TECHNICAL REPORT



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Reaction-to-fire tests — Heat release, smoke production and mass loss rate —

Part 3: Guidance on measurement

Essais de réaction au feu — Débit calorifique, taux de dégagement de fumée et taux de perte de masse —

Partie 3: Lignes directrices relatives au mesurage



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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 Maison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical convertees 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 apply 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is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 5660-3 was prepared by Technical Committee SQ/TC 92, Fire safety, Subcommittee SC 1, Fire initiation and growth.

at title Ophone alter by the ISO/TR 5660 consists of the following parts, under the general title Reaction-to-fire tests — Heat release, smoke production and mass loss rate:

- Part 1: Heat release rate (cone calorimeter method)
- Part 2: Smoke production rate (dynamic measurement)
- Part 3: Guidance on measurement [Technical Report]

Introduction

ISO 5660-1, describing a test method for rate of heat release from building products by means of a cone calorimeter, was published in 1993 (first edition) following approximately ten years of development within ISO/TC 92, *Fire safety*, Subcommittee SC1, *Fire initiation and growth*.

The cone calorimeter is a fire test instrument in which horizontal specimens are exposed to controlled levels of radiant heating by means of a truncated cone-shaped heater. Continuous spark ignition is provided and the time to ignition is reported for specimens which ignite. The rate of heat release from the burning specimen is determined from measurements of the amount of oxygen consumed from the air flowing through the apparatus, which has been demonstrated to equate to heat release. The mass of the specimen is also measured throughout the burning period. The specimens are usually tested under well ventilated conditions.

Results are expressed in terms of peak and average rates of heat release as well as total heat released and the effective net heat of combustion. ISO 5660-1 limits the specimen type to essentially flat. Several other groups are now utilizing the cone calorimeter and a number of new parameters in addition to those defined in ISO 5660-1 and ISO 5660-2^[30] have been defined and used. Some of these, including smoke measurement, require that measurements be made from the beginning of the test rather than at the onset of ignition which is commonly used as the starting point for heat release measurement.

The cone calorimeter is also designed to allow measurement of smoke and gases such as CO and CO₂. Smoke measurement is the subject of ISO 5660-2^[30]. Further work is under way to define a quality control tool for measuring burning rates of building products. This will be published as ISO 17554^[22] and is based on mass loss measurements using the thermal decomposition model of the cone calorimeter. A similar system which measures the temperature of combustion products generated by this apparatus and has been standardized by ISO/TC 61 as ISO 13927^[23]. The cone calorimeter fire model has also been used in a corrosivity International Standard developed by ISO/TC 61 as ISO 11907-4^[24]. The effect of the evolved gases on the resistance of a printed circuit board targets used to assess corrosivity.

During development of the cone calorimeter it became apparent that there was considerable interest in the use of the instrument for products other than building products. Several standards have been developed by various national and international groups based on ISO 5660-1 and ISO 5660-2.

This part of ISO 5660 provides recommendations for the testing of poducts in the cone calorimeter and gives guidance on the presentation of the results. Supplementary guidance is given in documents referred to in References [1] and [2].



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Reaction-to-fire tests — Heat release, smoke production and mass loss rate —

Part 3: Guidance on measurement

This part of ISO 5660 examines the limitations of the cone calorimeter as currently used for building products and recommends ways in which some of these may be overcome for other types of products for other application areas. It compiles information from a large body of experience with regard to the use of the instrument into a set of guidelines which will help to standardize the use of the cone calorimeter in this wider scope.

Particular guidance is given on aspects of specimen preparation and on the behaviour, such as melting, spalling and intumescing, of specimens exposed to radiant heat. The relevance of specimen thickness and the use of substrate, and methods of fixing to substrate, are also discussed. Advice is given on approaches to testing a variety of "non-standard" products. Recommendations are made on techniques of calibration of the apparatus, selection of appropriate heat flux levels and ignition protocols.

In addition to the guidance given to operators, the **cou**ment makes recommendations on presentation of the test results.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5660-1:2002, Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)

3 Capability and limitations of the cone calorimeter

Rate of heat release is one of the fundamental properties of fire and should alrost always be taken into account in any assessment of fire hazard. Heat release significantly affects fire growth. Considerable progress has been made in methods of using rate of heat release and ignition time results from the cone calorimeter to predict full scale fire characteristics such as time to flashover in a small room lined with the tested product and exposed to a high energy fire source such as that used in ISO 9705^[3].

The design of the instrument also provides for measurement of smoke (both gravimetrically and optically) and other gaseous products of pyrolysis or combustion. The instrument may thus be applied to the assessment of real fire hazards such as smoke and toxic and corrosive gas emission in addition to heat release, particularly when the results are expressed in terms of fundamental physically-based rather than ad hoc parameters.