PD 7974-3:2019

BSI Standards Publication

Application of fire safety engineering principles to the design of buildings

Part 3: Structural response to fire and fire spread beyond the enclosure of origin (Sub-system 3)

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Summary of pages
This document comprises a front cover, and inside front cover, pages i to vi, pages 1 to 118, an inside back cover and a back cover.

Foreword

Publishing information

This Published Document is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2019. It was prepared by Technical Committee FSH/24, *Fire Safety Engineering*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This Published Document supersedes PD 7474-3:2011, which is withdrawn.

Relationship with other publications

This Published Document is one of a series of documents published under the Fire Standards Policy Committee, and is a supporting document to BS 7974, *Application of fire safety engineering principles to the design of buildings — Code of practice*.

Other documents in the series are:

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 7974-4: *Detection of fire and activation of fire suppression systems*;

PD 7974-5: *Fire service intervention*;

PD 7974-6: *Evacuation*;

PD 7974-7: *Probabilistic risk assessment*.

Where appropriate, references to relevant standards are provided in order to assist the reader in understanding the design methodologies presented and to compare different approaches or sources of data. It is therefore important that PD 7974-3 is not used in isolation and reference is made to the relevant standards, particularly in relation to additional notes and subclauses describing its application.

Information about this document

This is a full revision of the standard, and 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 7974-1 and a new section on design fire selection process has been introduced. Additionally, the inherent assumptions and limitations of adopting these design fires have been explicitly stated;
- the information on potential mechanisms for fire spread has been expanded;
- the potential use of risk-based concepts described in PD 7974-7 has been added for the purposes of PD 7974-3;
- 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.

This and the other Published Documents (PDs) in this series contain guidance and information on how to undertake quantitative and detailed analysis of specific aspects of design. It is intended that they be updated as new theories, calculation methods and/or data become available.

However, it is important to recognize that the information contained within PD 7974-3 does not preclude data, information or methods of analyses from other sources, such as published peer reviewed research, manufacturers' data or codes of practice prepared on behalf of the construction materials industry, professional engineering and technical institutions and other professional bodies.

BS 7974 was first published in 2001. Since then there have been substantial changes in understanding in the behaviour of fire in the built environment and how materials and construction systems respond at elevated temperatures. Not least, the structural Eurocodes on Fire Actions have been published as full European Standards. These have resulted in revised formulations on the behaviour of structural components in fire, as well as new data on the thermal and mechanical properties of the various materials used in building construction. One of the most significant and recent advances in the understanding of buildings in fire has come about as a result of studies of experimental major fires in full size structures and the ensuing guidance this has generated on analysing the structural behaviour of the framework and compartmentation.

However, where understanding the behaviour of construction systems and building products cannot be quantified, or there are no specific analyses of some aspects of fire spread beyond the enclosure of origin other than the performance of products based upon a fire resistance furnace test, a commentary is given on the particular issues that need to be considered and how these could be treated.

A fire safety engineering approach that takes into account the total fire safety package can provide a more economical solution than prescriptive approaches to fire safety. In some cases, it is the only viable means of achieving a satisfactory standard of fire safety in some large and complex buildings.

A major issue in the determination of the structural response is the application of time equivalent methods in specifying an equivalent period of heating in the standard fire resistance test furnace. Any outputs need to consider the consequences of failure in relation to the particular occupancy and building dimensions (height and compartment size) and its location in the building, for example, BS 9999 specifies a risk-based approach for occupant life safety in building structures.

Fire safety engineering has many benefits. The use of BS 7974 facilitates the practice of fire safety engineering and, in particular:

a) provides the designer with an organized approach to fire safety design;

b) allows the safety levels for alternative fire safety designs to be compared;

c) provides a basis for selection of appropriate fire protection systems;

d) provides opportunities for innovative design; and

e) provides information on the management of fire safety for a building.

Fire is an extremely complex phenomenon and there are still gaps in the available knowledge. When used by suitably qualified and competent persons experienced in fire safety engineering, BS 7974 and its associated PDs provide a means of establishing acceptable levels of fire safety economically, without impeding building design.

For the purpose of this Published Document, spread of fire beyond the enclosure of origin is deemed to have taken place when any material outside of the fire enclosure ignites or suffers thermal degradation. Structural response is the interaction of loadbearing and non-loadbearing elements or frames as a result of thermal and/or mechanical actions due directly or indirectly to a fire. The level of sophistication employed to evaluate fire spread can vary. For example, a simple decision can be

taken that the creation of any openings or gaps in the enclosure boundaries precipitates fire spread. Alternatively, more complex analyses can be employed to consider whether flames project from openings in the enclosure's boundaries and whether such flames ignite or degrade materials outside the enclosure.

Use of this document

As a guide, this part of PD 7974 takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

This publication is not to be regarded as a British Standard.

Presentational conventions

The provisions of this Published Document are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller, italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Published Document cannot confer immunity from legal obligations.

1 Scope

This Published Document provides a framework for developing a rational methodology for design using a fire safety engineering approach through the application of scientific and engineering principles to the protection of people, property and the environment from fire. This Published Document considers the following issues:

a) the conditions that lead to fire spread beyond the enclosure of fire origin (see also Annex A);

b) the selection of design fires depending on the objectives of the assessment (see also Annex B);

c) the thermal and mechanical response of the enclosure boundaries and its structure to the fire conditions (see also Annex C and Annex D);

d) the impact of the anticipated thermal and mechanical responses on adjacent enclosures and spaces; and

e) 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 (see also Annex E and Annex F).

Annex G provides a methodology for establishing the extended application of fire resistance test results.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this Published Document the terms and definitions given in BS EN ISO 13943 and the following apply.

3.1 calculations (in support of extended application)

calculation methods that can be applied to one or more parameters of a tested construction and which are based on existing physical laws, or have been empirically validated and form part of the process of defining the extended application

3.2 consequence

damage that would occur if the structural failure has occurred or the time-equivalent period has been exceeded

NOTE *With respect to Approved Document B of the Building Regulations for England & Wales [1], consequence is directly proportional to height.*

3.3 construction parameter

aspect of the design and construction of an element that can be varied and which can result in a change in the fire resistance performance

NOTE *For example, a change in one or more of the dimensions of a stud in a stud framed separating element.*

