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# Guide to the development of fire tests, the presentation of test data and the role of tests in hazard assessment

ICS 13.220.40; 13.220.50

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee FSH/3, Harmonization of fire hazard assessment, upon which the following bodies were represented:

Consumer Policy Committee of BSI
Department of Trade and Industry — Consumer Safety Unit, C A Division
Health and Safety Executive
Home Office
Loss Prevention Council
Society of British Aerospace Companies Limited

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Committee reference FSH/3
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# Contents

# Foreword

This British Standard was prepared under the direction of Technical Committee FSH/3. It supersedes BS 6336 : 1982 which is withdrawn.

The first edition of BS 6336 was published in 1982 and was derived from DD 64 : 1979.

By 1995, BS 6336 needed to be revised to take account of developments in the subject, particularly in the areas of fire safety engineering and terminology. The major changes were to restructure the document so that the guidance was contained in the main body of the document and the descriptive elements were separated into annexes. In addition the term 'hazard concept' was rephrased as 'hazard component'.

The guidance in this British Standard is generally in line with the approach to fire testing being developed in the International Organization for Standardization (ISO), though in some respects it may not accord with the national practices of other countries.

**Compliance with a British Standard does not of itself confer immunity from legal obligations**.

**Summary of pages**

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 26, an inside back cover and a back cover.

## Introduction

There are over 450 000 fires each year in the UK and the cost is high: about 700 lives lost, many thousands of serious injuries and hundreds of millions of pounds worth of direct damage. A wide variety of materials, products, structures and assemblies is involved and for a number of years much concern has been expressed, both in the UK and internationally, over the use of inappropriate and possibly misleading results from fire test methods to assess the behaviour of such objects in fires. There has also been concern over the use of misleading fire terminology and the misuse of fire test data, particularly small-scale test results, as the sole indicators of fire safety.

It is hoped that the use of this British Standard will ensure in the interests of public safety that no one will misrepresent facts about fire tests or use their results in such a way as to give a false impression of fire safety.

This British Standard is intended to help anyone who prepares a specification or code of practice involving a material or product that can ignite, burn or overheat to take due account of any fire hazard which may arise from the use of that material or product. This it does by indicating the steps which are necessary in designing or updating fire tests, and by showing how the results should be applied in fire engineering and other fields.

This British Standard gives guidance to those concerned with maintaining acceptable standards of safety from fire and those concerned in any way with fire tests, fire test data and fire hazard assessment. It is intended to help writers of specification standards; standards, regulatory and enforcement bodies; fire safety engineers; designers and architects; manufacturers and fabricators; wholesalers and retailers; safety managers; consumer advice services and educational bodies; and any group which needs to use fire terminology.

The standard is also intended to help anyone purchasing, specifying or using materials or products to understand the need to consider the possible fire hazard and the way in which fire tests may help in assessing that fire hazard. It will help them too to understand the need to consider any special precautions that may be required for the safe use of these items in specific environments.

**Fire tests in isolation can never guarantee fire safety**.

## 1 Scope

This British Standard provides guidance on the development and use of fire tests, including advice on the circumstances when new tests should be standardized. It sets the need for fire tests into the context of the assessment of fire hazard. Recommendations on the use of related terminology are included as is a qualitative outline of fire theory.

## 2 References

### 2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 26. For dated references, only the edition cited applies; any subsequent amendments to, or revisions of, the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

### 2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on page 26, but reference should be made to the latest edition.

## 3 Definitions

For the purposes of this British Standard, the following definitions apply.

NOTE. Some of the technical terms used in this standard are not defined elsewhere. However, where definitions have been extracted or derived from another source, that source is given.

**3.1 assembly**

Unit or structure composed of a combination of materials or products or both.[1)]

**3.2 fire**

a) Process of combustion characterized by the emission of heat and effluent accompanied by flame, and/or glowing.

b) Rapid combustion spreading uncontrolled in time and space.[1)]

**3.3 fire hazard**

Potential for injury and/or damage from fire.[1)]

**3.4 fire model/modelling**

Simulation of some aspects of fire by mathematical or physical means.

1) Taken from ISO/IEC Guide 52

**3.5 fire resistance (time)**

Ability of an assembly, part or structure, to fulfil for a stated period of time the required load bearing capacity, fire integrity, thermal insulation and/or other functions, specified in a fire resistance test standard.

NOTE. Fire resistant (adjective) refers only to this ability.

**3.6 fire risk**

Product of:

a) the probability of occurrence of a fire to be expected in a given technical operation or state; and

b) the consequence or extent of damage to be expected on the occurrence of a fire.[1)]

**3.7 fire scenario**

Description of conditions, including environmental, of one or more of the stages from before ignition to the completion of combustion in an actual fire at a specific location, or in a full scale simulation.[1)]

**3.8 fire test**

Procedure designed to measure or assess the response of an object to conditions simulating one or more aspects of fire.

**3.9 flame (verb)**

To undergo combustion in the gaseous phase with emission of light.[1)]

**3.10 flame (noun)**

Zone of combustion in the gaseous phase usually with emission of light.[1)]

**3.11 flashover**

Rapid transition from a localized fire to the combustion of all exposed surfaces within a room or compartment.

**3.12 flashback (backdraft, backdraught)**

Rapid transformation from a fuel rich fire to general combustion in an enclosure, that has been triggered by some change in circumstances which makes new supplies of oxygen available.

**3.13 hazard component**

Characteristic type of behaviour which is capable of contributing to a fire hazard.

**3.14 ignition risk**

Probability that, if a source of heat is allowed into close proximity or contact with a combustible material, ignition will result.

**3.15 intermediate-scale test**

Test performed on an item of intermediate dimensions.

NOTE. A test performed on a specimen of which the maximum dimension is between 1 m and 3 m is usually called 'an intermediate-scale test'.[1)]

**3.16 large-scale test**

Test which cannot be carried out in a typical laboratory chamber, performed on a product or a test specimen of large dimensions.

NOTE. A test performed on a specimen of which the maximum dimension is greater than 3 m is usually called 'a large-scale test'.[1)]

**3.17 life risk (from fire)**

Probability that, if a fire occurs, an individual or individuals will suffer death or serious injury.

**3.18 property risk (from fire)**

Probability that, if a fire occurs, damage to property of a given magnitude will result.

**3.19 real scale test**

Test which simulates a given application which takes into account the real scale, the real way of working or set up, and the use environment.[1)]

**3.20 risk of fire spread**

Probability of a fire, once started, growing to a size and character that could produce life risk or property risk or both.

**3.21 screening test**

Test used for ascertaining whether a material, product or structure exhibits (or not) certain unusual or expected characteristics according to a standardized test method.[1)]

**3.22 small-scale test**

Test, which can be carried out in a typical laboratory chamber, performed on a product or test specimen of small dimensions.

NOTE. A test performed on a specimen of which the maximum dimension is less than 1 m is usually called 'a small-scale test'.[1)]

**3.23 smouldering**

Slow combustion of material without visible light and generally evidenced by smoke and an increase in temperature.[1)]

**3.24 toxic hazard (from fire)**

Potential for injury or loss of life by exposure to toxic effluent in fires, with respect to their potency, quantity, concentration and duration of exposure.[1)]

**3.25 toxic potency**

a) Measure of the amount of toxicant required to elicit a specific toxic effect.

NOTE. The smaller the amount required, the greater the potency.[1)]

b) As applied to inhalation of smoke or its component gases; a quantitative expression relating to concentration and exposure time to a particular degree of adverse physiological response, for example, death, on exposure of humans or animals.

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[1)] Taken from ISO/IEC Guide 52

**3.26 toxic risk**

Product of

a) the probability of occurrence of a toxic hazard to be expected in a given technical operation or state; and

b) the consequence or extent of injury to be expected on the occurrence of a toxic hazard.[1)]

**3.27 toxicity**

a) Inherent properties of a substance to produce adverse effects upon a living organism (irritation, narcosis, death, etc).[1)]

b) Propensity of a substance to produce adverse biochemical or physiological effect.

**3.28 unacceptable hazard**

A degree of hazard that is regarded by society in general as too great to occur repeatedly.

## 4 Advice about fire behaviour

A brief introduction to fire behaviour is given in annex A. The first step to be taken by anyone concerned about fire hazards is to obtain expert advice.

A 'fire expert' can advise in general terms about how, when and where fires are likely to start and to develop. It is essential that decisions about how such general principles should be applied in a given situation should only be taken by people fully conversant with the technical details and likely usage or application of materials and components in that situation.

As an illustration of this, a fire specialist will be able to point to the likely ignition sources that could start a fire in the combustible materials in a car. Examples of the fuels available are the upholstery covering and padding, the floor and head covering, the wiring insulation and the petrol or diesel fuel for the engine. The specialist can also advise on how a fire, once started, could spread, and on measures to prevent this. However, only someone familiar in detail with the construction of cars will be able to identify the materials used, how exactly they will behave and the possibility of substituting materials with different fire properties. Thus, joint consultation is needed to determine the likelihood of a fire starting, the chances of its developing and the feasible means of halting the fire's progress. In this context the criteria of feasibility are suitability of non-fire behaviour, economic viability, ready availability, ease of manufacture etc. Similar considerations apply wherever a fire could start and develop.

This general approach of interdisciplinary consultation has been formalized in DD 240 : Part 1 : 1997. This subject is outlined in annex B and its relationship to fire testing is shown in clause **7**.

## 5 Fire hazard

### 5.1 General

It is implicit in the definition of fire hazard that the hazard exists in a particular physical situation. A piece of insulated wire, a ceiling tile or a flammable liquid cannot be considered as a fire hazard in isolation. A situation has to be envisaged in which the article is placed or used in such a way that some possibility of harm to life, health or property arises. This situation is termed the fire scenario. It is inherent in such scenarios that some way exists in which a source of heat can arise. Many other factors may also determine whether a fire hazard is present, and if it does how severe the consequences might be.

NOTE. See also annexes C and D.

### 5.2 Fire hazard assessment

#### 5.2.1 *General*

If any possibility of harm from the effects of fire can be envisaged in a given situation, the hazard should be assessed. It cannot be emphasized too strongly that attention to this has to be paid at an early stage in any proposal or design for a new product or building. Once the design has taken shape, the reduction of fire hazard is likely to be much more difficult and costly. The recommendations in DD 240 are intended to be used at this stage for exactly these reasons.

The assessment process may have to be repeated many times, according to the different ways in which the material, product or design concerned can be involved in a physical situation with a potential for harm.

As in forecasting the behaviour of fire, (see clauses **4** and **8**), joint consultation should take place between a fire expert and specialists in the relevant materials, plant, equipment or building who are familiar with their characteristics under normal, everyday conditions. In this way, the general theory of fire can be applied to realistic hypothetical situations, and decisions can be taken about the severity of fire hazards and the prospect of reducing them.

