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**Reaction to fire tests — Fire growth —
Full-scale test for stairs and stair
coverings**

*Essais de réaction au feu — Évolution du feu — Essai en vraie
grandeur pour les escaliers et les revêtements d'escaliers*



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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Principle	2
5 Apparatus	3
6 Preparation of test specimen	3
7 Conditioning of test specimen and stair substrate	3
8 Ignition source	4
9 Initial conditions	4
10 Test procedure	4
11 Test report	5
Annex A (informative) Ignition sources	12
Bibliography	15

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 22269 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

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Introduction

This document is being issued in the Technical Specification series of publications (according to the ISO/IEC Directives, Part 1, 3.1.1) as a “prospective standard for provisional application” because the current experience of full-scale fire testing of stairs is limited to laboratories in four countries. Further development of the procedures used is possible and some additional inter-laboratory studies will be encouraged so that the precision of this potential International Standard may be determined.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO/TC 92/SC 1 Secretary.

Reaction to fire tests — Fire growth — Full-scale test for stairs and stair coverings

WARNING — So that suitable precautions can be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases can be evolved during combustion of test specimens.

The test procedures involve high temperatures and combustion processes from ignition to a fully developed room fire. Therefore, hazards can exist for burns, ignition of extraneous objects or clothing. The operators should use protective clothing, helmet, face-shield and equipment for avoiding exposure to toxic gases.

Means for extinguishing a fully developed fire should be available.

1 Scope

This test method describes a full-scale reference scenario procedure for assessing the burning behaviour of stairs or stair coverings, when exposed to a defined ignition source. The risks addressed in this scenario are essentially those of a deliberate rather than an accidental fire. The ignition sources specified include a wood crib to represent a local attack with burning crumpled newspaper and a gas burner to represent a more severe attack when the whole width of the bottom step is attacked.

The observations of burning behaviour provide a basis for assessing the fire exposure behaviour of stair coverings installed over different stair substrates.

This method is applicable to all types of stair coverings that can be installed on stairs or to the stairs themselves. The results obtained from this method reflect the performance of the total stair covering system together with the stair substrate, as tested, and are not intended to be the sole criterion for assessing the potential fire hazard of the product in use. Modifications to the stair covering, underlay, fixing system, stair substrate or other changes to the system can affect test results.

Tests are performed with an enclosed or open-sided staircase. In this test method, there is no closure at the top of the stairs to represent a ceiling on a stairs landing. The top of the stairs assembly is open so that the tests are conducted under well-ventilated conditions.

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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 13943, *Fire safety — Vocabulary*

ISO/TR 14697, *Fire tests — Guidance on the choice of substrates for building products*

ISO 13785-1, *Reaction-to-fire tests for facades — Part 1: Intermediate-scale test*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 apply, together with the following:

3.1

landing

level part of a staircase between flights of steps or at the top

3.2

nosing

projecting rounded edge of the step of a stair

3.3

riser

upright part of a step

3.4

stair

series of steps

NOTE The term is usually applied in plural to signify a flight from landing to landing.

3.5

staircase

structure enclosing a stair

3.6

stairfoot

level place at the foot of stairs

3.7

stairhead

level place at the top of stairs

3.8

step

one tread of a stair

3.9

stringboard

board covering the ends of the steps

3.10

tread

horizontal part of a step which is trodden on

4 Principle

4.1 A stair covering system is installed onto full-scale stairs constructed from products representative of end use and is exposed to a defined ignition source, such as a wood crib or propane burner (see Annex A).

4.2 Following ignition, any flame front that develops on the stairs is noted and a record made of the progression of the flame front horizontally or vertically across the risers and treads. The results are expressed in terms of time of the flame front to reach various positions on the stairs.

4.3 When the stairs are installed underneath an appropriate calorimeter hood/duct system, measurements on fire effluents, such as heat, smoke and combustion gases, can also be made.

5 Apparatus

5.1 Details of the apparatus are shown in Figures 1 to 6. Lengths of steel angle are fixed to square section steel uprights so as to support the treads and risers. The dimensions of the supporting framework are shown in Figures 4 and 5.

5.2 A suggested method of fixing the treads, risers and stringboards to the apparatus is shown in Figure 6. The actual fixings used will be dependent on the substrate, but where possible, the treads and risers shall be attached to the steel framework with screws from the underside. If the treads are suitable, the stringboards can be held in place with screws passing through the stringboard into the ends of the treads.

