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Fire tests — Smoke-control door and shutter assemblies —

Part 1: Ambient- and medium-temperature leakage tests

Essais au feu — Assemblages porte et volet pare-fumée —

Partie 1: Essais de fuite à température ambiante et moyenne

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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 2.

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.

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 5925-1 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

This second edition cancels and replaces the first edition (ISO 5925-1:1981), which has been technically revised.

ISO 5925 consists of the following parts, under the general title *Fire tests — Smoke-control door and shutter assemblies*:

— *Part 1: Ambient- and medium-temperature leakage tests*

— *Part 2: Commentary on test method and the applicability of test conditions and the use of test data in a smoke containment strategy*

Introduction

This part of ISO 5925 has been prepared to provide a test method for determining the smoke leakage through door and shutter assemblies. It is part of the series of International Standards dealing with fire doors, e.g. ISO 3008.

This second edition of ISO 5925-1 combines the procedure published in the first edition and the proposed revisions to it on medium-temperature testing. A further test procedure planned as Part 3 for high-temperature testing is currently in abeyance. Additional requirements for the installation and use of smoke-control door and shutter assemblies can be found in other International Standards and national regulations.

Fire tests — Smoke-control door and shutter assemblies —

Part 1:
Ambient- and medium-temperature leakage tests

1 Scope

The test described in this part of ISO 5925 determines the rate of leakage of ambient (cold) and medium (warm) temperature smoke from one side of door and shutter assemblies to the other under the specified test conditions. The test is applicable to door and shutter assemblies of different configurations intended for purposes of controlling the passage of smoke in case of fire.

The acceptable leakage rates for different situations are not addressed in this part of ISO 5925, but rather are specified by the regulations of the controlling authorities.

The principle of the test is explained briefly in Annex A.

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 834-1, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
door and shutter assembly
complete assembly, including any frame or guide, door leaf or leaves, rolling or folding curtain, etc., which is provided for closing of permanent openings in separating elements

NOTE This includes all side-panels, vision panels or transom panels, grilles and louvers together with door hardware, and any fire seals, smoke seals, draught seals and acoustic seals which are used in the assembly.

3.2
smoke-control door and shutter assembly
door and shutter assembly that, when in a closed position, has the function of restricting the passage of smoke to prescribed limits

3.3
ambient temperature
average air temperature of (20 ± 10) °C

3.4
medium temperature
average air temperature of (200 ± 20) °C

3.5
leakage rate
rate of air flow, corrected to standard temperature and pressure conditions, measured under specified differential pressure across a closed door and shutter assembly

NOTE Leakage rate is expressed in cubic metres per hour.

3.6
differential pressure
difference in static pressure created during the test between the inside and outside of the test chamber, as measured across a closed door

NOTE The symbol for pressure is p and it is expressed in pascals (1 Pa = 1 N/m^2).

3.7
test specimen
door and shutter assembly on which leakage measurements are to be made, including all components necessary for the use of the door when installed in a building, the seal between the frame and the wall and any associated construction which is provided

3.8
associated construction
specific form of construction into which the test specimen can be mounted

NOTE If an associated construction is used in the test, it shall be identical to that in which the door and shutter assembly is designed to be installed in practice. The method of sealing the joint between the test specimen and the associated construction is specific to that construction and forms part of the construction being evaluated by the test.

3.9
supporting construction
impermeable form of construction of adequate strength and stiffness to support the test specimen when an associated construction is not provided and to fill the opening in the test chamber when an associated construction is provided

NOTE The seal between the test assembly and the supporting construction is intended to be impermeable and withstand the test temperature, but it is not considered as part of the test construction being evaluated.

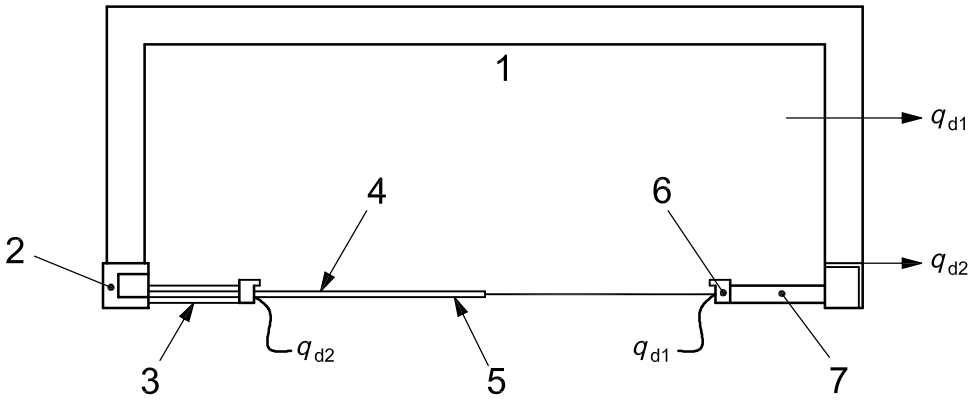
4 Symbols and abbreviated terms

See Figure 1.