#### 5.2.2 *Acceptability*

Once identified, the acceptability or otherwise of a fire hazard has to be decided. The point at which the hazard becomes unacceptable should be determined, if possible quantitatively. For instance, the use of a flammable form of electrical or thermal insulation may only be an acceptable fire hazard if the material does not exceed a specified thickness. Whether or not a certain severity of fire hazard is acceptable depends on factors which may be practical, financial, social, psychological or even political. Figure 1 summarizes these factors. It should not be forgotten

[1)] Taken from ISO/IEC Guide 52

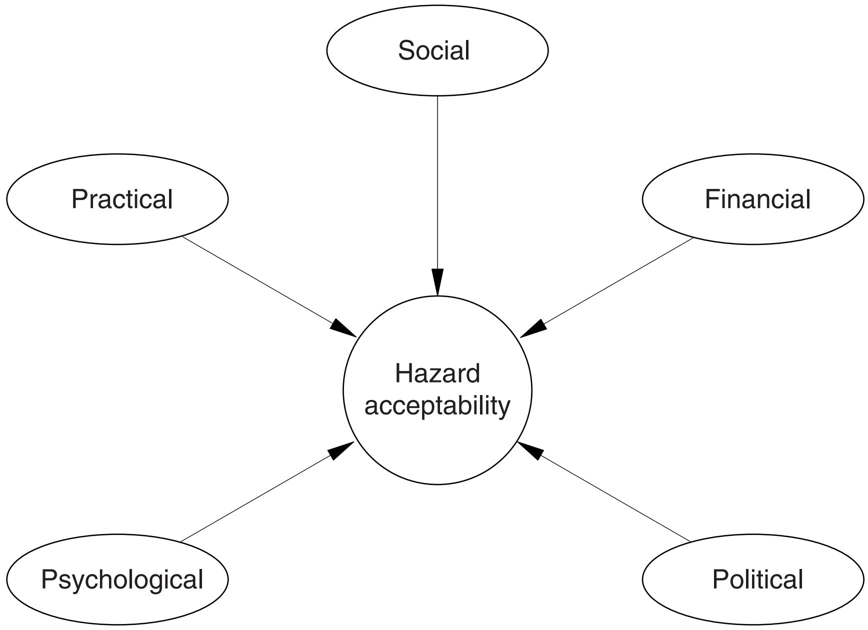


**Figure 1. Factors affecting acceptability of hazard**

that fire hazard can in some circumstances be controlled by fire protection and even fire-fighting measures. The spur for the development of fire safety engineering was the need to offset undesirable properties of materials or products by improvements in design processes, fire protection installations and fire safety management.

In most cases, the final decision on acceptability will lie with a regulatory or control authority with statutory powers.

**5.2.3** ***Fire hazard control***

When a fire hazard has been identified and assessed, steps should be taken to control the hazard, i.e. to bring it within the limits of acceptability. This task is made easier if the risk of harm is separated into its component probabilities. The course of action required should then be more evident. These probabilities can be expressed as follows:

a) fire risk, comprising

1) ignition risk;

2) risk of fire spread;

b) life risk;

c) property risk.

The probabilities involved can be developed as illustrated in **C.3**. Two examples of overall consideration of fire hazard are given in annex D.

## 6 The role of fire tests

Fire tests can be a vital factor in seeking detailed answers to the questions that have to be put in identifying and assessing fire hazards. They will be of help in ascertaining whether one material is likely to be the starting point of a fire through chance contact with a source of heat; whether another material, product or design will tend to spread fire rapidly; whether an enclosure or barrier will hold back fire for long enough; whether an assembly of electrical components will overheat dangerously under overload, etc. This view of the role of fire tests is summarized with examples in figure 2. Annex E categorizes fire tests in greater detail and justifies some recommendations of this standard.

If a fire test is correctly designed and performed, it may in some cases be the only available and reliable indication of an article's behaviour in a particular fire situation. However, because of the complex behaviour of fire, as described in annex A, the ability of a fire test result to provide information should not be overestimated. It can virtually never predict the course of an actual fire. It can only predict the behaviour of the test object in the unavoidably restricted situation of the test itself. This means that a fire test cannot evaluate fire hazard, though it can contribute to the assessment of some part of it. A fire test result that shows an acceptable performance by the test object can never of itself guarantee safety. One of the most important parts of any fire test method document is a list of the limitations of the test, as advised in **14.3**.

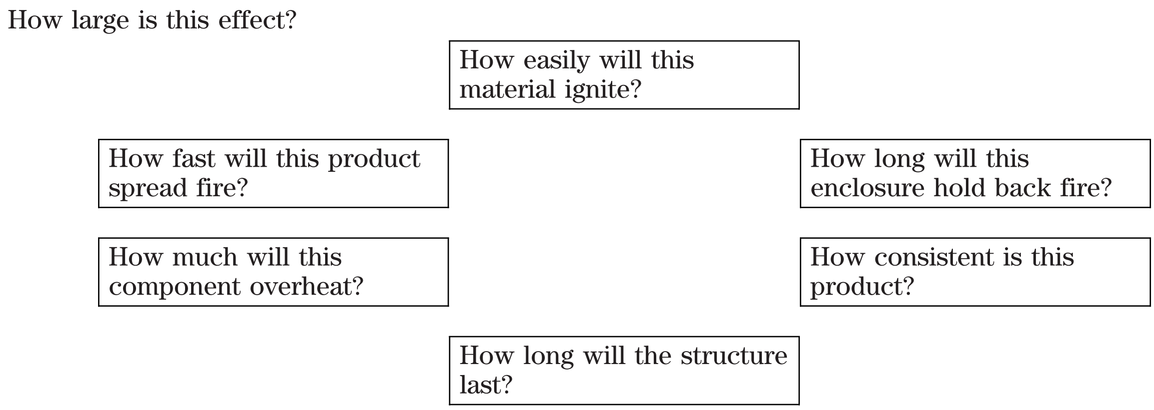


**Figure 2. Role of fire tests in answering questions of magnitude**

## 7 The relationship between fire tests and fire safety engineering

Fire tests provide much of the input data required for the calculations and procedures performed by fire safety engineers. This use of test results will become even more important in the future, so the development of tests should aim to assist this usage. Tests which attempt to measure parameters for the prediction of fire development should be designed to yield data of the types and in the forms needed for this later usage. Part of the interface between the two areas is already common to both, in that the list of hazard components provided by the first edition of this British Standard is widely used. There is however a difference in approach between the typical fire test and the typical fire safety engineering exercise. The former often relates to specific, early events in the course of a fire. The latter deals to a greater extent with many, late occurring events. This is not a fundamental division, as it has arisen from the practicalities and economics of testing. Some large-scale fire scenarios can never be tested. Others cannot be tested on a regular basis. This is the gap in testing that fire safety engineering procedures are intended to fill. The difference of approach does mean that it is important that all fire tests clearly explain the scenarios, and particularly the limitations of the scenarios, to which they are intended to apply.

The techniques of fire safety engineering will only produce results that are as reliable as the data used. Some fire tests need to have their precision improved before reliable engineering use can be made of the data produced. In other cases suitable data will be missing. Further, buildings are subject to constant change (e.g. the layout of departments in a store may alter). Even if the facts relating to an initial situation are known, constant attention will be needed by safety personnel to ensure that the assumptions of an initial review of the design are not nullified unwittingly.

## 8 Mathematical models

In recent years techniques have been in development for predicting the course of real fires by computer calculations on the basis of a limited number of fundamental parameters measured by specific tests. At present, this objective cannot be fully achieved. If it were attained, fire dangers might be reduced by less costly means than the present test regimes. In other circumstances, for example, to assess the hazards of an unbuilt building, it may be impossible to perform fire test procedures. In these cases the predictions of mathematical models might be substituted for fire test results. The principles of this British Standard should therefore also be applied to this new type of performance prediction. In addition, the following other special precautions should be taken before using predicted model results to evaluate safety.

a) Before utilizing results, the theoretical science on which the calculations are based should be rigorously validated and subjected to peer review. This aspect is dealt with more extensively in **6.2** of ISO/DIS 13389.

b) Before utilizing results, the software codes should be checked by a third party using the guidelines in **6.6** of ISO/DIS 13389.

c) The limitations on the accuracy of the predictions should be shown whenever results are used. These will consist of two classes, the first being the uncertainties in the measured data and the second the numerical accuracy of the calculation algorithms. These are covered in clauses **8** and **7** respectively of the ISO document.

d) Predictions affecting life safety should always be checked by actual tests and measurements. The computed results may allow these tests to be focussed on to critical aspects, so reducing the number and cost of tests.

These precautions are intended to uncover hidden assumptions and to evaluate their validity. If the assumptions are made explicit, the limits of validity of calculated results become clearer, and therefore the applicability of a model to situations changed by the availability of new products can be better judged.

Mathematical predictions ***in isolation*** can never guarantee fire safety.

Further details of the current state of the art in deterministic mathematical modelling are given in annex F.

## 9 Development of fire tests

### 9.1 Analyse responses to fire

A detailed analysis is required to determine whether or not a fire hazard exists. This analysis should show what properties are possessed by an item, or in which ways it can behave, such that it can contribute to the hazard. This will in turn indicate what tests are necessary to assess the response of the item to one or more of the stages of fire described in **A.2**. An example of these steps is given in **D.2**.

### 9.2 Hazard components

In the great majority of cases, the main properties or functions requiring to be examined will consist of one or more of the following:

a) ignitability;

b) combustibility;

c) softening and melting;

d) surface spread of flame;

e) rate of heat release;

f) rate of smoke (or gas) release;

g) toxicity of combustion products;

h) fire resistance;

i) flame penetration;

j) smoke (or gas) penetration.

These properties or functions are not basic single physical concepts, but may combine several more fundamental phenomena. They are elements of the ways in which a material or assembly can contribute to fire hazard, and are referred to as 'hazard components' (see **3.13**). More detailed explanations of all of these components will be found in annex G.

### 9.3 Fire test formulation

#### 9.3.1 *General*

With the exception of one-off simulations, fire tests do not exist in isolation, but form part of a system intended to control materials or products. It is necessary that tests are used to check an object against the levels of acceptability in a specification standard, or for conformity to a regulation, if there is to be uniform performance of products, assemblies or buildings.

The development of a fire test is therefore often undertaken as part of the development of a specification standard, though certain test series are called up by legislation as well as national or international specification standards. It is important that such standards apply to all materials and products intended for a particular purpose rather than to particular materials and products. If, for simplicity, regulations and specification standards are grouped together, the processes which produce specifications and tests are shown in figure 3.

#### 9.3.2 *Hazard component selection*

The first stage of the development process should be to assess the hazard. The subsidiary steps of identification and quantification should be performed with the assistance of appropriate experts both in fire and the article to be controlled (see clause **4**). If the hazard is judged to be acceptable with respect to the influences described in **5.2.2** and figure 1, the regulation or specification standard need not control the hazard nor use a fire test. If the hazard assessment proves to be unacceptable, a test will be needed to measure the critical parameters. At this stage, test development, as distinct from the development of a specification standard, should be started, as shown in figure 3.

#### 9.3.3 *Choice of fire test method*

Once the characteristics to be covered in a test have been decided, the next step to be taken is a survey of existing tests. If one of these is considered satisfactory, this test should be used. In this way the proliferation of similar but not identical tests can be slowed. This is a worthwhile end in itself, but economies of time and resources will also be made by using an existing test.

Six general criteria may be used to decide upon the fire test to be used. In order of importance these are:

a) relevance to reality;

b) precision;

c) discrimination;

d) apparatus independence;

e) operator safety;

f) ease of use.

These criteria are described in greater detail in annex H.

If no test is found to be suitable, the factors listed above need to be considered in formulating a test, although in some cases it may be necessary to compromise if different factors are contradictory. The example given in **D.1** on the fire hazard arising in the use of polystyrene tiles should be reviewed.

