TECHNICAL REPORT

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Plastics — Burning behaviour — Guidance for development and use of fire tests

Plastiques — Lignes directrices pour le développement et l'utilisation d'essais au feu

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Contents

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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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, 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).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 10840, which is a Technical Report of type 3, was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 4, *Burning behaviour*.

Introduction

ISO/TC 61/SC 4 has responsibility for the development of fire tests for plastics as materials. It is recognized that this task is best performed by efficient liaison with those ISO Technical Committees who have to develop fire tests for products. In this way the end-use conditions of a product can be identified, and the essential requirements concerning the fire safety of those products containing plastics can be determined. It is not practical for ISO/TC 61/SC 4 to develop tests for all common fire scenarios. It is possible however to measure the major fire parameters of plastics such as ignitability, rate of heat release, rate of flame spread and rate of smoke generation. These data may then be applied in a variety of hazard assessment protocols to monitor the fire performance of products made from plastics.

At the present time more than 700 different fire tests are in use worldwide to classify materials and manufactured products. Many of these do not take account of properties of thermoplastics such as deformation, melting and dripping when heat is applied. Intumescence is another property of certain plastics which is not taken into account. The specific problems associated with the fire testing of plastics are summarized in the Annex.

Such behaviour during testing can often make it difficult to interpret test results and, in some cases makes such interpretation impossible.

It is essential that fire test methods contain clear guidelines on data collection and interpretation in order to ensure that valid results are obtained.

Plastics — Burning behaviour — Guidance for development and use of fire tests

1 Scope

1.1 This Technical Report provides guidance on fire testing of plastics for manufacturers, converters, users, specifiers and regulators.

1.2 These guidelines are recommended for use in designing fire tests on plastics and in associated standards so that they fulfil the requirements of the intended use with particular reference to the following :

a) This guidance applies in particular to the working groups of ISO/TC 61/SC 4 'Burning behaviour of plastics' and is applicable to all the test methods developed by this sub-committee.

b) Fire tests are necessary for gathering information for estimating fire hazard.

c) Fire tests are used in legal codes and regulations, specifications, quality assurance, research and development. They are of particular value in monitoring of compliance with legal requirements, consumer protection measures and product design, development and use.

2 References

ISO 834 : 1975 Fire resistance tests on elements of building construction

ISO 1210 : 1992 Plastics - Determination of the burning behaviour of horizontal and vertical specimens in contact with a small ignition source

ISO 1716 : 1973	Building materials - Determination of calorific potential
ISO TR 3814 : 1989	Tests for measuring 'reaction to fire' of building materials - Their development and application
ISO 5657 : 1986	Reaction to fire - Ignitability of building products
ISO 5658-2[1]	Fire tests - Reaction to fire - Part 2: Lateral surface spread of flame on building products with specimen in vertical configuration
ISO 5659-2[1]	Plastics - Smoke generation - Part 2: Determination of optical density by a single chamber test
ISO 5660-1:1993	Fire tests - Reaction to fire - Part 1: Rate of heat release from building products (Cone calorimeter method)
ISO 5924[1]	Fire tests - Reaction to fire - Smoke generated by building products (Dual Chamber test)
ISO 6941[1]	Textile fabrics - Measurement of flame spread properties of vertically oriented specimens
ISO 8191-1:1987	Furniture - Assessment of the ignitability of upholstered furniture - Part 1: Ignition source : smouldering cigarette
ISO 8191-2:1988	Furniture - Assessment of the ignitability of upholstered furniture - Part 2: Ignition source: match-flame equivalent
ISO TR 9122-1:1989	Toxicity testing of fire effluents - Part 1: General
ISO TR 9122-2:1990	Toxicity testing of fire effluents - Part 2: Guidelines for biological assays to determine the accute inhalation toxicity of fire effluents (basic principles,criteria and methodology)
ISO TR 9122-3:1993	Toxicity testing of fire effluents - Part 3: Methods for the analysis of gases and vapours in fire effluents
ISO TR 9122-4:199	Toxicity testing of fire effluents - Part 4: Fire model