5.3 Two rectangular frames, constructed from $(40 \pm 1) \text{ mm} \times (40 \pm 1) \text{ mm} \times (5 \pm 0,1) \text{ mm}$ steel angle, are used to support the material simulating the sidewalls. These are positioned on plates protruding from the angle at the base of the apparatus, such that the flat face of the angle frame is against the side of the stair. The panels simulating the staircase walls shall be fixed within the frames, and the frames shall be attached against the sides of the assembled stair. This can be done by either directly fixing to the ends of the lower and upper treads, to the stringers, or by a clamp to the steel upright at the rear of the apparatus.

5.4 The panels forming the sidewalls shall be plasterboard according to ISO/TR 14697. The test is not intended to determine the effect of combustible wall finishes on the flame propagation over the stairs. If, in the intended end use, the material used in the walls or wall coverings is expected to contribute to the flame spread up the stairs, a similar material can be used to form the sidewalls of the apparatus.

5.5 An appropriate anemometer shall be used to check the airflow up the stairs. It shall be positioned 50 mm above riser 0 (see Figure 1).

6 Preparation of test specimen

6.1 The specimen shall be representative of the stair or stair covering system and shall simulate actual installation practice, especially fixing methods and end-use stair substrate.

6.2 The stair covering shall be cut to the width of the stair, measured between the stringboards or to the sidewalls if stringboards are not used. The stair covering shall also be of a length sufficient to fully cover the 13 steps of the full-scale stairs.

6.3 If the stair covering has a production direction or a directional surface effect that influence the fitting of it to a stair in normal use, the specimen for testing shall be cut from the floor covering in the same manner.

6.4 The stair or stair covering system shall be mounted on a stair substrate that simulates the material used to construct the stair in its intended end use. Although the fixing of the substrate to the apparatus is different from the normal method of stair construction, the depth of the treads should be calculated so as to create a nosing representative of end use. If gripper rods are used in the preparation of the test specimen, these shall be described in the test report.

6.5 If an adhesive is used in the preparation of the test specimen, it shall be the same as that used in practice and applied according to the manufacturer's instructions.

6.6 Stair or stair covering systems utilizing an underlay or interlay in the actual end use shall be tested with this underlay or interlay.

7 Conditioning of test specimen and stair substrate

7.1 The stair or stair covering system and the components of the stair substrate shall be conditioned separately prior to assembly. Where this is not possible, for example with stair or stair covering systems that are glued to the substrate, the assembled test construction shall be conditioned.

7.2 All specimens shall be conditioned before test at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %, according to one of the following options (see ISO 554):

- a) Conditioning for at least four days, until constant mass is achieved. Constant mass is attained when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0,1 % of the mass of the specimen.
- b) Conditioning for at least three weeks. Use of this option is not allowed for wood-based products or cement-based products.
- c) Conditioning for at least four weeks. The final mass and the relative mass difference of two successive weighing operations, carried out (24 ± 2) h and (2 ± 2) h before the test, shall be reported.

7.3 The entire testing procedure until the end of the test shall be carried out within 3 h of removal of the specimen from the conditioning environment.

8 Ignition source

8.1 Selection of ignition source

For tests where the primary ignition source is applied to a stair tread, select either wood crib source A or gas burner source B according to the guidance in Annex A. For tests where the secondary ignition source is applied to the riser of step 1, select gas burner source C as detailed in Annex A.

8.2 Conditioning of wood crib source A

Condition the crib before the test for 72 h in indoor ambient conditions and then immediately before the test for at least 16 h at (20 ± 5) °C and (50 ± 20) % relative humidity.

9 Initial conditions

Before starting the test, the initial conditions shall be as follows.

- a) The temperature in the test environment from the start of the installation of the test specimen until the start of the test shall be (20 ± 10) °C.
- b) The horizontal wind speed at a central position 50 mm above riser 0 (see Figure 1) of the test apparatus shall not exceed 0,5 m/s.
- c) The ignition source shall be in contact with the stairs according to the location guidance in Annex A. For initial testing with wood crib ignition source A, place the wood crib centrally on the lowest tread (tread 0), so that it is in contact with the next riser (riser 1).
- d) The surface area of the opening at the top of gas burners B or C shall be clean.
- e) The test specimen shall be photographed or video recorded before testing.

10 Test procedure

10.1 Start all recording and measuring devices and record data for at least 2 min prior to ignition of the fire source.

10.2 A photographic and/or video recording shall be made of the test. A clock shall appear in all photographs, giving time to the nearest 1 s.