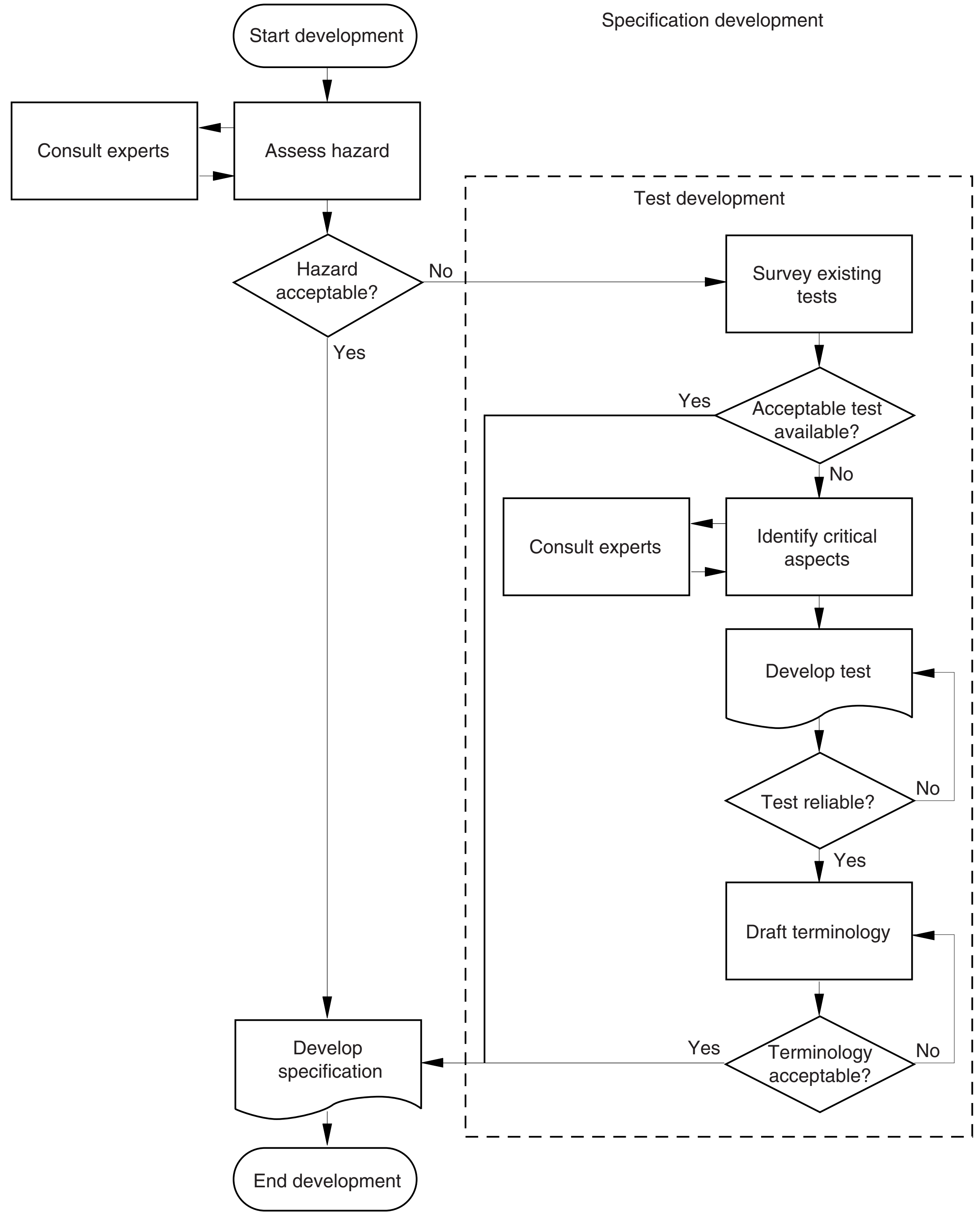


**Figure 3. Flowchart for test and specification development**

The process of choosing the critical conditions and hazard aspects should take the form of an interaction between regulators, producers, users, specifiers and testing experts. The aim is to produce the clearest possible brief for the test developers. It is important that the test conditions chosen should cover a similar range to those encountered in real fires. The test conditions should never be artificially limited to favour the performance of test objects (see **H.1** for a cautionary example).

**9.3.4** ***Devise terminology***

The final step in test formulation is to prepare the terminology or code system to express the results. These parts should follow the guidelines given in clauses **10**, **11**, **12** and **13**.

## 10 Fire test terminology

### 10.1 General

Experience has shown that there is a danger of confusion arising in the terminology relating to fire tests. This can occur because of a tendency to ascribe properties or qualities to materials, products, etc. without proper regard to the relationship between the test to which they have been subjected and fire hazard as a whole. Thus, a fire test may be performed on an article and the latter may be 'successful' in the test.

This result may lead to descriptions of the article that reflect that success. In turn, these descriptions may label the article as having some favourable property or performance in any fire situation. If, however, only a very limited aspect of performance is measured by the test, as will normally be the case (see clause **6**), the claim may be dangerously misleading, and this has proved to be the case in the past. Confusion can also arise if the name or description of a fire test does not truly reflect the hazard component that is being measured (fire resistance is an exception, see **G.1.7**).

To avoid confusion, two general principles should be followed.

a) Fire tests should be so drawn up that the expression of their results does not indicate success or failure; this is dealt with in clause **12**.

b) Terms used in fields involving fire tests should be either completely neutral or at least not favourably biased.

A 'neutral' term is one that does not imply that a thing is good or bad, acceptable or unacceptable. A 'favourably biased' term implies good quality or desirability. Thus 'incandescence' is neutral; 'flame resistance' is favourably biased in that it implies a useful action or quality; 'flammability' is biased, but implies a dangerous quality or action.

Biased terms which are slanted towards good qualities should be avoided because of the danger that the useful action or quality may only apply in the narrow field of a specific fire test; the article is unlikely to possess that quality in all other circumstances. Only if a favourably biased term is unquestionably true in all circumstances is it safe to use it.

These principles are summarized in figure 4, which shows the spectrum of possible usages from 'desirable' to 'deprecated'.

***Principle: the terms used shall not indicate success or failure*.**

| | |
|---|---|
| Desirable terms: | Neutral bias<br>e.g. incandescence, charring |
| Acceptable terms: | Unfavourable bias<br>e.g. flammability, smoke obscuration |
| Questionable terms: | Favourable bias<br>e.g. flame resistance, ignition resistance |
| Deprecated terms: | Misleading bias<br>e.g. fireproof, self-extinguishing |

**Figure 4. Terminology: principle and examples**

### 10.2 Deprecated terminology

On the principle stated in **10.1**, fire test terms should not imply a claim that is:

a) incapable of being substantiated; or

b) give a misleading impression of performance; or

c) imply a judgment of performance in the unknown circumstances of a real fire situation.

Specifically, the use of the following terms is deprecated:

1) fireproof;

2) flameproof (except in connection with electrical apparatus as defined in BS 4727);

3) low/very low flammability;

4) non-ignitable/not easily ignitable;

5) incombustible;

6) inflammable;

7) resistant to burning;

8) self-extinguishing.

An exception may be made in cases where an existing national or international standard uses one of these words or phrases that is defined in the same standard; it is then temporarily permissible to use it if its source is indicated, but the aim is that all such terms ultimately shall be eliminated.

 

Incombustible and inflammable are included in the list to avoid confusion. They are used as synonyms for non-combustible and flammable respectively with the prefix ‘in-’ taking opposite meanings in each case. They are therefore deprecated.

**10.3 Recommended terminology**

It is recommended in **9.3.2** that a clear understanding should be reached as to which of the hazard components listed in **9.2** is to be assessed by the test. This should be done before any move is made to adopt or standardize a fire test. When the component has been decided, the terminology used for the test, particularly in the title, supporting wording and expression of test results, should be based upon the name of the hazard component being tested. It is important that the words chosen should be accurate and consistent in meaning. The wording should indicate that the test is intended to establish to what extent the item tested promotes danger. This may be done by implication, but the wording should never suggest that safety is being measured.

Phenomena which are only aspects of a hazard component, for example afterglow, charring, etc., have not been included in the component list, though they are acceptable neutral terms.

**10.4 Application of hazard components**

In examining the list of hazard components, the test under consideration may show itself not to be concerned with any of the components listed, but with a new one. In this case the principles given in **10.1** should be followed and the naming of both the hazard component and the test should be harmonized. Some guidance may be useful in the application of hazard components to the titles of standards.

a) The title of a fire test, its supporting wording and the expression of results should employ in a nominal phrase one of the words or phrases listed in **9.2** and no variant of that word or phrase (e.g. ignitability test, surface spread of flame test).

b) If more than one test exists or is anticipated for assessing the same hazard component, a word or words may be added to distinguish them, e.g. vertical ignitability test, hoop ignitability test, 45° ignitability test.

c) other wording supplementary to the title may be added, concerned with some special feature of the test, or to indicate its field of application, e.g. flame penetration (small flame) test, ignitability test for conveyor belting.

d) If a single test has a bearing on two hazard components and one of them is subsidiary to the other, the more prominent hazard component should be used for the title and the other may be ignored or included in the supplementary element.

e) It is sometimes expedient to incorporate more than one form of test in the same specification. An example might be the testing of an electrical circuit device. This may need to be checked once by electrical overload (‘internal heating’), and again by use of the needle flame source (‘external heating’). This may offer some problems in the expression of results, especially when two different hazard components are involved (see clause **13**). The title and supporting wording (e.g. the foreword) should clearly indicate the full scope of the test.

The construction of a test title from these elements is shown in figure 5.

Nominal phase: Hazard component

+

Descriptive distinction: Test details

+

Descriptive distinction: Usage details

No alteration should be made to the name of the hazard component

**Figure 5. Terminology: formation of test titles**

## 11 Use of fire test results

Fire test results are utilized in three major fields of activity, for regulatory, technical or commercial purposes. The users in these fields have needs which may conflict. For example, a specifier may wish to emphasize the possible dangers of a particular product but the salesman bringing the product to market may wish to emphasize the possible benefits. This standard attempts to guide all groups but places greatest weight on the need to avoid dangerous situations arising. This is considered to be most likely if non-technical product users are misled by statements of safety. This is the reason for the deprecation of favourably biased terminology.

An extension of this reasoning suggests that acceptance levels need wider examination than by testing specialists alone. Therefore these levels should be decided by more general groups such as regulators and/or specification standards’ committees rather than testing specialists. Therefore acceptance levels should appear in documents separate from the test method, or at least distinct parts of a common document. This conforms with the model formats used in other areas of standardization and it is further clarified in **12.1**.

It is important that the users of fire test results ensure that test certificates are relevant to the product of interest. Cases have been known where certificates many years old have been offered. No technology stands absolutely still, and test data that was measured more than ten years previously might not be fully representative of current production. No global limit can be suggested in a general standard such as this, because the limit will depend on the nature of the product. A particular design of steel door is not likely to need such frequent testing as the surface finish on walls in the corridor which it closes. Standards committees should consider whether a limitation on the age of test certificates should be included in their specification standards, and what this limit should be. Similarly, regular product certification will produce a better control system than type testing once only at the beginning of production.

NOTE. Regulators may impose different requirements.

Extreme caution should be used if an attempt is made to deduce the results of one test from data obtained from another. It is advised that this should never be done without checks based on actual experiments. Such a task requires that these extrapolation or cross-reference exercises take account of the effects of many ill-defined influences. There will generally be great difficulty in ensuring that a proper balance is achieved. The dangers resulting from a wrong prediction mean that this course of action should be strongly discouraged.