q_a apparatus (test chamber) leakage rate, expressed in cubic metres per hour, corrected to standard reference conditions for temperature and pressure (see 10.2)

q_t total leakage rate, expressed in cubic metres per hour. This is the leakage rate measured in the test and includes the leakage rate of the test specimen and the test chamber corrected to the standard reference conditions for temperature and pressure (see 10.2)

q_d test specimen leakage rate. This is the leakage rate for the test specimen and is calculated as $q_d = q_t - q_a$



Key

1 test chamber
2 test frame
3 associated construction
4 test door
5 test door with its frame
6 door frame
7 supporting frame

Subscripts

a apparatus
t total
d door

$q_a = q_{a1} + q_{a2}$

$q_t = q_a + q_d$

$q_d = q_{d1} + q_{d2}$

Figure 1 — Test apparatus

5 Test apparatus

The test apparatus consists essentially of a test chamber with an open front in which the test specimen (door sample) is mounted to provide a sealed enclosure. The opening shall be sufficient to accommodate the door sample with its associated and/or supporting construction. In general, an opening of 3 m × 3 m is sufficient.

A smaller apparatus is feasible if its use is restricted to normal single-leaf doors.

An air supply system shall be provided to create a pressure differential across the door sample of at least 55 Pa. Provision shall be made to heat the circulating air to the test temperature of (200 ± 20) °C and to control the temperature within the prescribed limits. Annex B provides a general specification for a suitable apparatus, but other designs can achieve the same objectives.

The test apparatus leakage rate, q_a, shall not exceed 7 m^3/h at ambient or medium temperature. The air supply and heating systems shall be able to replace air at ambient temperature and medium temperature to compensate for leakage rates through the door sample up to 55 m^3/h.

6 Instrumentation

6.1 Differential pressure

A suitable instrument shall be provided to measure the static differential pressure between the inside and outside of the test chamber. The pressure head shall be mounted in the test chamber at the centre of the test specimen (100 ± 10) mm from the inside face of the test chamber. The pressure-measuring equipment shall be capable of measuring differential pressures with an accuracy of 5 Pa or 10 % of the measured value, whichever is lower. Barometric pressure shall be measured to an accuracy of ±5 %.

6.2 Air temperature

For the medium-temperature test, 12 thermocouples shall be used to monitor and control the temperature inside the test chamber. The thermocouples shall be arranged in four horizontal rows, with three thermocouples in each row. The end thermocouples in each row shall be in line with the sides of the door frame or jamb, and the middle thermocouple in line with the door central axis. The top row shall be 150 mm below the edge of the free opening and the bottom row 150 mm above the sill level. The other two rows shall be equidistant between the top and the bottom rows. The hot junctions shall be positioned (100 ± 10) mm from the door face.

The thermocouple shall be of bare-metal type with a wire diameter of 0,5 mm, or steel-sheathed type with the overall diameter not exceeding 1,0 mm. The temperature-measuring equipment shall be capable of measuring temperatures up to 250 °C with an accuracy of ±5 °C.

6.3 Air flow

Suitable instrumentation shall be provided to measure the volume, V_t, and the temperature, T_a, of air supplied to the apparatus to compensate for the total leakage. The apparatus shall be able to measure leakage rates up to at least 55 m^3/h with an accuracy of 1 m^3/h.

7 Test specimen

7.1 Number

As doors are usually of asymmetrical construction, leakage tests shall be carried out from both sides for full evaluation. For medium-temperature tests, this will require two separate test specimens (door samples). One specimen may be sufficient if the door is absolutely symmetrical in design, or in the special case where information on leakage from only one side is required for limited application. The test report shall clearly indicate the basis for the use of a single specimen.

7.2 Size

The door and shutter assembly (test specimen) shall be full size, or the largest size that can be accommodated in the test frame to be mounted on the face of the test apparatus, normally 3 m × 3 m.

