INTERNATIONAL STANDARD ISO 3009

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Fire-resistance tests — Glazed elements

Essais de résistance au feu — Éléments en verre

First edition — 1976-10-15
Corrected and reprinted — 1981-03-11

UDC 69.028.2 : 699.81 : 620.16 **Ref. No. ISO 3009-1976 (E)**

Descriptors : buildings, windows, doors, construction materials, glassware, tests, fire tests, test specimen conditioning.

Price based on 8 pages

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3009 was drawn up by Technical Committee ISO/TC 92, *Fire tests on building materials and structures*, and was circulated to the Member Bodies in April 1973.

It has been approved by the Member Bodies of the following countries :

Australia	India	South Africa, Rep. of
Bulgaria	Ireland	Spain
Canada	Israel	Sweden
Czechoslovakia	Italy	Thailand
Denmark	Mexico	U.S.A.
Egypt, Arab Rep. of	New Zealand	U.S.S.R.
Germany	Norway	Yugoslavia
Hungary	Romania	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Austria	France
Belgium	United Kingdom
Finland	

NOTE – Annexes A and B to this International Standard provide additional information but neither annex forms a mandatory part of this standard. The procedure described in annex B may be used as an optional requirement. Laboratories are advised to gain experience with this method, particularly with the aim of increasing its sensitivity to an acceptable level so that it may be included in the main body of the standard at a future revision.

Printed in Switzerland

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Fire-resistance tests — Glazed elements

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies methods of testing and assessing the fire resistance of non-loadbearing, vertical glazed elements of construction which are intended either to provide, wholly or in part, separation between different areas in a building, or to form part of the external walls.

It is applicable to glazed separating elements such as windows, walls of glass blocks and other light-transmitting assemblies.

2 REFERENCE

ISO 834, *Fire-resistance tests — Elements of building construction.*

3 PRINCIPLE

Glazed elements are unable to provide an appreciable degree of insulation against heat transfer and therefore the normal insulation criteria of ISO 834 are not considered to be applicable. However, the radiated heat will affect the safety of people; it could also cause ignition of combustible contents and fittings. This International Standard therefore specifies means for measuring transmitted heat; the appropriate acceptance criteria are the responsibility of the national standards authorities.

4 FURNACE

The furnace shall be capable of subjecting one side of the test element to the heating condition specified in ISO 834, and the furnace temperature shall be measured with respect to the test element and controlled within the tolerances specified in ISO 834.

Means shall be provided for increasing and maintaining the pressure conditions within the furnace chamber to a positive value in relation to the pressure in the laboratory according to the requirements of 7.1.

5 PREPARATION OF TEST ELEMENT

5.1 Dimensions

The complete assembly to be tested shall be full size. When either of the dimensions of the full-size construction is larger than it is possible to accommodate in the furnace, the test element shall have the maximum size that can be accommodated; in such a case the appropriate width or height shall be not less than the following :

— width : 2,0 m

— height : 2,5 m

5.2 Construction

The test shall be performed on a complete assembly constructed as intended to be used in practice, incorporating all the necessary hardware[1].

A vertical test element shall be tested in a wall of the type in which it is intended to be used or, when this cannot be specified, in a wall of concrete or brick having a thickness of

— about 100 mm for a test having an anticipated duration of 2 h or less;

— about 200 mm for tests of longer duration.

The fixing of the test element in the surrounding wall (see figure 1) shall follow the recommended method for the construction and no special provision shall be made for its retention.[2]

1) The term "hardware" covers such items as hinges, latches, door handles, locks, keyholes, letter plates, sliding gear, closing devices, etc.

2) Where the glazed element is mounted without structural connection to the surrounding vertical construction, its deflection from the vertical plane at the edges shall be recorded so that its compatibility with other forms of vertical construction may be judged from the deflections of those constructions when tested to ISO 834.

5.3 Conditioning

Test elements containing hygroscopic materials or other materials which can be affected by moisture shall be conditioned to equilibrium with the prevailing conditions in the laboratory, which shall be within the following limits :

- temperature (dry bulb) : 25 ± 5 °C
- relative humidity : 40 to 65 %

Test elements made entirely of glass or glass and metal do not require any conditioning. The wall containing the test assembly shall be constructed not less than 2 weeks before the test in the case of a brick wall or 4 weeks in the case of a concrete wall. To minimize the effect of excessive moisture in concrete walls, it may be necessary to condition them to a state of equilibrium.

6 TEST PROCEDURE

The test element shall be exposed to the heating conditions specified in ISO 834. For asymmetrical constructions, a testing authority may decide to expose a particular face to meet special circumstances or if exposure from that face is considered more onerous.

Measurements and observations specified in clause 7 shall be made during the test. The test shall be terminated when the assembly no longer satisfies the criteria under which its performance is being judged or at an earlier stage by prior agreement between the sponsors and the testing authority, even if no failure under any of the criteria has occurred.

