TECHNICAL REPORT

ISO/TR 11696-2

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Uses of reaction to fire test results —

Part 2: Fire hazard assessment of construction products

Utilisation des résultats des essais de réaction au feu —
Partie 2: Évaluation du risque-feu des produits de construction

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this part of ISO/TR 11696 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 11696-2 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

ISO/TR 11696 consists of the following parts, under the general title *Uses of reaction to fire test results*:

— *Part 1: Application of test results to predict fire performance of internal linings and other building products*

— *Part 2: Fire hazard assessment of construction products*

Introduction

This part of ISO/TR 11696 provides guidance on how to assess reaction to fire test results for construction products from tests developed in ISO/TC92/SC1. It provides a basis for reaching an informed judgement when balancing out any conflicting elements which may arise in a risk assessment exercise, where, of necessity, account must always be taken of many practical considerations.

The document has been designed to provide guidelines to be followed when assessing reaction-to-fire test results within the context of the overall hazard presented by a defined fire scenario. When using this guide, account should be taken of any statutory or control requirements (for example building regulations), information obtained from fire tests such as those developed by other organizations, published literature on non-standard tests and analytical and biological studies of fire atmospheres.

By establishing a toolkit of new fire tests, ISO/TC92/SC1 has provided a greatly improved facility for measuring the fire behaviour of materials and products more meaningfully than hitherto. The new test methods also provide data which can also be used in extended calculations and computer models to provide predictions of fire performance in a wide range of environments. The use of the test results in extended calculations and models has been explained in detail in ISO/TR 11696-1. At present, only a relatively small number of people and organizations are able to make use of the fire test data in this way, although a much larger number of organizations are able to conduct the tests and obtain the measurements. ISO/TR 11696-2 is intended to provide advice and guidance on the use of ISO toolkit test data by people and organizations who do not have facilities for extended calculations or computer models. Large numbers of test systems have been constructed and installed in many commercial fire test laboratories, the laboratories of materials manufacturers, universities and research institutions. A large number of users of the test apparatus currently require guidance in the use and interpretation of the results obtained.

Assessment of test results needs guidance, which provides a simplified method. With such guidance, results from the tests can be used by those who may not have knowledge of the mathematical modelling and the more complex fire science calculations. ISO/TR 11696-2 has been designed to encourage widespread acceptance of the tests by providing simplified guidance on the use of the results.

This guide enables assessment to be made of the likely fire hazards to occupants of existing buildings and transport as well as the effect that alterations to these structures may have on possible hazards. Experience with the specific procedure of this guide is limited to a few applications at present and more validation of the decision tree method is required. The concept of controlling the fire performance of construction products by assessing the contribution of products in reaction to fire tests is used widely by regulators.

It is recognized that the limitation and control of fire hazards will enable people to be confident in the safety of buildings and transport since fires would then be unlikely to occur and if one did, people would be able to escape. Fire testing is, however, only one of the techniques by which fire hazards and risks are limited and controlled. Other techniques include the application of codes of practice, laws controlling flammable materials and their misuse, inspection and education services provided by fire brigades, as well as fire detectors, sprinklers and other firefighting equipment.

Uses of reaction to fire test results —

Part 2:
Fire hazard assessment of construction products

1 Scope

This part of ISO/TR 11696 provides guidance on the principles and use of fire test data and other relevant information concerning construction products and their end-use environment, so that potential fire hazards and/or risks may be assessed. It suggests procedures for expressing results and how to interpret the data to aid the fire hazard assessment process. The guidance given is aimed at materials manufacturers and convertors, designers, wholesalers and retailers, specifiers and regulating bodies, and consumer representatives.