Technical committees drafting fire tests should be aware of the differing needs of prospective users so that a test document may be best fitted to the most significant groups of users of their standard. Further advice on the expected needs of users is offered in annex J.

## 12 Drafting of fire test method standards

### 12.1 Performance levels

A fire test standard should be a means of determining the performance attained by the test object, not of determining whether specified performance levels have been reached or not. A pass/fail test may of itself imply general fire safety (see **10.1**), and should be avoided. The acceptance or rejection function should be performed by a separate specification standard or regulation.

A further reason for this is that the inclusion of pass/fail criteria in the test would limit its usefulness by pinning the method and the criteria permanently together; the test may be rendered useless if there is some change in the performance level required.

One way of achieving this objective with an intrinsically qualitative examination such as ignitability is to group different severity levels into a single test as explained in **E.1**.

Statements of the level of performance required of the test object should be excluded from the test method. The required performance should either be specified in a separate standard or, if the test is included in a specification standard, it should be contained in a separately identified part of the text to the performance requirement. The test should stand by itself without qualification.

### 12.2 Limitations

Many fire test methods, such as those referred to in **F.2.1** as 'quality-control' tests are for screening purposes and are of very limited value as a means of assessing fire hazard. Such limitations should be clearly stated in the scope clause and in the requirements for the expression of results. Similarly, product specifications or codes of practice which refer to test methods having these limitations should carry a suitable warning to that effect. All fire tests will need similar indications, because all fire tests simulate some fire stages better than others.

Two examples of model limitations clauses are given in annex K. Expressions which are at least as detailed as these two examples should be incorporated into any fire test document. In test or specification standards, both the general and the specific areas of coverage and limitations should be given, but the emphasis should be placed firmly upon the specific arrangements of the test method, as general warnings have been misinterpreted to imply that an untested product is no more hazardous than one tested in accordance with a standard.

### 12.3 Supplementary information

Methods of test should include a definition or brief explanation of the hazard component on which the test is based. Supplementary information relating the hazard component to particular circumstances in the use of the product being tested may be added. Any special influences of the test conditions should be pointed out, such as the effects of humidity levels. References to studies or experiments which support the test should be given.

### 12.4 Test report

A specimen test report layout should be included in the document. This should contain not only the results themselves, but also brief forms of all the information listed above. The test conditions should be an essential part of the report as should be statements of the applicability and limitations of the test data.

## 13 Presentation of fire test results for professional and technical purposes

The aim in presenting the result of a fire test is to provide an index of performance in figures or letters. The index figure will most commonly be derived from the measurement of performance, for example a time, in seconds, or a length, in millimetres, of that part of the specimen that is burned in a given time. Where appropriate, it is acceptable to express test results in the form of a mathematical computation; an example of this is the index of performance given in BS 476 : Part 6. In those remaining cases, where it has not been possible to design a fire test to give a measured value that can be used as a performance index, an arbitrary neutral figure or letter should be used. The scale of possible values of the index should reflect the precision of the test (see **H.2**).

Standard product specifications or codes of practice should state the level of performance required by quoting the relevant index figure or letter, together with the number of the appropriate test method.

*Examples*

Flammability index of . . . . . . . . . . in accordance with BS EN ISO . . .

Fire resistance index of . . . . . . . . . . in accordance with BS EN ISO . . .

Care should be taken when designing the index system to avoid implying an order of relative merit in performance in fire: the great difference between a test situation and a real situation could render any such assumption misleading. It is only justifiable to allow an order of merit to be assumed when there is established evidence of the order of merit in relation to real fires. Similarly, words should not be used in association with test results that might imply a claim of a particular quality: an index of a particular value should not be referred to as a 'safe standard', for instance.

In cases where a fire test method has two or more elements, i.e. in which the sample is either tested by two different methods for the same hazard component, or for two or more components in the same method, it is important to give thought to the way in which the performance levels to be attained can be specified. It is simpler for the user if the results for the different stages can be combined arithmetically into one index, suitably 'loaded' in relation to the importance of each. A slightly more complex form of expression is to use a matrix to combine the indices. If a grid is set up with two different sets of possible indices shown vertically and horizontally, the areas of acceptance and rejection can be shown without the need for weighting factors. These approaches should, however, be used only when the results from the two parts can form a notional single index. If separate expressions are chosen, it is important that each part of the test method gives clear, unequivocal information in respect of the result.

## 14 Hazard control systems

### 14.1 General

Once a material or product has been tested, has yielded appropriate test result levels and has been placed on the market, users become interested in the fire properties of the object. These include those people who are responsible for the fire hazard control of the structure which contains the object. These people need to be informed about the fire scenario on which the hazard components tested were based.

### 14.2 Applications covered by the fire scenario

To assist the users of tests and test results, such as the safety management team for a building, a test method standard should always list the important features of the fire scenario which is imitated by the test. For example BS 476 : Part 7 requires that the substrate of the test specimen be stated as well as the adhesive used. Thus a designer seeking to use a particular wall covering should check that it has been tested together with materials representative of design proposals. The management team of a building will also be able to ensure that repair and refurbishment is effected with appropriate materials.

### 14.3 Limitations of the fire scenario

The information provided in a test document should also be sufficient to prevent the safety related decisions of the management team from overstepping the boundaries of the test scenario. An example is the Dublin 'Stardust' disco fire in the early 1980s (see *Dublin 'Stardust' discotheque fire* [1] and *An FPA review of the official report on the Stardust disco fire* [2]). In this fire one factor was the application of carpet flooring tiles to vertical walls. The usual test method for carpets is one in which the carpet is horizontal and there is no thermal irradiation additional to the small source. The use of these tiles from floor to ceiling took the service application beyond the tested limits and was a contributory factor in the deaths of 48 people. Several other factors were important, but the appropriate information provided to the interior designer or building user about the tile test methods might have helped to prevent the tragedy.

Those who draft fire test standards should ensure that the document contains an element which describes the limitations of the fire scenario. This should be provided in as much detail as can be foreseen to be necessary. The document should also contain a recommendation that these limitations are included in any test reports generated. Those who draft product specifications based upon the test results should take similar precautions.

## 15 Presentation of information

### 15.1 Guidance to manufacturers and traders

In the interests of public safety, it is important that information provided by manufacturers and traders about the fire characteristics of materials and products, in trade and advertising literature or in the labelling of goods, does not mislead consumers by implying safety where such a claim is not justifiable. This is not only a moral obligation but a legal responsibility as well.

To discharge this responsibility, the recommendations contained in this standard should be followed, amplified as follows.

a) Be familiar with the terms associated with fire in this document and in BS 4422 or ISO/IEC Guide 52, and use the proper terms only.

b) Avoid coining brand names or trade names for materials or products which imply fire safety misleadingly.

c) Support all statements on fire properties by quoting the performance when subjected to an appropriate fire test method, taking care to include all the criteria referred to in the test report. e.g. both integrity and insulation.

d) Ensure that the test method cited is strictly relevant to the statements made and to the use for which the material or product is intended.

e) Ensure that potential users are offered information on any known limitations of the test method scenario.

f) Avoid vague implications that the product conforms to national or international standards or regulations, etc.

g) If there are recognized fire hazards in the use or installation of a material or product, always warn the user and give advice on its correct usage to minimize fire risks. This is a legal requirement under the Health and Safety at Work etc. Act, 1974.

### 15.2 Descriptions of product quality for the general public

The basic principles developed in clauses **10** and **13** are that these principles are so important in avoiding misconceptions about the quality of tested materials and products that they cannot be ignored in communicating with the public.

However, while the recommendations of clause **13** are appropriate for professional and technical users, indices of performance are not readily comprehensible to the general public.

There is therefore a need for an intermediate step between obtaining information from fire tests and conveying it to the public. This step may be achieved by the setting of standards of performance through a national or international standard, or (if Government action is called for) through legislation. Such standards should explain fully the hazard components involved and how the required level of performance has been arrived at. This explanation should include a description of the fire scenario which is simulated by the test.

Advertising matter used by manufacturers, retailers, etc. and directed at the general public should then claim conformity for the material or product to the performance requirement in respect of the hazard component concerned, by quoting the full reference of the document containing the requirement but not referring to the index value itself. Where labelling for the information of the public is concerned, the fullest information should always be given. If there are any limits, for example because of space restrictions, then precedence should be given to safety related matters over other subjects.

## 16 Recommendations

### 16.1 Summary

The recommendations given in **16.2** and **16.3** are intended for the developers of specification standards and for developers concerned with test methods. Both should be read together with figure 3. Those given in **16.4** are for the specialists concerned with mathematical modelling.

### 16.2 Preparation of specification standards

The following is a summary of the actions that should be taken to assess and control fire hazard when preparing specification standards or codes of practice.

a) In consultation with fire experts, assess the fire hazards that might arise in the use of the material, product, structure or assembly (see **5.2.1**).

b) Consider what level of fire hazard is acceptable in the use of the material, product, etc. and what scope there is for reducing the hazards (see **5.2.2**).

c) Ensure that the fire scenario modelled by the test method is described in the specification or code (see clause **14**).

d) List the application areas covered by the fire test method (see **14.2**).

e) List possible application areas which are not covered by the fire test method (see **14.3**).

f) Take care at all times to use only terminology that is recommended in this standard, that is accurate and specific and that is based on relevant test procedures (see clause **10**).

g) Recognize that the results of fire tests can never guarantee fire safety.

### 16.3 Preparation of test methods

When a fire test method is sought, the following actions should be taken.

a) Verify that all existing test methods are unsuitable and that the development of a new test method is necessary (see **9.3.3**).

b) Identify the properties or functions of the material, product, etc. which seem critical in the control of fire hazard (see **9.2**).

c) Develop fire test methods which will provide information to assist in the assessment and control of the hazard in terms of these properties or functions (see **9.3**).

d) Select a type of test procedure which will give numerical results in preference to a pass/fail type (see clauses **7** and **12.1**).

e) Ensure that the title of the test describes the test in terms of the relevant hazard component (see **9.2** and **10.4**).

f) Describe the hazard and the fire scenario which produces it in the test method (see clause **14**).

g) List the application areas covered by the fire test method (see clauses **12** and **14.2**).

h) List possible application areas which are not covered by the fire test method (see **12.2** and **14.3**).

i) Ensure that the expression of test results does not indicate success or failure but is an expression of performance on an open-ended, neutral index scale (see **10.1**).

j) Ensure that terms used in the fire test are either completely neutral or at least not favourably biased avoiding all expressions which might imply safety (see **10.1**).

k) Recognize that the results of fire tests can never guarantee fire safety.

### 16.4 Preparation of mathematical models

When a mathematical model has been built the following actions should be taken.

a) Before utilizing results, the theoretical science on which the calculations are based should be rigorously validated and subjected to peer review (see clause **8**).

b) Before utilizing results, the software codes should be checked by a third party (see clause **8**).

c) The limitations on the accuracy of the predictions should be shown whenever results are used (see clause **8**).

d) Predictions which might affect life safety in the future should always be checked by actual tests and measurements (see clause **8**).

e) Recognize that fire calculations can never guarantee fire safety (see clause **8**).