7 MEASUREMENTS AND OBSERVATIONS

7.1 Furnace pressure

The static pressure in the furnace shall be measured, for example, by using the static pressure probe detailed in figure 2. The measurements of the static pressure shall be made at a minimum of three positions located along a vertical axis on one side of and close to the test assembly in line with the top and bottom edges and at one-third of the height as shown in figure 1. The pressure shall be controlled so that a positive pressure is maintained at least over the upper two-thirds of the assembly.

7.2 Radiation from unexposed face

Radiant heat flux shall be measured from the unexposed face of the test element by means of a radiometer or other suitable means along an axis normal to the glazed element at the centre and at a known distance from the face. This distance shall be such that the field of view just covers the diagonal of the glazed assembly. A description of a type of radiometer suitable for this purpose has been published.[1)]

Information on the measurement technique and the type of instruments used shall be given in the report.

7.3 Cotton pad test

The cotton pad test is appropriate only for partially glazed test elements or for determining the loss of integrity between the frames and the surround. The test shall not be applied in positions where exposure to radiation from the glazing can cause the cotton pad to ignite.

The passage of flames and gases through cracks, holes or other openings in or around the test element shall be determined by applying a cotton pad to such openings at regular intervals during the test. The cotton pad shall not be in contact with the test element but shall be located centrally over the aperture in a plane parallel to the surface of the element between 20 and 30 mm away and held in position for not less than 10 s and not more than 30 s. The pad shall not be re-used if it has absorbed any moisture or become charred during a previous application.

The cotton pad, measuring approximately 100 mm square × 20 mm thick, shall consist of new undyed and soft cotton fibres without any admixture of artificial fibres, and shall have a mass between 3 and 4 g. The pad shall be conditioned by drying in an oven at 100 °C for at least 0,5 h. The pad shall be attached by wire clips to a 100 mm × 100 mm frame of 1 mm diameter wire, to which a wire handle approximately 750 mm long is fixed. Note shall be made of the time when the first ignition of the cotton pad occurs and the position where this takes place. With glazed elements having no, or only slight, insulation, it may not be possible to apply this test shortly after the commencement of heating; note shall be made of the time after which it is not practicable to apply this test.

7.4 Other observations

Note shall be made of the deformation of the test element, softening and melting of glass, cracking of blocks, formation of holes[2)], formation of gaps between frame and surround, and any sustained flaming for 10 s or more on the unexposed face of the combustible surround or framing members. When necessary, the measurement of the temperature of the unexposed glazed face may be made.

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1) A wide-angle field type radiometer with provision for water cooling, similar in design to that described in *Journal of Scientific Instruments*. 1960, **37**, 128-30, has been found to be suitable for radiation measurements, provided that a screen of polished aluminium is used in conjunction with it to ensure than only the specified area of the test assembly is covered. Where high intensities of radiation are anticipated, the screen may also need to be water cooled. With radiometers having flat plate type receivers, the included angle of incidence shall not exceed 50°. Improved types of instrument are being developed for this purpose by a Working Group of ISO/TC 92.

2) Some national standards specify a limit to the size of holes, orifices and gaps around the edge of the test element. These limits may represent an additional requirement for initial integrity failure.

8 PERFORMANCE CRITERIA

The fire resistance of glazed elements shall be judged under one or more of the following criteria. The national standards authorities can introduce acceptance levels under different criteria where none are shown, or modify those given in this section.

8.1 Loss of integrity (initial integrity failure)[1)]

8.1.1 *Flaming*

The time shall be stated at which flaming is sustained for 10 s or more on the unexposed face.

8.1.2 *Cotton pad test*

If the cotton pad test is performed, the time shall be noted at which the first ignition of the cotton pad occurs.

8.2 Loss of integrity (ultimate integrity failure)[2)]

The time shall be noted at which the test element collapses as a whole or substantially.

8.3 Radiation hazard

The radiation measurements shall be used to determine the time at which critical radiation levels exist at specified distances from the face of the test element. The specification of limits for safe radiation levels both for contents and for personnel is the responsibility of the national standards authorities.

9 TEST REPORT

The test report shall include the following information :

a) name of testing laboratory;

b) name of sponsor;

c) date of test;

d) name of manufacturer and the trade name (if any) of the product;

e) details of construction and conditioning of the test element and of the materials used;

f) description of fixing of the test element to the test frame or surround;

g) side exposed to heating;

h) test results

1) furnace time/pressure chart and temperature curves;

2) the times at which particular conditions are reached as required by 8.1.1, 8.1.2, 8.2 and 8.3,

3) (for glazed elements with slight insulation only) time required by last sentence of 7.3;

i) data for establishing the distances from the unexposed face at which radiation levels exceeded specified limits;

j) any other relevant observations.

1) Some national standards specify a limit to the size of holes, orifices and gaps around the edge of the test element. These limits may represent an additional requirement for initial integrity failure.

2) Laboratories may find it useful to employ the canopy test described in annex B as a means for defining "ultimate integrity failure".

ANNEX A

EXPLANATORY NOTES ON VARIOUS CLAUSES

NOTE – So that suitable precautions to safeguard health may be taken, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved in combustion of test elements.