7.3 Construction

The door and shutter assembly (test specimen) construction and finish shall be fully representative of that intended to be used in practice. Any seal used in the door and shutter assembly or between the assembly and the associated construction shall be identical to that intended for application in practice.

7.4 Conditioning

The general requirements of ISO 834-1 for conditioning shall be followed. Assemblies made entirely of non-hygroscopic materials, such as metal, glass, etc., do not require conditioning.

7.5 Pre-test analysis

The physical characteristics of the door and shutter assembly (test specimen), such as size, thickness, material specification, shall be determined before the test to check the construction of the assembly against the manufacturer's specification and to allow adequate description of the tested assembly.

All gaps through which smoke can leak shall be measured and recorded. Generally, these gaps are between the edge of the door leaf/leaves and the door frame, between door leaves, at the sill level, and curtain and wall, barrel and wall, etc. A full description shall be given of the conditions prevailing at each edge, and the presence and the nature of any seals.

The force required to open the swinging door leaf or leaves shall be determined in accordance with the relevant International Standards. If any latches are fitted, these shall be disengaged during the test.

8 Test procedure

8.1 Setting-up procedure

8.1.1 The door and shutter assembly (test specimen) shall be mounted as in practice, in an associated or supporting construction, in accordance with the manufacturer's instructions, with appropriate gaps and clearances between the fixed and movable parts.

Test assemblies with plastered or back-filled frames shall be mounted in the supporting construction so as to prevent gaps between the frame and the associated and/or supporting construction.

Where the installation of the frame in practice does not involve complete plastering or backing with mineral mortar, the intended installation condition shall be simulated by mounting the specimen in the supporting construction.

All gaps between the supporting construction and test frame shall be tightly sealed with an impermeable material.

8.1.2 After installation of the door and shutter assembly (test specimen) into the associated or the supporting construction but before it is mounted in front of the test chamber, each door leaf, or moving element of a hinged-door assembly, shall be opened to an angle of 30° and closed 5 times using the automatic closing devices, if provided, to ensure the assembly operates normally. With other types of door, such as folding, sliding or rolling shutters, the opening and closing operation shall be carried out as far as practicable to check the operation of the assembly. If the door and shutter assembly is required to comply with the maximum opening or closing forces, these shall be recorded and reported.

NOTE This procedure is not a durability test, for which special procedures are available.

8.1.3 The measuring equipment described in 6.1, 6.2 and 6.3 shall be installed and verified.

8.1.4 After checks and verifications, the door and shutter assembly (test specimen) in its associated or supporting construction shall be mounted and sealed in front of the test chamber preparatory to performing the air leakage test. The door shall be in its final closed position, unlocked, and the key, if any, removed.

8.2 Air leakage test

8.2.1 The leakage rate of the apparatus (q_a) shall be established when the apparatus is used for the first time; this rate shall be checked prior to the ambient-temperature exposure tests and after the elevated-temperature exposure tests. The extraneous test chamber leakage after the elevated-temperature exposure shall be measured when the faces of the door assembly have returned to within 13 °C of their temperatures prior to elevated-temperature exposure. The leakage rate shall be determined under the temperature and the pressure conditions used in test. Since the permitted fluctuations in temperature and pressure can cause

significant errors due to volume changes, all readings shall be taken over a period of at least 1 min at each pressure differential, and an average value of leakage calculated at the nominal pressure.

8.2.2 After the setting-up procedure, leakage tests shall be performed on the door and shutter assembly (test specimen) following the appropriate protocol, as shown in Table 1, for the information required.

Table 1 — Test protocol

Application	Temperature	No. of tests
General	Ambient	One test for each side [a]
General	Medium	One test for each side [b]
Special	Ambient/medium	One test from the specified side

[a] The same door can be used by either reversing the sample or by creating under-pressure in the test chamber. A separate specimen is required in each case.

[b] For medium-temperature tests, the average air temperature close to the face of the door shall be stabilized at (200 ± 20) °C.

The average air temperature close to the face of the door shall rise linearly to 160 °C in (20 ± 3) min, and then linearly to the stabilization temperature of 200 °C, which shall be reached in a total time of (30 ± 3) min.

The temperature distribution over the face of the door shall be controlled to (200 ± 40) °C as measured by each individual thermocouple. During the heating period there shall be no over-pressure in the test chamber.

