 in 1997.

DD 240 was described at the time as being the most important document produced in the UK in support of the use of these more fundamental approaches to fire safety design. It provided the designer and the regulatory enforcement authorities with an overview of what was considered to be necessary. It was structured into sub-systems and, importantly, it indicated that there were still gaps in knowledge, and that much had still to be achieved by the use of engineering judgement.

Since the publication of DD 240, under the direction of the Standards Policy and Strategy Committee, FSH/24 remains the Technical Committee responsible for the development of standards for fire safety engineering in buildings. FSH/24 has been responsible for developing, from DD 240, the standard BS 7974. The British Standard was published in 2001.

FSH/24 and BS 7974

The work of FSH/24 is continuous. As research progresses and knowledge expands, the standard and its supporting documents evolve. The last part to be written from scratch was PD 8, which was published in 2012, and the last revision was PD 5, which was renewed in 2014. PD8 is an interesting document, because it describes the use of an established business continuity management tool in a novel way. It introduces the concept of using an organisation's Business Impact Analysis to inform the fire safety objective setting, right at the start of the QDR (Quality Design Review) process, ensuring the design team meet the specific resilience objectives important to the client.

It is generally agreed that traditional prescriptive design techniques can stunt innovation and creativity, and are impossible to apply sensibly to buildings with special functions, such as entertainment venues, high-rise developments, sports stadia, and airports.

Fire safety engineering has freed up building design, whilst, thanks to the standardisation of the process as documented in BS 7974, fire safety engineering has provided suitable levels of safety, when carried out properly.

We see BS 7974 as a key process for facilitating such design freedoms, whilst giving a robust methodology for ensuring adequate levels of safety and resilience are provided.

And that's why we embarked on a renewal programme to ensure the standard, and all supporting documents, remain relevant, current and useful.

Five year review

During 2016, FSH/24, the technical committee that oversees and maintains the standard BS 7974, and associated documents, reviewed the suite as part of BSI's five-year cycle. It was decided that the suite required revision. Panels of leading experts were formed and the revision process began.

Since 2016, the Panels have worked tirelessly to critically appraise their document, update the contents, and totally re-write in some instances. All draft documents have been made available for public consultation as DPC, with all comments resolved.

Structure of BS 7974

BS 7974 is intended to provide a framework for the application of fire safety engineering principles to the design of buildings. It is supported by the PD 7974 series of Published Documents that contain guidance and information on how to undertake detailed analysis of specific aspects of fire safety engineering in buildings.

PD 1 to PD 7 provide a summary of the state of the art and it is intended that they are updated as new theories, calculation methods and/or data become available.

The parts of PD 7974 are structured as follows:

- **PD 7974-1**, Initiation and development of fire within the enclosure of origin
- **PD 7974-2**, Spread of smoke and toxic gases within and beyond the enclosure of origin
- **PD 7974-3**, Structural response and fire spread beyond the enclosure of origin
- **PD 7974-4,** Detection of fire and activation of fire protection systems
- **PD 7974-5**, Fire service intervention
- **PD 7974-6**, Occupant evacuation, behaviour and condition
- **PD 7974-7**, Probabilistic fire risk assessment

PD 1 provides guidance on evaluating fire growth and/or size within the enclosure of fire origin, as well as enclosures to which the fire has subsequently spread.

The characteristics and products of the design fire for any particular scenario are influenced by a number of factors, including building design, environmental influences, potential ignition sources and location, types of combustible materials, distribution and arrangement of combustible materials, ventilation conditions and other events occurring during the fire. The determination of the characteristics and products of the design fire from ignition through to decay is used by other sub-systems.

PD 2 contains guidance and information on how to undertake quantitative analysis for smoke control. This PD is a summary of the latest knowledge and techniques and it does not preclude the use of appropriate methods and data from other sources. When used by suitably qualified persons, experienced in fire safety engineering, this PD provides a means of establishing acceptable levels of fire safety economically and without imposing unsuitable constraints on aspects of building design.

Whilst sub-system 1 (see PD 1) provides information on the rate of production of heat and combustion products from the fire source, the aim of sub-system 2 is to provide design approaches to estimate the spread of the combustion gases within and beyond the room of origin and to evaluate their properties, i.e. temperature, visibility and concentration of toxic products.

PD 3 considers the following the conditions that lead to fire spread beyond the enclosure of fire origin, the selection of design fires depending on the objectives of the assessment, the thermal and mechanical response of the enclosure boundaries and its structure to the fire conditions, the impact of the anticipated thermal and mechanical responses on adjacent enclosures and spaces; and the structural responses of loadbearing elements and their effect on structural stability, load transfer and acceptable damage according to the design and purpose of the building.

It also provides a methodology for establishing the extended application of fire resistance test results.

PD 4 has now been withdrawn; it provided guidance on the detection of fire and activation of fire protection systems. This guidance is now included in the various parts of the PD 7974 series and other standards covering the subject. PD 4 is referred to as part of the PD 7974 series for the sake of completeness but is no longer maintained as a current document.

PD 5 provides guidance on the necessary interaction with fire and rescue service intervention activities. This Published Document applies irrespective of whether the design objective, or fire and rescue service activities, are intended to support life safety, property, business, mission, or heritage protection objectives, as defined in the QDR process. It provides an understanding of both the capabilities and limitations of fire and rescue service intervention, and takes into account the physiological demands on fire-fighters, the fire-fighting procedures that are used and the limitations of fire-fighting equipment.