A.0 GENERAL

These notes give additional information which could not be included in the body of this International Standard. Their main purpose is to indicate to the testing and building authorities the limitations of various clauses, the need for caution in the application of data, and the testing aspects which may need to be revised on the availability of further data.

A.1 NOTE TO CLAUSE 1

The purpose of this International Standard is to provide a method of determining the ability of fully or partially glazed separating elements to prevent fire penetration. It specifies the same technique as that recommended for door assemblies. It cannot be applied directly to horizontal constructions, for example concrete/glass floors, which should be dealt according to ISO 834 as a special case.

A.2 NOTE TO CLAUSE 3

Glazed elements can be designed to act as a barrier to the passage of flames and gases for up to the time when softening of glass will lead to a loss of integrity. Glazed elements cannot provide the same degree of insulation as other fire-resisting elements as they would normally allow nearly half of the applied heat to be transmitted as radiant energy. This requires special consideration to be given to the fixing of glazing in combustible constructions, the location of combustible materials in the vicinity and the use of glazed partitions on escape routes.

A.3 NOTE TO CLAUSE 6

Opening glazed windows may need to be tested from both sides to ensure that the heating conditions do not represent a more severe exposure from one side than from the other. However, where the windows occur in the external wall, conditions of an internal fire exposure are expected to represent a more severe exposure.

A.4 NOTE TO SUB-CLAUSE 7.3

The location of the radiometer and its field of view should be such that it can measure radiation flux emitted from the whole of the glazed area. This may necessitate the use of masks in front of the radiometer having the same shape as the test element. The radiometer suggested is only one type of instrument which may be used for this purpose.

A.5 NOTE TO SUB-CLAUSE 7.4

It will generally not be practicable to apply the cotton pad test to the glazed area; the test may, however, be used to check for openings between the frame and the surround.

A.6 NOTE TO SUB-CLAUSE 8.3

Heat radiation from the glazed element will affect the safety of combustible materials and goods in the vicinity of glazing and the passage of people in front of the glazed partitions.

If the level of radiation on cellulosic materials exceeds 3,35 W/cm^2, they are likely to ignite. For fires of 30 min duration or less, the separation is not critical and may be fixed nominally at 300 mm. For fires of duration between 30 and 60 min, the distance should be not less than the height of the glazed element.

The level of radiation which a person can tolerate is related to the exposure time and consequently to the length of the screen and the speed of travel. Radiation intensities of 0,96 W/cm^2 can be tolerated for 5 s, whereas an intensity of 0,335 W/cm^2 may be tolerated for nearly 1 min. The former represents a screen length of 1 m with a travel speed of 0,2 m/s and the latter a screen length of 80 m with a travel speed of 2,0 m/s*.

* LAW, M. Safe distance from wired glass screening a fire. In : *The Institution of Fire Engineers Quarterly.*

ANNEX B

CANOPY TEST PROCEDURE

B.0 INTRODUCTION

This annex defines a canopy test procedure which initially was included as part of the specification but which is now only an optional requirement (see Foreword).

The purpose of the canopy is to try to simulate the conditions produced close to a ceiling when the glazed element is installed in a building. The partial enclosure on the sides is provided to minimize disturbance by the air currents in the laboratory and it is therefore desirable that measures should be adopted, such as closing of the laboratory doors, to produce draught-free conditions in the vicinity of the furnace. The canopy procedure can be used to establish the loss of initial or ultimate integrity of a glazed element.

The canopy test measures the transfer of heat by convection and radiation from the face of the glazed screen and also the effect of any hot gases emitted if gaps develop around the glazing.

The temperature rise limits given are tentative and may need to be revised in the light of further experience.

B.1 APPARATUS FOR CANOPY TEST

A canopy of the shape and size shown in figures 1 and 4 is provided on the unexposed side of the test element such that its underside is 100 mm above the top edge of the test assembly. The canopy is constructed of a steel frame with the top and adjustable side panels covered with asbestos insulation board approximately 20 mm thick (density approximately 600 kg/m^3).

The canopy bears against the face of the wall containing the test element with any gaps sealed. Six thermocouples, each consisting of wires having a diameter not exceeding 1 mm, are provided with the hot junctions located as shown in figure 3. Porcelain tubes of a diameter not exceeding 8 mm are used where thermocouples pass through the canopy. The hot junctions of the thermocouples are located 25 mm below the lower surface of the canopy with the porcelain tubes projecting not more than 10 mm below this surface. The holes for the porcelain tubes are on an axis parallel to the front face of the canopy.

B.2 TEMPERATURE FOR CANOPY TEST

The temperature of the gases below the canopy is measured by means of six thermocouples having bare junctions arranged and constructed as shown in figures 1 and 3.

B.3 OBSERVATIONS

Times are noted at which the mean and the maximum temperatures measured by the thermocouples in B.2 exceed the initial temperature by prescribed amounts.

Present knowledge does not permit any precise recommendations to be made but limited experience indicates that temperatures in the range of 150 to 500 °C would be appropriate to express "ultimate integrity failure" for certain types of glazed element.