# Annexes

## Annex A (informative)

## How fire behaves, physics and chemistry

### A.1 General

Despite its apparently simple definition (see **3.2**) fire is a complex phenomenon in which many simultaneous processes interact. Most fires start from a small source, usually in a context where a source of heat and a combustible material are brought together, such that thermal decomposition of the material occurs producing flammable vapours which may be ignited. If the heat source is too small, or its temperature is too low, only localized damage may occur without ignition occurring. Alternatively, if the ability of the material to dissipate heat is too great, or its ignition temperature is too high, ignition may not be sustained. Different combustible materials need different amounts of heat to be applied before ignition can occur. For continued combustion, the rate of heat loss needs to be less than the sum of the rate of heat supply from the heat source and the rate of heat generation from the combustion process. Similarly the rate of generation of vapours has to be sufficient to maintain flammable concentrations in the ignition zone.

### A.2 Stages of fire

The progress of most flaming fires can be divided into the following stages.

a) Initiation.

The process, as described in **A.1**, in which ignition occurs and fire is established.

b) Spread (or growth, or propagation).

Continued local combustion with radiation of adjacent areas leading to further release of flammable vapours and spreading combustion. This continues until the fire has spread to the limits of the accessible fuel area or the air supply reaches its upper limit. Flashover may occur during this stage.

c) A ‘steady’ period.

The stage at which the fire may be said to be ‘fully developed’ and all available combustible materials are burning. For liquid pool fires, this stage may have a relatively long duration with a constant burning rate; for compartment fires of solid fuels it may only be a short peak between growth and decline.

d) Decay

The final phase during which the fire is burning itself out.

These stages may be formalized in terms of the thermal and ventilation conditions within a typical large compartment fire as shown in table A.1. A diagram showing the development of a ‘typical’ compartment fire is shown in figure A.1, which is used also in annex J to relate the hazards of a fire to its development stages.

In table A.1, the values shown for the different parameters are intended to give a perspective upon typical levels in a fire. The values of CO and $CO_2$, for example, represent conditions in the outward flow where combustion has been largely completed, whilst the radiation figure typifies the flux falling on exposed surfaces within the room. The figures are indicative and are not intended to define absolute limits for the stages, nor are they representative of many small-scale fire tests. The size of a flaming fire and the composition of its effluents will depend upon the amount and type of fuel available and upon the ventilation. If the ventilation to the room of origin is not freely available, combustion may occur outside the room in the fuel rich smoke plume.

Some fires may die out naturally without stage c) being reached. In others, all four stages may be telescoped into a very short space of time, e.g. a person’s clothing catching alight, or a flammable vapour/air mixture ‘exploding’. Other fires may be positively extinguished, by the action of sprinklers or the fire brigade.

**Table A.1 General classification of fires**

| Development stage | Oxygen % | CO2 : CO ratio | Temperature ° C | Radiation kW/m$^2$ |
|---|---|---|---|---|
| Decomposition | | | | |
| i) Smouldering (self sustained) | 21 | N/A | < 100 | N/A |
| ii) Non-flaming (oxidative) | 5 to 21 | N/A | < 500 | < 25 |
| iii) Non-flaming (pyrolytic) | < 5 | N/A | < 1000 | N/A |
| Developing fire (flaming) | 10 to 15 | 100 to 200 | 400 to 600 | 20 to 40 |
| Fully developed fire (flaming) | | | | |
| iv) Relatively low ventilation | 1 to 5 | < 10 | 600 to 900 | 40 to 70 |
| v) Relatively high ventilation | 5 to 10 | < 100 | 600 to 1200 | 50 to 150 |

N/A: not applicable

 

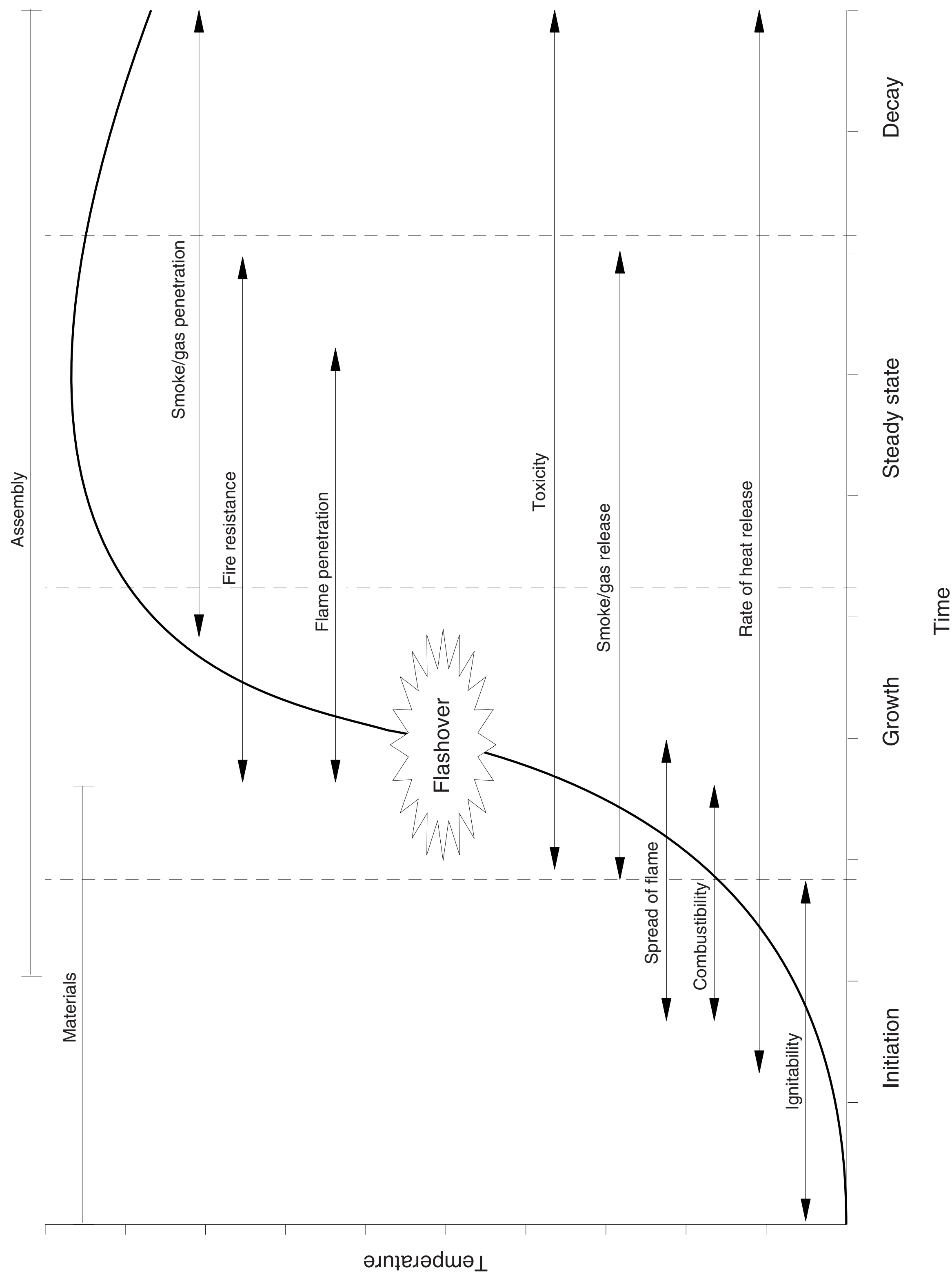


**Figure A.1 Hazard concepts for tests: relationships to fire phenomena, materials and assemblies**

Though these stages are characteristic of a fire as a whole, different parts of a fire may exhibit different stages at the same time: some parts of the fuel or fuels may be reaching their termination phase, for example, while other parts of the fire are still in the growth phase. The fact that growth is taking place means that new parts of the fuel or fuels are continuously entering their initiation stage.

**A.3 'Flashover' and 'flashback'**

The 'spread' stage is not necessarily one of growth at a uniform rate. The phenomenon of flashover may represent a dramatic change in the potential of a fire to cause loss of life and property. Some fires in a room may grow relatively slowly until the thermal radiation raises all the combustible surfaces to their ignition points at the same time. This leads to a great increase in the output of heat and smoke from the fire, which is known as flashover. This sudden increase in thermal radiation, decrease in oxygen and increase in carbon dioxide produces conditions within a room where flashover has occurred that are lethal to unprotected people. The potential for spread beyond the initial room is also greatly increased.

It is important to distinguish this normal instability from a similar phenomenon which is known, by convention, as flashback or backdraft. Flashover will arise naturally in any room with sufficient fuel and a suitable degree of ventilation without any increase in the ventilation available to the fire. However, the rapid growth stage may also be triggered by a coincidental event, such as the breaking of the glass in a window. The added air available within the room may lead to the involvement of volatiles which had previously had insufficient oxygen to burn. This is known as flashback. The effect on the harm likely to result from the fire is the same in both cases. Full burning in the room causes a sharp step increase in the danger to life and risk to property.

Thus it can be seen that at any point in the progress of a fire, its course may be altered by random events such as the involvement of petrol in a car fire, the rupturing of a container of flammable liquid in a chemical plant fire, the breaking of a window in a room fire, or the failure of fire preventive systems, any of which may have drastic effects on the fire's development.

**A.4 Smouldering fires**

The pattern of development of smouldering fires is different from those that start and continue in the flaming phase. Only fuels which are, and remain, in the solid phase when heated are susceptible. Smouldering can spread from a very small source of energy, provided that the energy is not dissipated. The fundamental energy balance discussed in **A.3** still applies, but the balance can often only be maintained in the interstices of bulk fuels. In these circumstances, the surrounding fuel itself acts as thermal insulation to retain the heat. The supplies of oxygen needed are typically very small, an air inflow with a velocity of a few millimetres per minute being sufficient. The growth of the zone of combustion occurs at similar linear speeds.

Combustion in these circumstances is often very incomplete, with a wide variety of organic compounds being distilled from around the hot zone. The effluent may thus be in the form of a complex hydrocarbon aerosol. In an enclosure, the atmosphere may reach concentrations within, or above, explosive limits. Large explosions have been known to occur, for example in the Chatham Dockyard fire, if such an atmosphere becomes ignited (see *Fatal mattress store fire at Chatham Dockyard* [3] and *The explosion risk of stored foam rubber* [4]).

In most cases of smouldering, the outcome is not so dramatic. In some fires, the combustion may slowly consume all the available fuel and then decline without ever entering the flaming phase. In others there may be a transition to flaming. For example, in the traditional hay rick fire this occurred when some part of the smouldering zone reached the surface and gained sufficient ventilation to support flaming combustion. If a transition to flaming does occur, the subsequent stages will be similar to those described in **A.2**. The one difference is that the progress through the stages may be faster, since some of the fuel will have been preheated.

**A.5 Examining behaviour of materials in fire**

The examination of the behaviour of materials, components, products, etc. in fire, which is vital in setting up safety measures, is exceedingly difficult in a complex environment. Since many features of the combustion process are not yet clearly understood, only some of them can be analysed, and then only in situations that are well defined and in which the number of factors involved is kept to a minimum. All but the most elaborate analytical experiments will therefore have to concern themselves with one of the stages of fire at a time.

Manufacturers need to study the stage at which their material or assembly will actively contribute to the dangers of a fire. Materials on the surface of a product are subject to the aggressive fire environment before the properties of the whole assembly become important. During the most intense part of the fire, the 'steady' period, those parts of an assembly intended to provide fire resistance will be most highly stressed. Therefore products that are required to be more fire-resistant should be subjected to test procedures representative of later fire stages. The test conditions chosen should be derived from the fire scenario rather than from the expected behaviour of any test items.