The leakage rate through the door and shutter assembly (test specimen) shall be measured at differential pressures of 10 Pa, 25 Pa and 50 Pa, or for special purposes at the differential pressure specified by the test sponsor. During measurement of leakage rate, the differential pressure shall be maintained for 2 min and the value of q_t established 35 min after starting the heating-up period. Additional readings may be taken at 30 min intervals, following the required heating-up period and stabilization.

8.2.3 The leakage rate of the door and shutter assembly (test specimen), q_d, in cubic metres per hour, shall be calculated for each condition examined, where $q_d = q_t - q_a$.

9 Observations

9.1 During the ambient- and medium-temperature tests, any observed deformation of the specimen and the magnitude and position of such deformation perpendicular to the plane of the leaf or curtain shall be measured and recorded. The pressure and temperature at which any significant breakdown of the seal occurs shall be noted and other observations of the behaviour of the test specimen shall be recorded.

9.2 After the test, it shall be noted whether the test specimen has been physically damaged as a result of the test.

10 Expression of results

10.1 The leakage rate of the test specimen, Q_d, shall be adjusted to standard reference conditions, rounded to three significant figures. The test specimen leakage rate adjusted to standard reference conditions is defined as Q; both Q and Q_d shall be reported.

10.2 Standard conditions are defined as dry air at a temperature of 20 °C and a pressure of 101 325 Pa.

The value of the leakage rate adjusted to standard conditions, q, is determined as shown below:

$$q = q_d/(T_a + 273{,}15) \times [k\,(p_a + p_m) - 3{,}795 \times 10^{-3} \times M_w \times p_{H2O}]$$

where

q is the test specimen leakage rate adjusted to standard conditions, in m^3/h;

q_d is the test specimen leakage rate at $(T_a + 273{,}15)$ and $(p_a + p_m)$, in m^3/h;

p_m is the pressure increase measured on the exposed side of the door assembly, in pascals;

p_a is the barometric pressure, in pascals;

T_a is the temperature of the air supplied to the chamber, in degrees Celsius;

k is a constant, $293{,}15/101\,325 = 2{,}89 \times 10^{-3}$;

M_w is the relative humidity of air, in percent;

p_{H2O} is the saturated water vapour pressure, in pascals.

The test results shall be presented in tabular form as below, filling in the data for the number of tests carried out:

Door type: .....

No. of door leaves, if multi-leaf door: .....

Identification of door sides A and B: .....

Dimensions of the door opening: .....

Test No.	Specimen No.	Side exposed to pressure	Temperature	Leakage rate q m^3/h at differential pressures of		
				10 Pa	25 Pa	50 Pa
1	1	Side A	Ambient			
2	1	Side A	Medium			
3	2	Side B	Ambient			
4	2	Side B	Medium			

11 Test report

The test laboratory shall prepare a test report including the following information:

a) name and address of the test laboratory;

b) date of the test;

c) name and address of the test sponsor;

d) identification of the door and shutter assembly (test specimen), trade name, model, etc.;

e) description of the door and shutter assembly (test specimen), e.g. mass, dimensions, glazing (if any), door hardware, measured gaps and clearances, frame details, seals, etc. (drawings shall be included to illustrate the construction), installation instructions provided by the test sponsor;

f) self-closers, if any, measured opening forces;

g) description of the associated/supporting construction used, the method of fixing and the joint between the door and shutter assembly (test specimen) and the associated/supporting construction;

h) leakage rate values, q_{d}, as calculated, and as corrected to normal pressure and temperature conditions, q, for each door and shutter assembly (test specimen), for each condition examined, and for each side;

i) failure of any component observed in the test and any other observations made;

j) if a summary report is prepared, it shall refer to the full report and include at least the information given in items a), b), c), d), e) and h).

12 Field of direct application

The results of the leakage tests may be deemed applicable under the following conditions.

a) The results of the required tests apply to door and shutter assemblies of the same construction and type as tested and mounted in the test.

b) An assembly tested from only one direction is acceptable for use only in respect of exposure in the tested direction.

c) Decorative finishes, such as paints, may be changed.

d) The section of the door frame profile may be enlarged if the sealing technique tested remains unaltered.

e) Clearances and gaps smaller than those tested are permissible. For double-leaf doors, the freedom restraint at the meeting stiles shall be verified.

f) The clearance between the bottom edge of the door leaf and the floor may be altered only if the floor seal remains effective.

g) The dimensions of doors or shutters may be reduced but not increased.

h) The dimensions of the glazing may be reduced but not increased.

i) The type of glass may be changed, i.e. toughened, laminated, wired or of borosilicate, provided the sealing system is not altered.

j) If a swing door is tested at ambient temperature with a closing device, the test results apply with a different closing device of the same type, provided the closing moment is not decreased and the method of sealing is not altered.

k) The seals on a tested door can be altered as a result of confirmation from a test.