1) To be published

ISO TR 9122-5:1993	Toxicity testing of fire effluents - Part 5: Prediction of toxic effects of fire effluents
ISO 9239[1]	Floor coverings - Determination of critical radiant flux using a radiant heat energy source
ISO 9705[1]	Fire tests - Full scale room test for surface products
ISO 9772[1]	Cellular plastics - Determination of horizontal burning characteristics of small specimens subjected to a small flame
ISO 9773:1990	Plastics - Determination of burning behaviour of flexible vertical specimens in contact with a small flame ignition source
ISO 10093[1]	Plastics - Categories of ignition sources
ISO 10351 : 1992	Plastics - Method of test for the determination of combustibility of vertically oriented specimens using a 125 mm flame source
IEC 332-1:1979	Tests on electric cables under fire conditions Part 1: Test on a single vertical insulated wire or cable
IEC 332-2:1989	Tests on electric cables under fire conditions Part 2: Test on a single small vertical insulated copper wire or cable
IEC 332-3:1992	Tests on electric cables under fire conditions Part 3: Tests on bunched wires or cables
IEC 695-1-1	Fire hazard testing - Part 1: Guidance for the preparation of requirements and test specifications for assessing fire hazard of electrotechnical products - Section 1 General guidance
IEC 695-2-1	Fire hazard testing - Part 2: Test methods - Section 1: Glow-wire test and guidance
IEC 1034-1 : 1990	Measurement of smoke density of electric cables burning under defined conditions - Part 1: Test apparatus

[1] To be published

IEC 1034-2 : 1991	Measurement of smoke density of electric cables burning under defined conditions - Part 2: Test procedure and requirements
ISO/IEC Guide 52:1990	Fire tests: Terminology

3 Terminology

3.1 Definitions which can lead to misunderstandings in the method of the fire test or the representation of test data should be avoided. Terminology as defined in ISO Guide 52 'Glossary of fire terms and definitions' should be used as far as possible.

4 Fire scenarios and fire models

4.1 Plastics are used in a wide range of potential fire scenarios such as buildings, transport systems, electrical equipment and packaging.

4.2 In recent years the public awareness of fire hazards has increased. This is in part due to technical developments and improvements in living standards. Consequently the need to improve preventive fire protection has become increasingly important.

4.3 Fire tests are necessary in the evaluation of fire hazard and relevant safety requirements are assessed using such tests. This explains why fire tests should be relevant to the end use of the product.

4.4 The contribution of a solid material to the initiation and growth of a fire, to the development of smoke and to the toxicity of effluents is influenced not only by the specific properties of the material, but also by :

- its form,
- its surface area,
- its mass,
- the contact and reaction with other materials,
- its orientation.

4.5 The intensity of a fire is determined by :

- the intensity and application time and position of the ignition source
- the ventilation conditions
- the geometry of the enclosure
- the heat release of the burning materials

4.6 In order to initiate a fire we require the interaction of the following three components :

a) energy (as heat),
b) oxygen (in air),
c) combustible materials (fire load of fuel).

The combined action of these three components is illustrated in Figure 1.

4.7 No two fires are alike. The number of influences which may change the development of a fire is extremely high. The development of a fire however can generally be split into phases as shown in Figure 2.

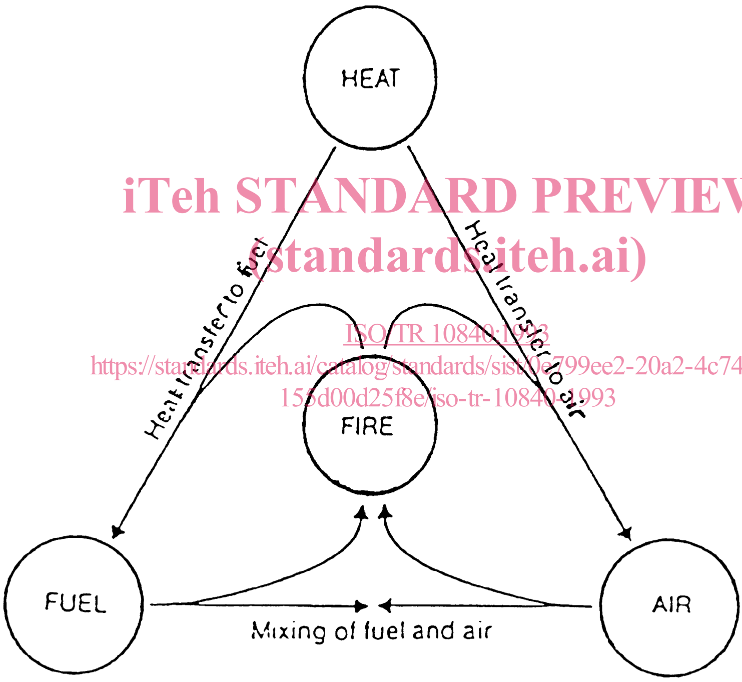

Figure 1. The interaction between energy, combustible material and air in a fire

4.8 The nature, intensity and application of the ignition source as well as the ignitability of the material on which they work determines if ignition occurs. After ignition, flame propagation of combustible materials and heat released decide further fire development. Sufficient heat build-up can cause flash-over of all combustible material within the fire zone. This event is followed by what is known as the 'fully developed fire'. Further spread of the fire beyond this point depends upon the fire resistance of the confining structure.

