
Fire-resistance tests — Elements of building construction —

Part 3:

Commentary on test method and test data application

Essais de résistance au feu — Éléments de construction —

Partie 3: Commentaires sur les méthodes d'essais et application des données d'essais



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO members 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 in 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 Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.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 834-3, which is a Technical Report of type 1, was prepared by Technical Committee ISO/TC 92, *Fire tests on building materials, components and structures*, Subcommittee 2, *Fire resistance*.

ISO 834 consists of the following parts, under the general title *Fire resistance tests — Elements of building construction*:

- *Part 1: General requirements for fire resistance-testing*
- *Part 2: Special requirements for different elements*
- *Part 3: Commentary on test method and test data application*

Annex A of this part of ISO 834 is for information only.

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Fire-resistance tests — Elements of building construction —

Part 3:

Commentary on test method and test data application

1 Scope

The information provided in this part of ISO 834 is advisory in nature and is intended to provide guidance on the use of the fire resistance test method and the application of the data obtained. This part of ISO 834 also identifies a number of areas where future editions may benefit by research: into phenomena associated with the performance of assemblies under test and their relationship with actual building construction; and into technology related to the instrumentation and testing techniques.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 834. At the time of publication, the edition indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 834 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards

ISO 834-1:—¹⁾, *Fire resistance tests — Elements of building construction — Part 1: General requirements for fire resistance testing*.

ISO/TR 3956:1975, *Principles of structural fire-engineering design with special regard to the connection between real fire exposure and the heating conditions of the standard fire-resistance test (ISO 834)*.

ISO/TR 10158:1991, *Principles and rationale underlying calculation methods in relation to fire resistance of structural elements*.

3 Standard test procedure

Practical considerations dictate that it is necessary to make a number of simplifications in any standard test procedure in order to provide for its use under controlled conditions in any laboratory with the expecta-

tion of achieving reproducible and repeatable results.

Some of the features which lead to a degree of variability are outside of the scope of the test procedure, particularly where material and constructional differences become critical. Other factors which have been identified in this part of ISO 834 are within the capacity of the user to accommodate. If appropriate attention is paid to these factors, the reproducibility and repeatability of the test procedure can be improved to an acceptable level.

3.1 Heating regimes

The standard furnace temperature curve described in ISO 834-1, subclause 5.1.1 is substantially unchanged from the time-temperature curve employed to control the fire test exposure environment for the past seventy or so years. It was apparently related in some respects to temperatures experienced in actual fires in buildings using references such as the observed time of fusion of materials of known melting points.

The essential purpose of the standard temperature curve is to provide a standard test environment which is reasonably representative of a severe fire exposure condition, within which the performance of various representative forms of building construction may be compared. It is, however, important to remember that this standard fire exposure condition does not necessarily represent an actual fire exposure situation nor is it necessarily indicative of the expected behaviour of the structural element under test should it become involved in an actual building fire. The test does, nevertheless, grade the performance of separating and structural elements of building construction on a common basis. It should also be noted that the fire resistance relates to the test duration and not to the duration of a real fire.

The relationship between the heating conditions, in terms of time-temperature prevailing in real fire conditions and those prevailing in the standard fire-resistance test is discussed in ISO/TR 3956. A series of cooling curves is also discussed.

1) To be published.

It should be noted that the standard furnace temperature curve may also be expressed in exponential terms which closely approximate the curve expressed by $T = 345 \log_{10} (480t + 1)$ and which may be considered preferable for calculation purposes. The expression thus becomes

$$T = 1\,325(1 - 0,325 e^{-0,2t} - 0,204 e^{-1,7t} - 0,471 e^{-19t})$$

where

T is the temperature increase, in degrees Celsius;

t is the time at which temperature increase has occurred, in hours.

The comparison of the areas of the curves represented by the average recorded furnace temperature versus time and the above standard curve, in order to establish the deviation present, d , as specified in ISO 834-1, subclause 5.1.2, may be achieved by using a planimeter over plotted values or by calculation employing either Simpson's rule or the trapezoidal rule.

While the heating regime described in ISO 834-1, subclause 5.1.1, is the fire exposure condition required by this Technical Report, it is recognized that it is not appropriate for the representation of the exposure conditions such as may be experienced from, for example, fires involving hydrocarbon fuels. Such exposure environments will, more appropriately, be provided for in other standards which cover fire resistance tests of other than building constructions. An example of one heating regime which has recently been proposed to represent hydrocarbon fires is as follows:

$$T = 1\,100(1 - 0,325 e^{-0,1667t} - 0,204 e^{-1,417t} - 0,471 e^{-15,833t})$$

where

T is the temperature increase, in degrees Celsius;

t is the time at which temperature increase has occurred, in hours;

or, in practical terms:

$$T = 1\,100(1 - 0,33 e^{-0,17t})$$

where t is the time, in hours.

3.2 Furnace

The heating conditions prescribed in ISO 834-1, subclause 5.1.1, are not sufficient by themselves to ensure that test furnaces of different design will each present the same fire exposure conditions to test

specimens and hence provide for consistency in the test results obtained among these furnaces.

The thermocouples employed for controlling the furnace temperature are in dynamic thermal equilibrium with an environment which is influenced by the radiative and convective heat transfer conditions existing in the furnace. The convective heat transfer to an exposed body depends upon its size and shape and is generally higher with a small body such as a thermocouple bead than with a large body like a specimen. The convective component will therefore tend to have greater influence upon the thermocouple temperature while the heat transfer to a specimen is mainly affected by radiation from the hot furnace walls and the flames.

Both gas radiation and surface to surface radiation are present in a furnace. The former depends on the temperature and absorption properties of the furnace gas as well as being significantly influenced by the visible component of the burner flame.

The surface to surface radiation depends on the temperature of the walls and their absorption and emission properties as well as the size and configuration of the test furnace. The wall temperature depends, in turn, on its thermal properties.

The convection heat transfer to a body depends on the local difference between the gas and the body surface temperature as well as the gas velocity.

The radiation from the gases corresponds to their temperature, and the radiation received by the specimen is the sum of that from the gases and the furnace walls. The latter is less at the beginning and increases as the walls become hotter. The thermocouples prescribed by this part of ISO 834 are small and will adjust to the gas temperature. The specimen, on the other hand is more sensitive to the irradiance.

From the foregoing discussion, it is apparent that the ultimate solution in the matter of achieving consistency among testing organizations utilizing the requirements of this part of ISO 834 will only be realized if all users of this part of ISO 834 and idealized design of test furnace which is precisely specified as to size, configuration, materials, construction techniques and type of fuel used.

One method of reducing the problems which have been outlined, which can be applied to existing furnaces is to line the furnace walls with materials of low thermal inertia that readily follow the furnace gas temperatures such as those with the characteristics prescribed in ISO 834-1, subclause 4.2. The difference between the gas and wall temperatures will be reduced and an increased amount of heat supplied by the burners will reach the specimen by radiation from the furnace walls and hence there will be an