Annex A
(informative)

Test principle

A.1 Test procedure

The test procedure represents, in a simplified way, the exposure of a door to the effects of a fire when the resulting smoke travels along various routes and its movement comes across a door. As part of the fire safety system, the door may be required to restrict the passage of smoke in order to ensure that conditions on the other side of the door do not become unacceptable. If the door is at some distance from the seat of the fire initially, the smoke reaching the door will have lost much of its heat in its travel. Consequently, it will be less buoyant and at low temperatures but nevertheless capable of adversely affecting the safety level, due to its effect on visibility, and capable of causing smoke damage. Even where doors are not too distant from a fire, the exposure conditions alter progressively.

The test procedure has simulated two exposure situations. Firstly, in relation to either the distance from the fire or the stage of development of a fire, a condition where there is no noticeable rise in temperature. Secondly, a condition when the temperature has risen to a level at which ignition of combustible materials does not occur but heat damage can be caused by deformation or by failure of seals. These conditions have been termed as:

a) ambient-temperature conditions with air temperatures around 20 °C;

b) medium-temperature conditions with air temperatures around 200 °C.

In both cases, it is assumed that there is no stratification of smoke.

Pressure is, however, developed on the exposed side, and the pressure differential between the two faces of the door forces the smoke through all available gaps and openings. The differential pressures of up to 50 Pa which can be developed during this early stage are sufficient to cause an unlatched door to be forced open.

The test procedure measures the leakage of air from one side of the door and shutter assembly to the other. The smoke leakage rates are likely to be almost the same, since smoke is particulate material transported by air.

Most doors are of asymmetrical construction and, therefore, leakage characteristics depend on the side which is exposed to higher pressure. Full assessment tests thus need to establish the leakage rates from both sides by reversing the door installation. For special conditions, a single exposure may be sufficient but such a test has restricted application.

A.2 Classification procedure

The test does not specify a classification procedure or an acceptable leakage rate, as this depends on the needs of the controlling authority. In a number of countries, a leakage rate of between 20 m^3/h and 25 m^3/h has been considered acceptable where life safety is the main consideration. When the need is to protect goods or fabric against smoke damage, higher rates can be acceptable.

Annex B
(normative)

Test apparatus

B.1 Test apparatus

The test apparatus consists essentially of a well-sealed box, termed the test chamber, which has an open side, provision for supply of air to the inside of the chamber and a provision for heating the air to temperatures of (200 ± 20) °C. A schematic arrangement of the test apparatus is shown in Figure 1 in Clause 4.

B.2 Test chamber

The test chamber may consist of a sheet steel construction with a layer of insulation on the inside to prevent loss of heat from the circulating air. The permissible leakage rate for the chamber is not more than 7 m^3/h. The front opening of the chamber shall be designed so as to accommodate the largest size assembly on which information is required. In general, a 3 m × 3 m opening allows tests to be undertaken on the majority of constructions, as this is also the recommended size for fire-resistance furnaces for vertical elements. If a laboratory is only likely to be interested in testing single-leaf doors of dimensions found in normal buildings, an even smaller opening may be feasible. As the test door has to be mounted in an associated or supporting construction, the actual size of the door that can be tested is smaller than the size of the opening. The frame containing the test door assembly and the associated/supporting construction is fixed and sealed against the test chamber opening. The chamber shall have provision for the following:

a) an air supply system capable of producing a pressure differential across the specimen of up to 55 Pa and of circulating air in the chamber such that the differential pressure over the height of the door is small;

b) a piping system for the supply of air;

c) equipment for measuring the volume of air flow supplied to the chamber to compensate for the air leakage;

d) a valve arranged in the piping system to control the volume of air flow;

e) provision for fastening and sealing the test frame to the chamber;

f) a heat exchanger capable of heating the air supplied to the chamber;

g) adequate insulation for the walls and the piping to minimize heat loss from the apparatus;

h) equipment for measuring air temperature and pressure inside the chamber and air temperature close to the flow meter.

Bibliography

[1] ISO 3008, *Fire-resistance tests — Door and shutter assemblies*

[2] ISO 13943, *Fire safety — Vocabulary*

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