 

A classification of fires according to the materials involved has been standardized, as it simplifies reference to fires. BS EN 2 and ISO 3941 divide fires into:

| | |
|---|---|
| Class A: | fires involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers; |
| Class B: | fires involving liquids or liquefiable solids; |
| Class C: | fires involving gases; |
| Class D: | fires involving metals. |

This classification is primarily used to assist the selection of fire extinguishers, but the type of material involved also affects the relevance to reality of fire test methods (for example, the charring or melting behaviour of a particular material controls susceptibility to smouldering).

## Annex B (informative)

## General information on fire safety engineering

Considerable progress has been made in applying scientific and engineering principles to the protection of property and people from fire dangers. This has become known as fire safety engineering. DD 240 : Part 1 builds a consistent approach to these problems on four foundation elements. The first is that at the design stage of a building, a multi-disciplinary team should be assembled to consider the potential problems and solutions. Secondly, at all fire stages, and for all aspects of hazard, stepwise analysis should be carried out to identify the areas where the concentration of effort will be best repaid. Thirdly, the common factor for the comparison between different hazards should be the time dimension. Lastly, advantage may be taken of trade-offs between different ways of dealing with a design. The analysis of risk probabilities may be used at all these stages to select the optimum courses of action.

In broad outline, the third element implies that if the time required for people to escape is longer than that taken to develop hazardous conditions, design decisions have to be taken. These should accelerate escape and/or slow fire development. An example of the fourth element in operation is that a very high fire load may be permissible on the sales floors of a department store, provided that sprinklers are installed and that escape provisions and the store's fire safety management are maintained at an appropriately high efficiency. The essence of the engineering approach is that these qualitative statements will be analysed into elements which can be quantified individually. These are then integrated by focussing upon the earliest significant hazard predicted in the course of a particular fire scenario.

DD 240 : Part 1 establishes six subsystems which may be viewed as calculation modules. These are as follows:

| | |
|---|---|
| subsystem 1: | initiation and development of fire within the enclosure of origin; |
| subsystem 2: | spread of smoke and toxic gases within and beyond the enclosure of origin; |
| subsystem 3: | spread of fire beyond the enclosure of origin; |
| subsystem 4: | detection of fire and activation of fire protection systems; |
| subsystem 5: | fire service intervention; |
| subsystem 6: | evacuation. |

Developers of fire tests should preferably design tests to provide results which can be used as input for these calculation modules (see annex J).

## Annex C (informative)

## The assessment of fire hazard and risk

### C.1 Interested personnel

Any study of the techniques of fire hazard assessment has to start from the standpoint of all persons with an interest in fire hazard. It may be simplified by arbitrarily assuming that there are five main groups of interested people.

a) Those dealing with a material or product that may either give rise to a fire or become the starting point of a fire through chance contact with a source of ignition (e.g. a floor covering; an electric blanket; a thermostat).

b) Those dealing with a material, product or design that, if involved in a fire, can constitute the means for that fire to develop, spread and thus promote further damage and/or loss of life (a warm-air heating system; a building material; a design for a warehouse; a plastics fascia board over a shop).

c) Those dealing with a component or product that may not necessarily fit into either of categories (a) or (b) but that is liable to be damaged, destroyed or rendered unserviceable by a fire and needs to be protected from its effects (e.g. insulated electric cable; a stanchion supporting a piece of plant; a storage cabinet; an electrical transformer).

d) Those, such as regulators, fire safety engineers or architects, dealing with the effects of many (possibly unknown) materials, components or products.

e) Those who might suffer loss from fire.

These groups are not mutually exclusive, nor do they include many smaller groups. The intention is to illustrate the breadth of view points that has to be accommodated in an assessment.

## C.2 Hazard identification

There are several ways of identifying fire hazards: personal knowledge or experience (this is the most direct and probably the most common); statistics; formal fire reports from fire brigades or other sources. The process is fundamentally one of asking questions designed to analyse and probe the physical situation in which a component or product will be used, to examine every accident that can reasonably be postulated, and to think out all the ways in which a material or product will be used, or could be misused, or could be affected by fire or flame.

## C.3 Breakdown of risks

### C.3.1 *Fire risk*

This combines two more elemental probabilities, i.e. that a fire will start, and that it will spread. These two probabilities can be considered separately (see **C.3.2** and **C.3.3**).

### C.3.2 *Ignition risk*

A high risk may result from relatively high probabilities of electrical failure, overheating, accidental or malicious ignition, frictional sparks, chemical reaction, etc. Reduction of this risk may be affected by:

a) eradicating the use of materials, products, parts or components, etc. which are ignited with undue ease;

b) restricting or prohibiting, for example, the use of smokers materials, or machinery, plant, equipment or practices that could give rise to unwanted sources of heat, or, alternatively, separating such things from flammable substances or materials.

### C.3.3 *Risk of fire spread*

The risk of a fire spreading away from the item first ignited is a probability which depends on the way individual items are assembled in a larger product or in a space. The means of control rely on changing the behaviour of the assembly by changing its components. There is a great variety of techniques for controlling fire spread, for example: the use of materials in which fire will not develop rapidly; the provision of barriers or enclosures that will retard the passage of fire for a certain time; the provision of open spaces to break the succession of combustible objects (e.g. plant, equipment and furniture) that fire needs in travelling from one point to another; the provision of improved protective measures such as sprinklers.

### C.3.4 *Life risk*

The combination of the following three elements creates life risk:

a) the possibility of a fire starting;

b) the possibility of the fire growing to a potentially damaging size; and

c) the presence of people in places where the fire can cause them harm.

There are therefore three broad means of lessening the risk:

1) reducing the risk of fire starting;

2) reducing the risk of fire spread by the appropriate choice of design, materials and protective systems;

3) improving facilities for the escape of people who might be affected by fire.

The consequences of a fire do not necessarily affect only those people at or near the scene. For example, death, serious injury or suffering may result directly from the effects of smoke, toxic gases or burning on people exposed to the fire. Less direct harm to people may result from the effects of smoke preventing escape from a fire. Lastly, indirect harm may occur, such as from the loss of a breadwinner, or loss of occupation, income or facilities through fire, or from the long-term effects of inhaling toxic products of combustion.

### C.3.5 *Property risk*

Like life risk, the risk to property can be controlled in three main ways:

a) by preventing the start;

b) by restricting the spread of fire;

c) by avoiding or reducing the exposure of goods, plant, equipment, furniture, etc. to a possible fire outbreak.

Fire damage to property can, as with life risk, come about by direct or indirect routes:

1) *Direct damage*, for example, the destruction of plant, equipment, other installations, building contents, or whole buildings themselves by the heat and flames of a fire.

2) *Secondary effects*, for example, the breakdown of services remote from a fire through the destruction of wiring or pipes; the weakening of remote parts of a structure through attack by fire on their supports; the corrosive damage done by the effluents of a fire to sensitive equipment; the damage done by smoke deposits remote from a fire; damage caused by fire fighting actions themselves, e.g. the effect of water on paper or paper products, stored grain, etc.

## Annex D (informative)

## Examples of examination of fire hazard

The following purely illustrative examples are included to emphasize the care that has to be taken in deciding on action for specific control purposes.

***Example 1: Overall effect of polystyrene tiles***

Expanded polystyrene is widely used in the form of tiles for decorative and other purposes. Since the basic material can be ignited fairly readily by a small flame, fire retardants are added to the material and a simple burning behaviour test on a polystyrene tile can show that it contains the specified amount of additive. However, the actual hazard presented by tiles in a particular situation depends on many factors, including, not in any order of priority, the following:

a) orientation of the tiles;

b) tile thickness;

c) nature of joints between the tiles;

d) nature of adhesive fixing the tiles to a substrate;

e) nature of the substrate;

f) surface finish applied to the tiles;

g) surface format of the tiles;

h) area exposed;

i) proximity and nature of potential ignition sources;

j) proximity and nature of other combustibles;

k) size and ventilation of the room in which the tiles are used;

l) ambient temperature;

m) presence of fire detectors and/or extinguishing systems;

n) physical and mental characteristics of those using the room;

o) ease of exit from the room.

All these need to be considered in conjunction with the physical properties of the tiles. Similar reasoning applies to many other situations, and complex analyses are often necessary.

***Example 2: The testing of flexible tubing***

A test to examine the fire hazard presented by the use of a particular type of flexible tubing is needed. The tubing carries a flammable liquid (e.g. hydraulic oil or lubricating oil) in a machine. It is necessary to assume the possibility of fire in the machine, and an analysis should then be made of the ways in which the tubing might contribute to the fire risk:

1) it might ignite;

2) it might be penetrated by a flame;

3) it might fail mechanically, and rupture;

4) it might part at the joints;

5) it might distort and leak due to thermal effects;

or it might respond in other ways to the effects of fire.

A detailed analysis on these lines will show what information is needed about the properties of the tubing and what fire test procedures it should undergo.

## Annex E (informative)

## Nature of fire tests

### E.1 Types of fire test results

Ideally, a fire test procedure, like any other scientific test, should be capable of yielding quantitative results. Many early fire test procedures cannot meet this criterion, being instead 'pass/fail' types of test but the development of new or old test Standards should concentrate upon those that do. In some cases a combination of similar 'pass/fail' experiments at different levels of severity may be combined to give an answer on a severity scale. The result then will be the level at which the undesired phenomenon first occurs, for example, the size and/or duration of flame needed to cause ignition. The scale against which results are expressed then runs from the minimum severity to the maximum, with the individual steps representing subdivisions. This scale, although coarse, will be more finely divided than a simple dichotomy. The work involved in testing is increased, but so is the information output. This approach has been applied to ignitability test methods, as, for example, in ISO 5657. Test procedures for ease of ignition are often difficult to develop in a quantitative form if techniques such as this are not used.

### E.2 Types of fire test method

#### E.2.1 *Standard test methods*

It is not easy to categorize fire test methods because they cover such a wide variety of laboratory procedures designed to elicit information about fire. The majority are 'standard' test methods. Although no two fires are the same, fire test methods normally need to be standardized for four reasons:

a) so that a variety of products or components intended for the same purpose can be tested under exactly the same conditions;

b) so that different people, perhaps in different laboratories, can be sure of testing products or components by exactly the same procedures;

c) so that results on different occasions or from different laboratories are as reproducible as possible;

d) to remove national technical barriers to international trade.

Without standardization, no two results can be correlated. This has been proven true for tests on the reaction to fire of building products. Several major technical efforts have been made to remove the barriers formed by the different procedures used in various European countries. In the very long term, similar but slightly different test methods should be reduced to an agreed set covering the relevant hazard concepts.

Standard fire test methods can usually reproduce only one of the stages of fire described in **A.2**, and they are therefore usually designed in such a way as to reproduce closely the conditions likely to apply in whichever stage is most relevant to the function of the item to be tested. Included among these standard test methods is a number of relatively simple bench procedures known as 'quality control' tests. These are small in scale and can be simply and rapidly performed, but they are characterized by the extremely limited amount of information they give. The flammability test methods for plastics given in ISO 1210 and ISO 9772 are typical of these. These simple procedures provide information about the behaviour of materials, but of such a restricted kind and in a way so isolated from any environment that they are only normally used as sampling tests to ensure the consistency of a material or product in manufacture. They can point to a dangerous feature, but could never by themselves be evidence of a safe one. It is especially important that the written text of a standard specifying such a test should always draw attention to these limitations (see **14.3**).