2 References

ISO/IEC *Guide 52*, *Glossary of fire terms and definitions.*

ISO 1182, *Reaction to fire tests for building products — Non-combustibility test.*

ISO 1210, *Plastics — Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame ignition source.*

ISO 1716, *Reaction to fire tests for building products — Determination of the gross calorific value.*

ISO 5657, *Reaction to fire tests — Ignitability of building products using a radiant heat source.*

ISO/TR 5658-1, *Reaction to fire tests — Spread of flame — Part 1: Guidance on flame spread.*

ISO 5658-2, *Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building products in vertical configuration.*

ISO 5658-4, *Reaction to fire tests — Spread of flame — Part 4: Intermediate-scale test of vertical spread of flame with vertically oriented specimen.*

ISO 5659-2, *Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test.*

ISO 5660-1, *Reaction to fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (Cone calorimeter method).*

ISO 5660-2, *Reaction to fire tests — Heat release, smoke production and mass loss rate from building products — Part 2: Smoke production rate (dynamic measurement).*

ISO 6925, *Textile floor coverings — Burning behaviour — Tablet test at ambient temperature.*

ISO 6941, *Textile fabrics — Burning behaviour — Measurement of flame spread properties of vertically oriented specimens.*

ISO/TR 9122-6, *Toxicity testing of fire effluents — Part 6: Guidance for regulators and specifiers on the assessment of toxic hazards in fires in buildings and transport.*

ISO 9239-1, *Reaction to fire tests for floor coverings — Part 1: Determination of the burning behaviour using a radiant heat source.*

ISO 9239-2, *Reaction to fire tests — Horizontal surface spread of flame on floor coverings — Part 2: Flame spread at higher heat flux levels.*

ISO 9705, *Fire tests — Full-scale room test for surface products.*

ISO 10093, *Plastics — Fire tests — Standard ignition sources.*

ISO 10351, *Plastics — Determination of the combustibility of specimens using a 125 mm flame source.*

ISO/TR 11696-1, *Uses of reaction to fire test results — Part 1: Application of results to predict fire performance of internal linings and other building products.*

ISO/TR 11925-1, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 1: Guidance on ignitability.*

ISO 11925-2, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 2: Single-flame source test.*

ISO 11925-3, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 3: Multi-source test.*

ISO 12992, *Plastics — Vertical flame spread determination for film and sheet.*

ISO/TR 13387 (all parts), *Fire safety engineering.*

ISO 13784-1, *Reaction to fire tests — Scale tests for industrial sandwich panels — Part 1: Intermediate scale test.*

ISO 13784-2, *Reaction to fire tests — Scale tests for industrial sandwich panels — Part 2: Large-scale test.*

ISO 13785-1, *Reaction to fire tests on façades — Part 1: Intermediate scale test.*

ISO 13785-2, *Reaction to fire tests on façades — Part 2: Large scale tests.*

ISO/TR 14696, *Reaction to fire tests — Determination of fire parameters of materials, products and assemblies using an intermediate-scale heat release calorimeter (ICAL).*

IEC 61034-1, *Measurement of smoke density of cables burning under defined conditions — Part 1: Test apparatus.*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements.*

ASTM E1321, *Standard Test Method for Determining Material Ignition and Flame Spread Properties.*

3 Terms and definitions

For the purposes of this part of ISO/TR 11696, the terms and definitions given in ISO/IEC Guide 52 and the following apply.

3.1
fire hazard
the potential degree of personal injury or damage to property by a fire

3.2
fire risk
the expected loss from a fire is defined in terms of probability as the product of:

— frequency of occurrence of an undesired event to be expected in a given technical operation or state; and,

— consequence or extent of damage to be expected on the occurrence of the event

3.3
smoke
visible part of fire effluent

3.4
thermal inertia
a parameter usually represented as kDc where:

k is thermal conductivity (W/mK);

D is density (kg/m^3);

c is specific heat (J/g·°C).

NOTE This is an important parameter which governs the rate of surface temperature rise of a product when it is exposed to a heat flux.

