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BSI Standards Publication

PUBLISHED DOCUMENT

Application of fire safety engineering principles to the design of buildings

Part 3: Structural response and fire spread beyond the enclosure of origin

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Foreword

Publishing information

This Published Document is published by BSI and came into effect on 30 November 2011. 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This Published Document supersedes PD 7474-3:2003, which is withdrawn.

Information about this document

This Published Document (PD) is one of a series of documents published under the Fire Standards Policy Committee, and is a supporting document to BS 7974, *Code of Practice on the Application of Fire Safety Engineering Principles to the Design of Buildings*. Other documents in the series are:

PD 7974-0: *Guide to design framework and fire safety engineering procedures*;

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*.

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.

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.

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Introduction

This Published Document is one of a series of documents intended to support BS 7974, *Code of Practice on the Application of Fire Safety Engineering Principles to the Design of Buildings*.

This and the other Published Documents (PDs) contain "state of the art" 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 should 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 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.

Throughout PD 7974-3 reference is made to relevant codes of practice. Where appropriate, relevant extracts are provided in order to assist the reader in understanding the design methodologies presented and to compare and contrast between 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 codes of practice, particularly in relation to additional notes and sub-clauses describing its application (see Figure 1).

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. The Published Document considers the following issues:

a) the conditions within a fire enclosure and their potential to cause fire spread;

b) the thermal and mechanical response of the enclosure boundaries and its structure to the fire conditions;

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

d) 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;

e) fire following structural impact to the building.