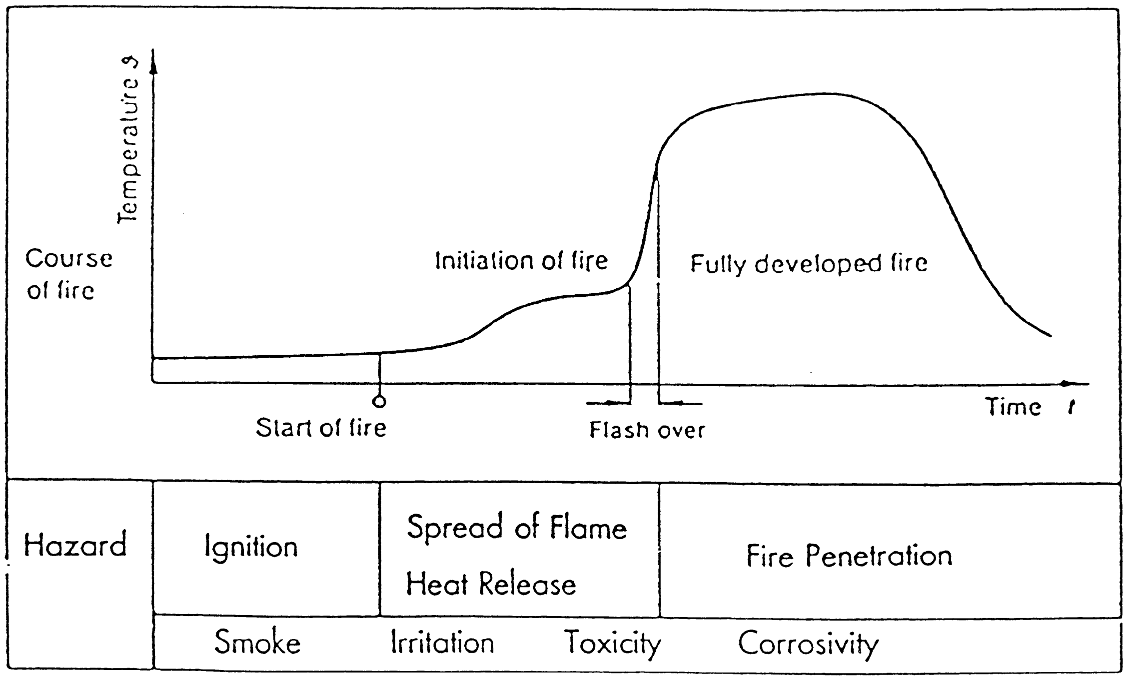

Figure 2. Diagram showing the different phases in the development of a fire within a room

4.9 Generally, fire tests simulate only a few limited aspects of a real developing fire. No single test can reflect accurately all aspects of each separate phase in a developing fire.

4.10 Fire tests on plastics have an integral role to play in the assessment of the flame and fire response of manufactured products and systems incorporating plastics as component parts. The meaningful interpretation of the results of fire tests on plastics is essential when it comes to making cost effective analysis of the fire risk of such systems and assemblies.

4.11 The best way of assessing the fire response of manufactured products and systems incorporating plastics would be to test under conditions which duplicate exactly those encountered in real life. This ideal approach, however, suffers from several major disadvantages, not least of which are the cost, the imperfect reproducibility and the difficulty of interpretation which large scale or full scale fire testing frequently involves. The wise use of data derived from the smaller scale fire tests on plastics themselves can help to resolve these difficulties, provided that the limits of applicability of these data are recognized and taken into account in the analysis of fire risk.

4.12 New scientific approaches to the evaluation of fire hazards (via computational modelling) as well as the experimental correlations found between some small scale and full scale tests constitute a new field of major importance for the evaluation of the fire hazards of all combustible materials including plastics.

5 Types of fire tests

5.1 Fire performance tests (large and full scale tests)

5.1.1 These tests imitate real fire scenarios as closely as possible. Their design and the interpretation of their results, however, is a very difficult task and requires a great deal of expertise as many interrelated factors play a role in the course of such tests. Further problems arise from repeatability, reproducibility and high cost.

5.1.2 Well designed fire performance tests are however, a useful tool for showing if the results of a small scale test make a relevant contribution to fire hazard analysis.

5.2 Combustion characteristics tests (small scale tests)

5.2.1 With these kind of tests, properties or parameters related to some aspect of burning behaviour are measured on standardized test specimens under defined test conditions. Properties and parameters obtained for a material in such a test are generally not representative of conditions other than those specified in that test method.

5.2.2 Combustion characteristics tests may be used for quality assurance and preselection. This however, is only meaningful, if correlation has been established between the results of such a test and the burning behaviour under end-use conditions.

6 Characteristics of burning behaviour

The characteristics, their definitions and examples of typical test methods for each of them are shown in Table 1.