4 Fire characteristics

By its nature, fire is a complex phenomenon, with its growth and ultimate severity depending upon a number of interrelated factors. For the purpose of this part of ISO/TR 11696, uncontrolled development of most fires can be divided into the following stages:

a) **Initiation:** The process of heating a material to ignition and thereby establishing a fire, during which the continued release of flammable vapours leads to sustained combustion;

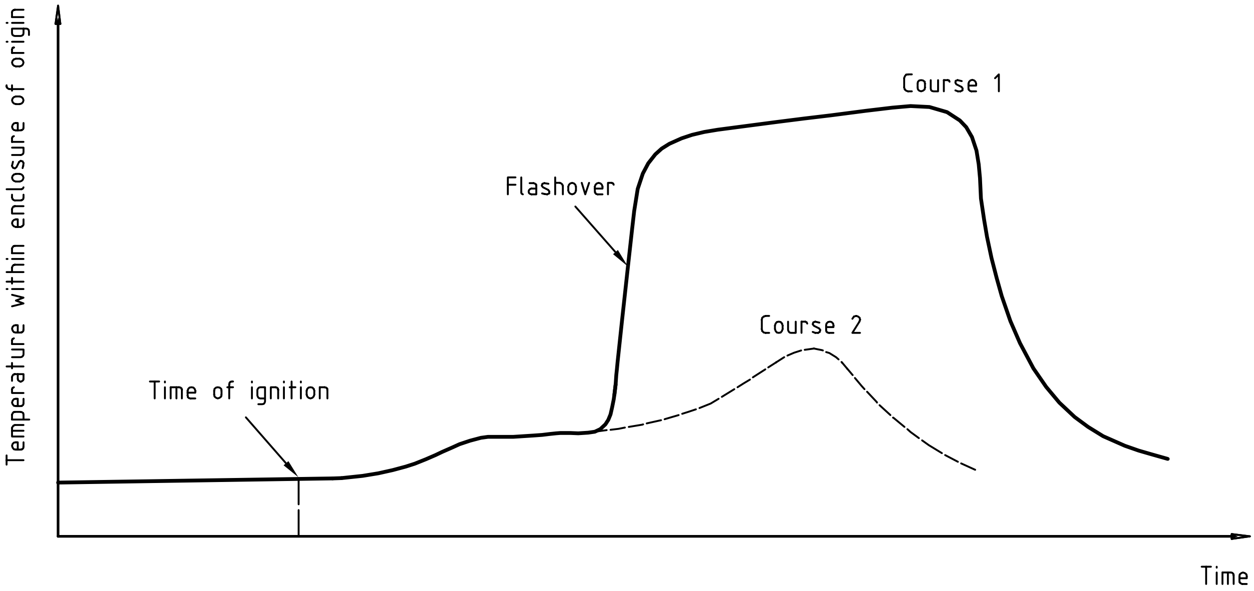
b) **Growth:** The spread or propagation of the fire which continues until there are no further supplies of immediately accessible fuel (combustibles) or air to become involved. This stage may involve the ignition of adjacent combustible materials;

c) **Flashover:** The sudden transition from a localized fire to combustion of all exposed fuel surfaces within an enclosure;

d) **Fully developed fire:** The stage at which the fire may be said to be "fully developed" and all combustible materials are burning at a rate controlled by the supply of air to burning surfaces;

e) **Decay:** The final stage during which the fire is burning itself out.

Heat produced by a typical uncontrolled fire in an enclosure changes with time (see Figure 1) and is affected by the design of the compartment and the ventilation conditions. Figure 1 also shows the four stages of development of the fire and the flashover point. The duration and severity of the fire at each stage varies markedly with the rate of air supply to the combustion zone. The degree of risk to life and property is, in turn, largely controlled by the stage to which the fire has progressed. The contribution of different products, components and elements of construction to those risks may also change considerably from one stage to another.



Initiation	Fire growth	Fully developed	Fire decay

NOTE Not all fires go to flashover.

Figure 1 — Diagram showing the different phases in the development of a fire within an enclosed space

5 Fire hazard assessment

Realistic assessment of the fire performance of a product can only be obtained by considering a representative sample in the form and orientation in which it is actually used; an isolated assessment of this kind can only indicate the response of the product to the combustion environment selected. It must be emphasized, however, that no fire test can in normal circumstances measure fire hazard, nor can it be assumed that satisfactory results on a single standard fire test will guarantee a certain level of safety. Results from a variety of fire tests will provide information to assist in the determination and subsequent control of fire hazard assessment. A schematic representation of hazard assessment is given in Figure 2.