It also contains analytical tools that allow an analysis of fire and rescue service intervention and offers a range of approaches that could improve the efficiency and effectiveness of fire and rescue service intervention if analysis indicates that design objectives might not be achieved.

PD 6 provides guidance regarding the evaluation and management of occupant behaviour during a fire emergency and for the evaluation of occupant condition related to exposure to fire effluent and heat. This Published Document addresses the parameters that underlie the basic principles of designing for life safety and provides guidance on the processes, assessments and calculations necessary to determine the location and condition of the occupants of the building, with respect to time. This is achieved using the information presented on the evaluation, quantification and management of occupant behaviour, particularly escape behaviour, during a fire emergency. This Published Document also provides a framework for reviewing the suitability of an engineering method for assessing the life safety potential of a building for its occupants.

PD 7 provides guidance on probabilistic risk. It sets out the situations in which a probabilistic risk assessment can add value to traditional deterministic analyses and outlines acceptance criteria for the assessment. Furthermore, common analysis techniques of probabilistic risk assessment are summarily discussed.

This Published Document also includes data for probabilistic risk assessment based on fire statistics, building characteristics and reliability of fire protection systems.

Summary of changes in 2019 revision

BS 7974 has been subject to a full revision of the standard, and introduces the following principal changes:

- the incorporation of recommendations previously contained in PD 7974-0:2002 and PD 7974-8:2012;
- a greater emphasis on the competence of the fire safety engineer;
- additional recommendations for the quality assurance and verification of fire safety engineering reports; and
- the terminology used has been simplified and consolidated. The underlying process of fire safety engineering based on the qualitative design review has not changed, but every effort has been made to ensure that the terms used to describe that process are consistent throughout the standard.

PD 1 has been substantially restructured and fully revised. It introduces the following principal changes:

- consolidation of all principal design fire development considerations into sub-system 1 which are subsequently called upon as an input for other sub-systems (e.g. 2 and 3);
- greater clarity regarding the phases of fire development;
- design correlations that logically follow a conventional fire timeline of events;
- where practicable, explicit acknowledgements of the inherent assumptions underpinning design correlations;
- further generalization of design approximations for growing fires;
- revised correlations with respect to ignition, heat flux from localized fires, pre-flashover compartment fire temperatures, and sprinkler-controlled fires;
- the introduction of a travelling fire framework for fully developed fires that might not develop to flashover;
- improved reference data for smoke and toxic gas yields;
- removal of some reference data as it is either too generalized or out of date.

PD 2 has been significantly updated. It introduces the following principal changes:

- greater clarity regarding smoke control design principles, application and procedures;
- new information on the practical application of natural and mechanical smoke control, and the use of smoke barriers;
- rationalization of guidance on computer simulation modelling principles, as the intent of this guide is smoke control rather than computer fire modelling;
- where practicable, explicit acknowledgements of the inherent assumptions and limitations of underpinning design correlations;
- revised and new correlations with respect to spill plumes and the axisymmetric plume;
- new figures to aid the correct use of design correlations;
- calculation of smoke detection time for activating smoke control;
- greater clarity on design considerations for smoke reservoir; size, and the interaction between sprinklers/ smoke ventilation;
- improved reference data for smoke and toxic gas yields.

PD 3 has been substantially restructured and fully revised. It introduces the following principal changes:

- the content has been updated to include the recommendations in the latest standards and guidance documents;
- design fires for structural fire engineering have now been integrated with PD 1 and a new section on design fire selection process has been introduced in PD 3. Additionally, the inherent assumptions and limitations of adopting these design fires have been explicitly stated;
- the section on potential mechanisms for fire spread has been expanded;
- the potential use of risk based concepts described in PD7 for the purposes of PD3 has been added;
- information such as material properties that was available in other British Standards has been removed to avoid repetition and reduce the length of the document;
- the layout of the document has been re-arranged so that self-contained technical information is provided as an annex.

PD 5 is, at the time of writing, being reviewed. It is likely that some minor revisions will be made to the document to reflect changes in practice, advancement in knowledge and theory, and emerging lessons from recent events.

PD 6 has been substantially updated and represents a full revision, and introduces the following principal changes:

- the principal guidance and bibliography have been updated in line with recent developments and publications since 2004;
- the data tables in the annexes have been expanded to include more recently published data and bibliography;
- a full set of expressions has been provided for fractional effective dose calculations with worked examples to illustrate the calculation methods.

Continued overleaf

PD 7 has been largely re-written. It introduces the following principal changes:

- the PD has been re-written in a more appropriate style for this topic, which is becoming more popular in fire safety analyses;
- the Design Approach includes objectives and use of probabilistic risk assessment (PRA) in fire safety engineering, and the steps taken in carrying out a PRA;
- Acceptance Criteria are discussed in detail with a framework defined. PRA are also described in terms of application to life safety objectives.
- Analysis methods are described and compared, including the evaluation of probabilities, consequence evaluation, fire risk indicator quantification and sensitivity analysis;
- Data collection for PRA is introduced as a topic, with updated statistical data presented in Annexes.

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