10.3 When using wood crib ignition source A, slowly add $(1,4 \pm 0,1)$ ml of propan-2-ol to the centre of the lint positioned inside the crib. Within 2 min of adding the propan-2-ol, ignite the alcohol and simultaneously start the clock.

10.4 When using gas burner source B, ignite the propane gas and control the gas flow to 5 l/min.

10.5 Observe for evidence of ignition on the adjacent riser and the tread beneath the ignition source and record the times.

10.6 Record the time of arrival of the flame front to each tread, each riser and each stringboard.

10.7 Observe and record any significant phenomena such as melting, charring, blistering, flaming droplets, debris, or transitory flashing. Observations should also be made of any other phenomena such as intumescence and/or deformation of the specimen, separations, spalling, etc.

10.8 The test shall be conducted for a maximum of 60 min. The test may be terminated before 60 min if any of the following occurs.

- a) The specimen fails to ignite. This shall only be assessed with the wood crib ignition source A after all flaming of the crib has ceased. For gas burners B and C, this is assessed if there are no flames or evidence of combustion 2 min after the gas flow to the burner has been switched off.
- b) Flame ceases to spread along the specimen and goes out, and no further flaming of any type ensues within the next 10 min.
- c) The flame front reaches the top tread.

10.9 Note the extent of damage of the test specimen after the test.

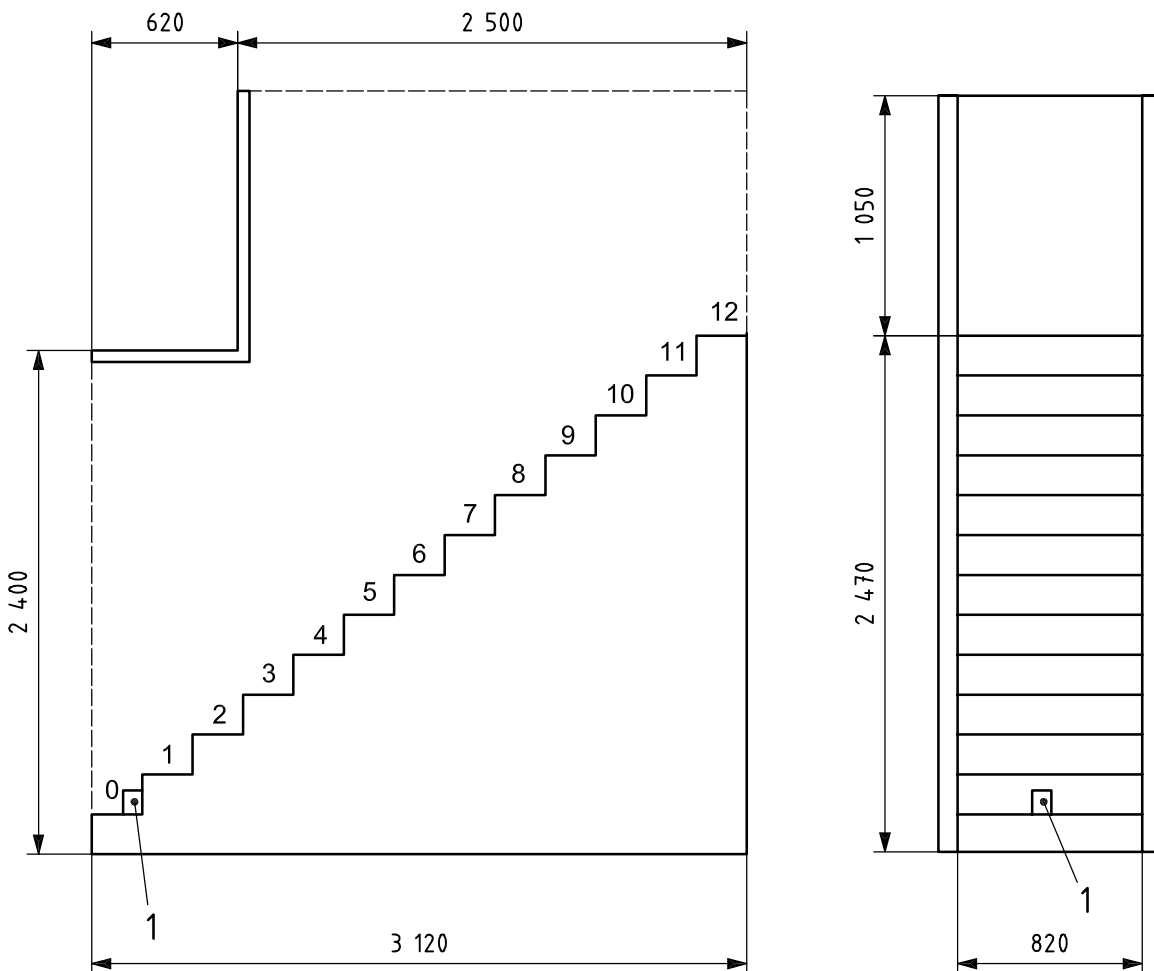
11 Test report

The test report shall contain the following information:

- a) reference to this test procedure, and any deviation from it;
- b) name and address of the testing laboratory;
- c) date and identification number of the report;
- d) name and address of the sponsor;
- e) name and address of the manufacturer or supplier of the product;
- f) date of supply of the product;
- g) date of test;
- h) full description of the stair covering tested including trade name, together with its construction, orientation, thickness, density and where appropriate the face subjected to the test;
- i) full description of the stairs including whether the staircase was fitted with side panels or openings;
- j) substrate used, the underlay (if used) and the method of fixing the specimen onto the substrate;
- k) description of the ignition source and any change to the position of the ignition source (see Annex A);

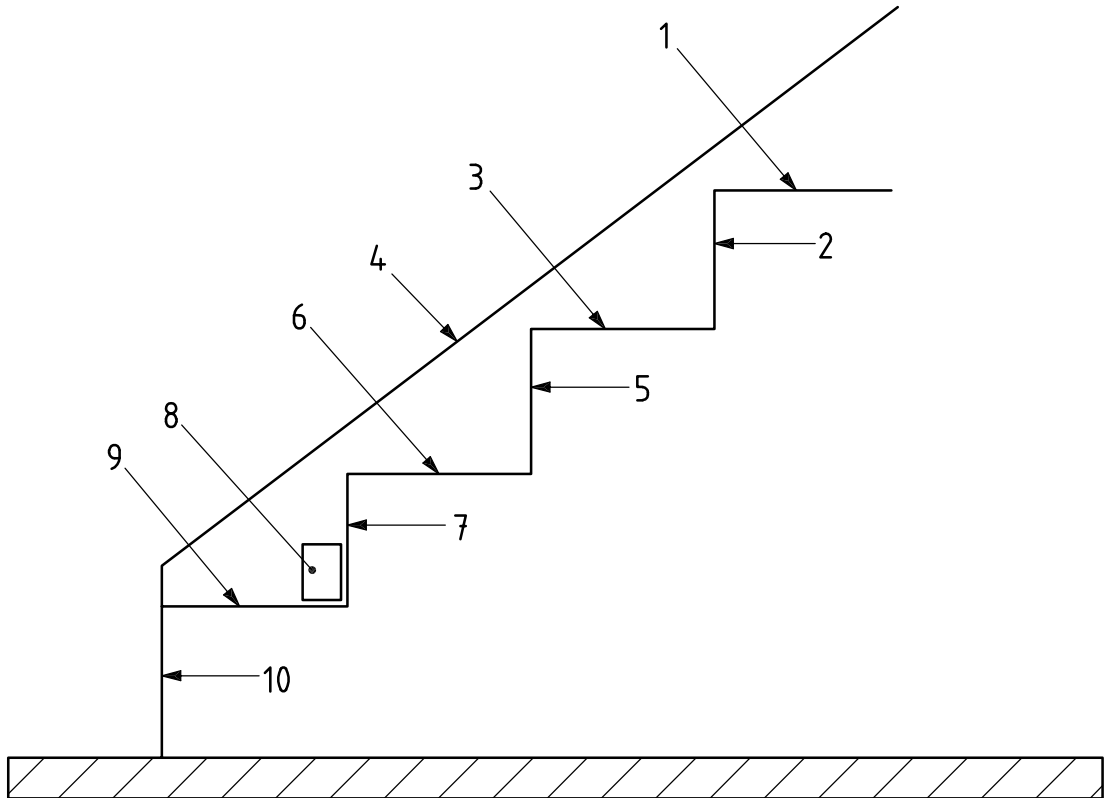
- l) data from the test including:
 - description of the conditioning,
 - airflow at riser 0,
 - duration of the test,
 - observations of the movement of the flame front,
 - other observations of the behaviour of the stair covering;
- m) a limiting use statement, such as “These test results relate only to the behaviour of the product under the particular conditions of the test, and they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.”