If a fire chain as depicted in Figures 1 and 2 can develop, a detailed appraisal of the proposed use of the product should be carried out. This process is necessary so that decisions may be taken about the type of action which will eliminate or reduce the severity of any potential fire hazards. It is recommended that this appraisal process is performed in a standardized procedure so that all relevant factors are considered.

The standardized procedure recommended is to consider the input data from the ISO toolkit tests as providing the bottom layer of a decision tree triangle (that is, the database is the roots of the tree) (see Figure 3). Where no evidence exists from modelling studies for the scenario under consideration, there will be a need to conduct additional testing (probably on a large scale, and possibly of an ad hoc nature). The middle layer of the decision tree triangle is therefore a correlation table between the test results and the full-scale behaviour. There will be gaps in this table initially and so it is recognized that additional validation information (often of an ad hoc nature) will need to be provided at the revision stages of this part of ISO/TR 11696.

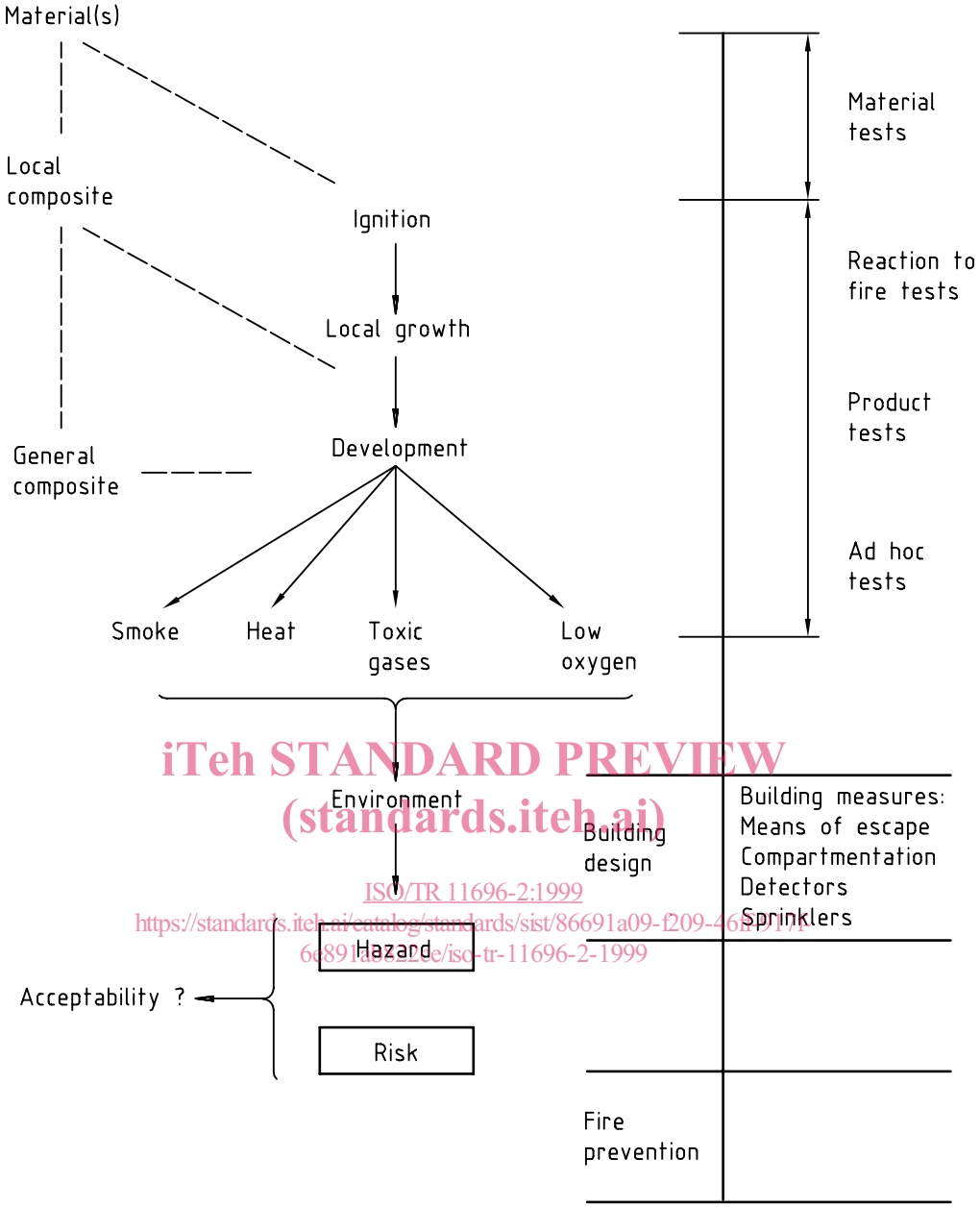


Figure 2 — Hazard/risk assessment

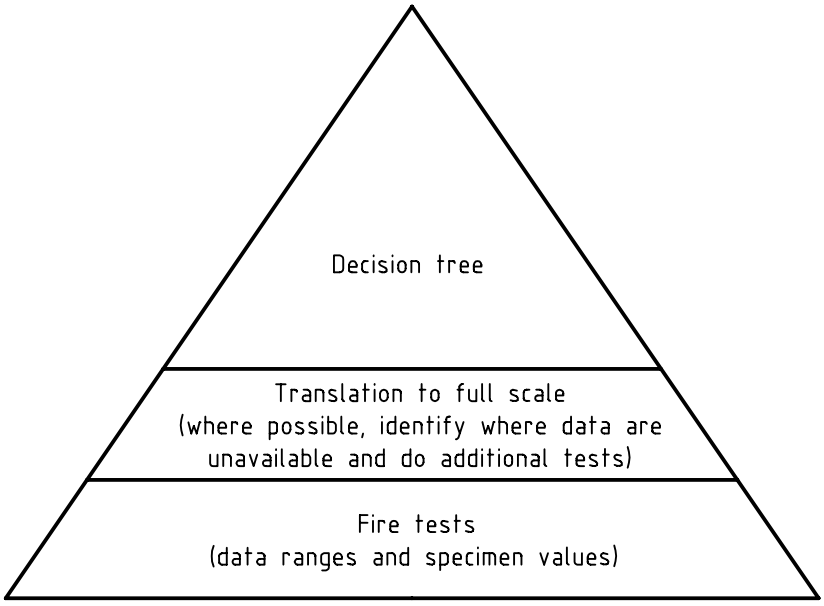


Figure 3 — The decision tree triangle showing input of test data

This part of ISO/TR 11696 suggests a 5-step approach to fire hazard assessment based upon a decision tree; the decisions about the acceptability of the fire safety questions may be made using classification techniques or mathematical modelling (or combinations of both). The decision process used and the level of acceptable results is the responsibility of individual regulators, users, etc.

The procedure for fire hazard assessment assumes that fires develop in the manner indicated in clause 4. It is then possible to consider the stages of a potential fire in different steps. It is particularly important to note that at each step data from fire tests are considered together with information on the product design and anticipated conditions of the fire scenario.

6 The decision tree

NOTE The complete 5-step process is illustrated in Figure 4.

6.1 Step 1 — Definition of fire scenario (probabilistic)

Consideration should be given to both the immediate fire site and to the surrounding areas which may subsequently become involved. Once the scenario has been defined, the probability of its occurrence should be assessed. It is important to include a diagram of the scenario and the anticipated smoke movement at this step.

6.2 Step 2 — Ignition hazard (deterministic)

Fire statistics are available on ignition sources and the causes of fire in different environments (for example, domestic and industrial buildings) and they should be consulted. These statistics can be used to assess the relative probability of specific ignition incidents.

Ignition sources selected for tests should be relevant to those considered to be realistically capable of existing in the defined scenario.

Factors influencing the decision about whether there is an ignition risk are shown in Figure 5. A reliable decision can only be made if each factor is carefully considered in terms of potential influences on the ignition hazard (see clause 7).