**E.2.2** ***Full scale simulations***

At the opposite end of the scale are the elaborate and costly experiments that sometimes have to be mounted in cases of great consequence, where important public issues or large financial investment is at stake. In these, a hazardous situation may be reproduced in detail, and in entirety, perhaps comprising large items of plant or part of a building; they are mounted on rare occasions, usually for purposes of demonstration or for the removal of doubt, for instance as to the cause of a fire or the sequence of events in a fire or the behaviour of materials. They are not the type of fire test procedures that can usefully be standardized since they usually relate to a specific event or situation and are virtually unrepeatable.

**E.2.3** ***Other experimental results useful for fire hazard assessment***

For particular purposes, non-standard fire test procedures may be useful. If, for example, the existence of a new type of hazard is suspected, a new test method may be needed to investigate it. In general, much useful data has been gained from non-standard methods designed to investigate particular phenomena. This type of test will often be highly relevant to real fires, having been designed for this purpose. If the hazard proves to be important, the process of standardization of test methods and control specifications should be started.

In addition, the process of assessing a fire hazard often requires information obtainable from experiments other than fire test procedures. Measurements of such properties as the melting point or the thermal conductivity of a material may be of great value, and, for these, normally accepted procedures in the appropriate field are adopted.

## Annex F (informative)
## Mathematical modelling of fires

### F.1 Types of deterministic models of fires

Two general deterministic types of computer models of fires have emerged, field models and zone models. The former attempts to solve the set of equations describing the physical and chemical changes between short time intervals at every point on a closely spaced three dimensional grid throughout the volume being investigated. The second, which was developed earlier, simplifies the problem by dividing the fire volume into a number of zones, each of which is assumed to be uniform in its properties and parameters. Both types of model have had successes in explaining detail in investigations of fire incidents. Neither type seems able at present to predict the course of a large-scale fire from basic data if the rate of burning of the fuel is not known or assumed.

### F.2 Modelling of test methods

Instead of attempting to model a general fire, it may be possible to model a specific test procedure. This might allow the prediction of test results more quickly or more cheaply than by actual testing. The more limited and closely defined is the test procedure, the easier the construction of a model will be. Some progress has been made concerning the scaling factors relating component test results to the behaviour of assemblies. An example is the research programme on the reaction to fire of upholstered furniture sponsored by the European Commission (Combustion Behaviour of Upholstered Furniture known as 'CBUF'). This provided a correlation between small-scale tests, intermediate test rigs and the burning of full-sized articles of furniture. In this case, however, doubts still remain as to the applicability of the largely empirical process to materials or designs that were not included in the experimental set. Nor has the accuracy of the predictions in general situations yet been verified. In any similar studies the precautions listed in clause **8** should be applied.

## Annex G (informative)
## Further details of fire hazard components

### G.1 General

Some comment on the hazard components may be helpful as an aid to deciding their applicability. The explanations given in **G.1.1** to **G.1.9** should not be regarded as definitions and are not intended to override specific definitions provided elsewhere.

NOTE. Several of the terms are defined elsewhere for specific purposes, for example in ISO/IEC Guide 52.

**G.1.1** ***Ignitability***

A measure of the ease with which a material, product or component can be ignited. The type of test known as a flash-point test is an example of ignitability. Care is necessary in considering this since ignitability is not exclusively governed by the properties of the material or substance concerned. It is also markedly affected by the source of ignition. A substantial source may readily produce ignition; a small igniting source may only just ignite the object, with subsequent combustion being dependent only on the properties of the material.

**G.1.2** ***Combustibility***

The combination of properties that determines the rate at which fire might develop in a material, product or component. It is dependent on such factors as chemical composition and physical configuration, and may vary with temperature and the availability of oxygen. It is usually measured by the energy released under standardized conditions.

**G.1.3** ***Surface spread of flame***

The spread of flame across the surface of a material without the flame necessarily involving the main body of the material at the same rate. It is allied to rate of heat release and the orientation and chemistry of the surface.

**G.1.4** ***Rate of heat release***

A measure of the contribution that a burning material makes to the growth of a fire in progress. A high rate of heat release will produce a high rate of rise of temperature in surrounding, unburnt material and will accelerate fire spread.

**G.1.5** ***Smoke (or gas) release***

The release by a material of smoke and/or gas when heated by fire and/or an ignition source. It may present a toxic hazard or impede the escape of people from a fire.

**G.1.6** ***Toxicity***

An indication of the level of hazard represented by the smoke and/or gases produced by the fire. All fires will produce some toxic danger, so that the difference between particular fires is one of degree. Similarly, most common materials fall into one group of comparable toxic potencies.

NOTE. Toxicity was not included in the list provided in the first edition of this British Standard. This was because at that time there was little prospect of an acceptable test method being standardized. Progress is being made in this difficult field of research. The term 'toxic potency' has now been defined rigorously in BS ISO 13344. BS 7899 : Part 1 indicates in outline how toxic potency might be used in an overall hazard assessment.

**G.1.7** ***Fire resistance***

An indication of the length of time for which a structure will continue to resist the effect of a standardized fire before failing.

NOTE 1. An example of a fire resistance test may be found in ISO 834.

NOTE 2. The name of this component is an exception to the general rule that names should be chosen to indicate hazardous properties rather than safe ones; the term is, however, so well established that it would not be expedient to try to align its nomenclature with that of other terms.

Failure can take several forms; for example, in a building it may be:

a) true structural failure, where an element of construction is no longer able to carry the load applied to it;

b) insulation failure, where sufficient heat from a fire is transmitted through an element to ignite material on the non-fire side;

c) integrity failure, where the element breaks down sufficiently to allow the passage of ignition or products of combustion to the far side.

**G.1.8** ***Flame penetration***

Penetration of a covering material or protective structure by a flame with the consequent probability of damage. This has to be distinguished from penetration through the effect of a standardized fire as described in **G.1.7**b) and c). The concept is widely applicable within the fields of building, aircraft and vehicle equipment, electrical insulation and connectors, etc.

**G.1.9** ***Smoke (or gas) penetration***

This is a property (or may, in some cases, be the failure of an intended function) of an enclosure such as a door or cover, or other form of barrier whereby the protection offered by the barrier against the passage of smoke or gas is rendered ineffective through a failure of integrity. The result of this failure may be that smoke or gas released by a fire will penetrate to areas, often remote from a fire, where they can do damage to people or things, by impeding escape or by toxic effects or, for example, by corroding electrical or electronic equipment or attacking a building structure.

NOTE. *Flammability.* This is not included in this British Standard as a hazard component, since it is a combination of several components and its determination will provide little or no information of value in fire hazard assessment. Measurement of, for example, ignitability or rate of heat release will provide much more useful data.

### G.2 Hazard components, fire stages and assemblies

A particular hazard component may be important at one stage of the development of a fire and not at any other. Another hazard component may cause dangerous conditions for much of a fire's duration. These differences are illustrated in figure A.1. The broadest division for room fires is into those components which are important before or after flashover. If the scenario of concern is pre-flashover, the primary hazards to be tested will be ignitability, flammability and spread of flame. After flashover flame penetration, fire resistance and smoke or gas penetration become the most important factors. Heat release, smoke or gas release and toxicity are the exceptions to this general pattern. The magnitude of the former will contribute to the degree of overall hazard at any time once the fire has become well established. Smoke and gas release also spans the time of flashover, but in most fires it will assume importance later, and decline in importance earlier than heat release. Toxicity follows the same general pattern.

Hazard components also establish a link between fire test procedures and the subsystem approach disccussed in annex B. The first three subsystems listed are concerned with topics for which fire test standards have been, or may have to be, devised. Figure G.1 shows the subsystems to which the individual hazard components are related. Any new test standards based on the individual components should therefore be drafted to provide data of the type, and in the form needed to perform the subsystem calculations most efficiently. Similarly existing test standards should be modified when they are revised to improve the use made of the data which they will produce.

## Annex H (informative)
## Details of criteria for choice of fire tests

### H.1 Relevance to reality

If the existence of a specific hazardous situation is known or suspected, and a fire test procedure is required to help in assessing the hazard, the test conditions should simulate the situation as closely as possible. In practice, simplifications may be necessary to reduce the cost and time involved, but the conditions finally adopted should relate as nearly as possible to the actual environment in which the hazard

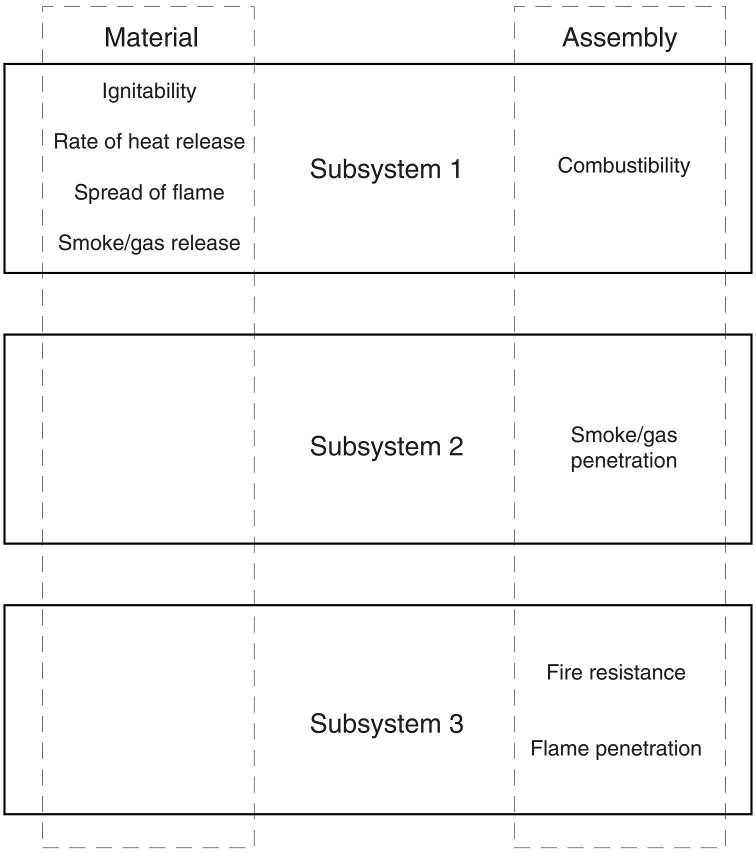


**Figure G.1 Hazard components fire tests: relationship to code of practice on fire safety engineering subsystems**

is thought to arise. This criterion means that the designers of fire tests should ensure that the fire scenario which is to be modelled includes the critical hazard components which were identified in the assessment step and that the relationship between their test procedure and this scenario can be objectively demonstrated.

If a test method is designed to assess materials, products, etc. that are intended for a particular use, it is essential that the test method be capable of being applied to all possible materials or products which might be used for that purpose, and on an equal basis. The test method may be invalidated if some product emerges having characteristics that make it impossible to obtain a test result. A test method should also be capable of being used with materials with different thermophysical characteristics. Solid materials may char or melt when burning, and the difference may influence the course of a fire. A test procedure which emphasizes one or the other type of behaviour may not be suitable as a general method.

It is often necessary to establish the response to fire of a material or component in a variety of situations because that material or component may be used in many different ways. In these circumstances a test should be designed to elicit information that is as comprehensive as possible within the likely range of use of the object under test. It is often unwise for a fire test to make measurements or observations under only one set of conditions (of heating, timing, etc.) since this may present a less true picture of performance than if a range of conditions is examined. Testing over a range of conditions will increase the confidence that a change in performance just beyond the test settings does not affect the reliability of predictions based upon the test results. A hypothetical example might be a test procedure for toxic effluents conducted at 400 °C. Two materials are tested, and both reach the required specification level. However, experiments conducted over a wider temperature range show that one material produces little effluent up to 800 °C whilst the other shows deteriorating performance from 450 °C. Although the hypothetical test procedure would not separate them, real fires may happen which give conditions outside the range envisaged in the test description. The ability of the test procedure to give accurate hazard predictions would therefore have been diminished by an unrealistic limitation placed on the test conditions.

Where possible, all fire hazard control systems should take account of changes in performance during the service life of a product. Contamination by dirt, grease or dust may occur as may surface chemical or physical changes. In some circumstances these changes may have an effect upon the overall performance of a product. Though this will primarily be a problem to be solved by specification standards, a test method should allow the possibility of examining this type of effect.

### H.2 Precision

Precision has two mathematical components: reproducibility and repeatability (see ISO 5725). A fire test method should include a statement of the variation in results to be expected when the test is performed in different laboratories (reproducibility) and repeated within a given laboratory (repeatability). In general, wider tolerances should be specified if there could be sampling difficulties or if the fire model cannot be laid down precisely, etc. Validation of a test method by experiments at different laboratories is essential before publication. This is best done by a planned inter-laboratory experiment conforming to the principles given in ISO 5725. The decision as to whether a test procedure yields sufficiently precise and reliable results to fulfil its intended function is one of the critical stages of development (see figure 3).

There are also practical factors which should be controlled if precision is to be maintained. These may be grouped under six headings:

a) operator variation

b) equipment variation

c) variation within set conditions

d) effects of the test environment

e) sampling errors

f) specimen variability

The overall effect in the field of fire tests is that unavoidable random errors will be found in all methods. For well defined methods of this type the uncertainty limits on a result may be as close as ± 5 % for inter-laboratory comparisons, but might be ± 25 % for less well controlled methods. Comparisons between results should only be made bearing in mind this degree of ability to separate apparently different values.

### H.3 Discrimination

A test procedure should yield results which are more sensitive to those characteristics that are of greater importance in the hazard assessment and are less sensitive to others.

### H.4 Apparatus independence

A fire test method should ideally be so designed that features of the apparatus used do not influence the results. The intention is that the results will be a true reflection of performance of the test object, not distortion arising from the peculiarities of the apparatus. It is very difficult to attain this ideal and many fire tests fall short of it.

### H.5 Personal safety and hazards in conducting fire tests

Attention should be paid in designing fire test methods to the need to ensure adequate protection of personnel against the following:

a) risk of explosion (including flying fragments) or the spread of fire outside the experiment;

b) inhalation of smoke and/or toxic combustion products;

c) danger from toxic residues.

A specific statement should be included in the text of all fire test methods warning everybody who may be involved of these hazards.

NOTE. Attention is drawn to the Health and Safety at Work etc. Act 1974 [5].

### H.6 Ease of use

Tests should not require elaborate equipment or instrumentation. They should not involve a large number of operators nor take a long time to conduct. If they involve too much effort or expense they are less likely to be used. In general, small-scale test methods should require only one operator and only moderate setting-up time. As a rough guide, simple tests should be capable of completion in no more than two hours; a test of medium complexity in four or five hours; and a complex test in no more than a day. These times do not include specimen preparation and conditioning, which may be rapid in some cases but take months in others. See **3.16**, **3.17** and **3.23** for precise definitions of test scales.

There is some degree of conflict between the need for economy and ease of testing and the ability of a test to represent use conditions or to be adaptable to different circumstances. Perfection in all of these aspects is usually not possible. Compromises often have to be made, but should not be allowed to reduce the relevance or the potential precision attainable by the test.

## Annex J (informative)

## Advice on the expected needs of users of fire tests

### J.1 Writers of Standards

The relevance of particular tests will be of concern to writers of specification standards. The precision of the results yielded will also affect the number of grades or levels that may be incorporated into a specification standard.

### J.2 Regulatory bodies

Regulatory bodies are likely to have concerns similar to those of writers of standards. They are also likely to be concerned that, for legal and contractual reasons, the wording used for the test is especially clear and not open to misinterpretation.

### J.3 Fire safety engineers

This group will be the most knowledgeable about the science of fire. Their primary need will probably be to gain the most relevant and accurate data for use in further calculations and assessments. The developers of test standards for this audience should concentrate upon ensuring that the test conditions represent real fire conditions and that these are well controlled to ensure the optimum precision. A precision statement will form an important part of a test standard for this group of users. Suitable warnings should be included if there is any possibility of inaccuracies propagating when results are used in mathematical modelling.

### J.4 Designers and architects

The members of this group are not likely to be fire specialists. Their primary concerns may be to guard the safety of the users of a building or product, whilst ensuring that it can be constructed economically and attractively. For them a clear expression of test limitations will be needed, and a single test standard capable of covering a wide range of performance abilities will be easier to understand than several more limited procedures.

### J.5 Manufacturers and fabricators

Whilst most members of this group will have some awareness of the fire properties of their product, this knowledge may not be of a general nature. The interactions of the products of several different industries are not likely to be well known. Therefore the applicability of a test procedure to composite products or to a wide range of materials will be an advantage. Drafting groups will need to devise terminology free from the possibility of confusion, so that sales benefits may be expressed fairly and in a way that does not mislead.

### J.6 Wholesalers and retailers

If this group is to be an important user of a test standard, drafters should beware of relying upon words or terms which have both common and also a specialized technical meaning. Any subtleties of meaning attached to the latter may not be appreciated by people accustomed only to using words in a common sense. The avoidance of favourably biased terms will help to prevent misunderstandings and the over-enthusiastic presentation of products.

### J.7 Safety managers and advisors

This group may bear personal responsibility in the case of an accident. The most important information for them is likely to be the limitations of the fire scenario modelled by a test procedure. This should be presented as clearly as possible, because it will be a small part of the data which they should assimilate in finding solutions to problems of safety. For these users, conservative terminology that leans heavily on the side of safety will be needed.

**J.8 Consumer advisors and educational bodies**

This audience group are not likely to be concerned with the precision or ease of use of a test method. All of the precautions mentioned in **J.4**, **J.5** and **J.6** above should be considered necessary for these users. Clarity of expression becomes the top priority, particularly of any limitations on the fire scenario modelled by a test procedure. It is very important that no unsupported implications of safety are allowed in the expression of test results. It will be better to use terms indicating danger.

**J.9 Users of fire terminology**

Those who draft fire test standards should ensure that the possibility of misuse of any terminology from test standards is made as small as possible. Those who draft fire requirements standards should prescribe the forms of reference to test data that are, and are not, permissible. Every effort should be made to prevent the coining of misleading terms.

**J.10 Standards bodies, committees and staff**

To this group is addressed all the advice in the preceding paragraphs. The tendency of fire test standards to be used in ways that were not foreseen by the original designers should never be forgotten.

## Annex K (informative)

## Examples of fire test 'limitation' clauses

**K.1 ISO example**

A model of a general clause describing test limitations is as follows. It has been widened in application from one which appears in BS ISO 13344.

'This test method has been designed to provide data for use in the assessment of fire hazard as a means for the evaluation of materials and products and to assist in their research and development. The data are not, in themselves, an indication of fire hazard, or relative hazard, nor are they to be used in the absence of fire hazard assessment in the regulation of products of commerce'.

In BS ISO 13344 this statement is followed by both positive and negative statements of the limits of applicability of the method. It is clearly stated that the results are based upon the gaseous effluents, but that it does not attempt to deal with particulates or even with changes of the gaseous constituents as a real fire progresses.

**K.2 CEN example**

A second example is in the proposed European Standard on smoke extraction ducts (prEN 1366-8) which has a scope that limits the fire scenario being examined to 'exposure to a fully developed fire' and the test objects to 'ducts constructed from non-combustible materials'. In a dedicated clause, further explanation of the field of application is given. This clause states the applicability of results to ducts of different orientations, to ducts of different sizes and lastly to ducts subject to different levels of underpressure and overpressure.

# List of references (see clause 2)

## Normative references

### BSI publications

BRITISH STANDARDS INSTITUTION, London

| | |
|---|---|
| BS 4422 | *Glossary of terms associated with fire* |
| BS 4422 : Part 1 : 1987 | *General terms and phenomena of fire* |

### ISO and IEC standards publications

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) AND INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC), Geneva (All publications are available from BSI Sales)

| | |
|---|---|
| ISO/IEC Guide 52 [2)] | *Glossary of fire terms and definitions* |

## Informative references

### BSI publications

BRITISH STANDARDS INSTITUTION, London

| | |
|---|---|
| BS 476 : | *Fire tests on building materials and structures* |
| BS 476 : Part 3 : 1975 | *External fire exposure roof test* |
| BS 476 : Part 6 : 1989 | *Method of test for fire propagation for products* |
| BS 476 : Part 7 : 1987(1993) | *Method of classification of the surface spread of flame of products* |
| BS 4727 | *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms* |
| BS 7899 | *Code of practice for assessment of hazard to life and health from fire* |
| BS 7899 : Part 1 : 1997 | *General guidance* |
| BS IS0 13344 : 1998 | *Determination of the lethal toxic potency of fire effluents* |
| DD 240 | *Fire safety engineering in buildings* |
| DD 240 : Part 1 : 1997 | *Guide to the application of fire safety engineering principles* |
| DD 240 : Part 2 : 1997 | *Commentary on the equations given in Part 1* |

### ISO and IEC standards publications

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) AND INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC), Geneva (All publications are available from BSI Sales)

| | |
|---|---|
| ISO 834 | *Method for determination of the fire resistance of elements of construction (general principles)* |
| ISO 1210 : 1982 | *Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame ignition source* |
| ISO 3941 : 1992 | *Classification of fires* |
| ISO 5657 | *Method of measuring the ignitability of products subjected to thermal irradiation* |
| ISO 5725 : 1986 | *Guide for the determination of repeatability and reproducibility for a standard test method by inter-laboratory tests* |
| ISO 9772 | *Cellular plastic materials — Laboratory assessment of horizontal burning characteristics of small specimens subjected to a small flame* |
| ISO/DIS 13389 | *Fire safety engineering — Assessment and verification of mathematical fire models* |

[2)] Currently being revised for publication as ISO 13493

**CEN and CENELEC publications**

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN) and EUROPEAN COMMITTEE FOR ELECTROTECHNICAL STANDARDIZATION (CENELEC), Brussels. (All publications are available from Customer Services, BSI.)

| | |
|---|---|
| BS EN 2 : 1992 | *Classification of fires* |
| prEN 1366-8 | *Service installations — Smoke* |

**Other references**

[1] The Stardust Discotheque Fire. *In: Fire Prevention.* 1982, **148,** pp 22-23
[2] An FPA review of the official report on the Stardust Disco Fire.
*In: Fire Prevention.* 1982, **158**, pp 12-19
[3] Fatal mattress store fire at Chatham Dockyard. *In: Fire.* 1975, **67**, No. 835, p 388
[4] WOOLLEY, W.D. and AMES S.D. The explosion risk of stored foamed rubber.
*In: BRE Current Paper*, *CP 36/75*
[5] GREAT BRITAIN. *Health and Safety at Work etc. Act 1974.* London: The Stationery Office

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