Dimensions in millimetres



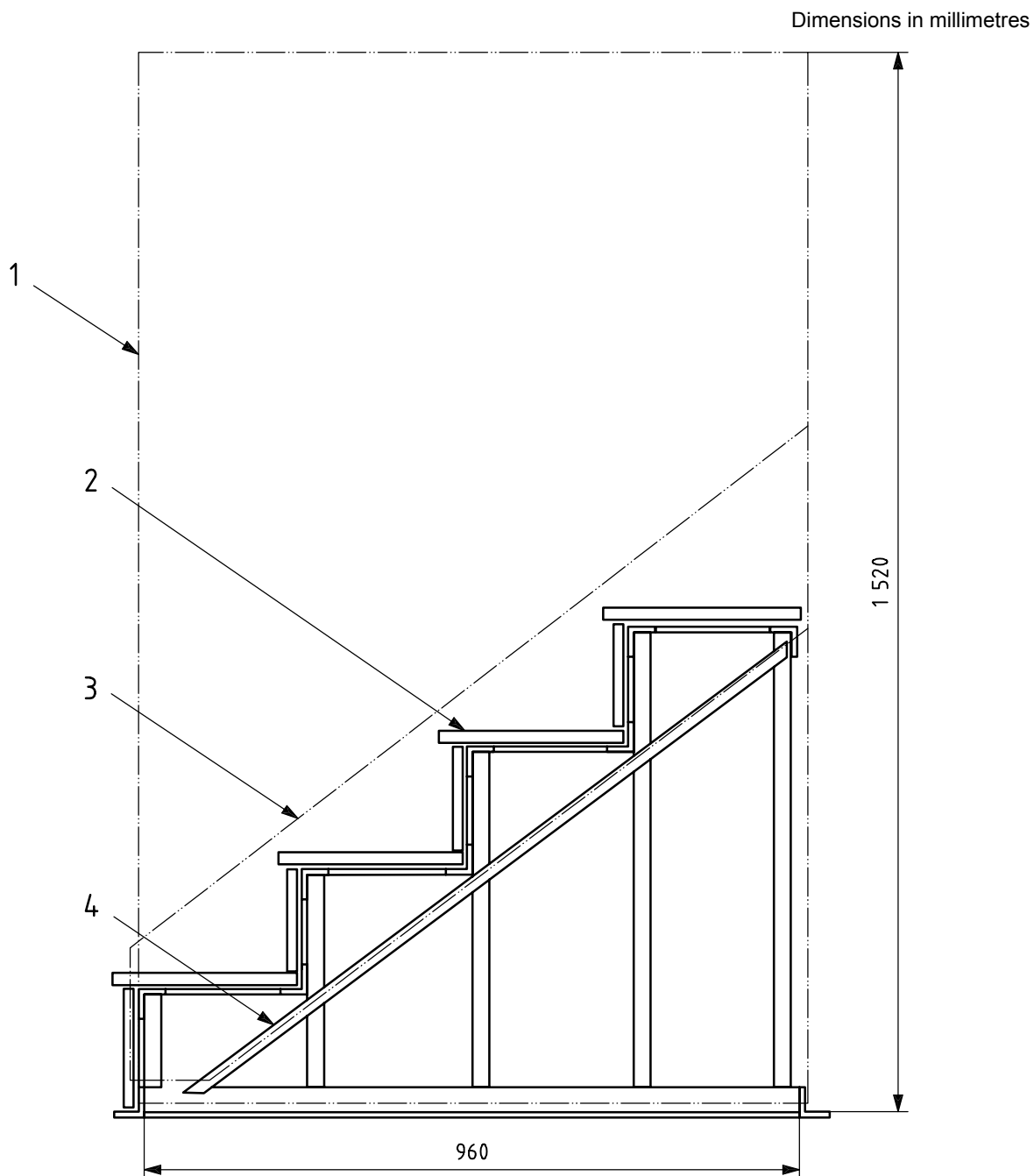
- Key**
- 1 ignition source
 - open area
 - ==== enclosed area

Figure 1 — Schematic layout of full-scale stairs test rig

**Key**

- 1 tread 3
- 2 riser 3
- 3 tread 2
- 4 stringer
- 5 riser 2
- 6 tread 1
- 7 riser 1
- 8 ignition source
- 9 tread 0
- 10 riser 0

Figure 2 — Terminology of the stairs test



Key

- 1 position of steel angle frame to support side panels (e.g. plasterboard or calcium silicate board)
- 2 removable treads and risers
- 3 position of stringboard
- 4 adjustable support for stringboard

Figure 3 — Side view of first four steps of stairs rig

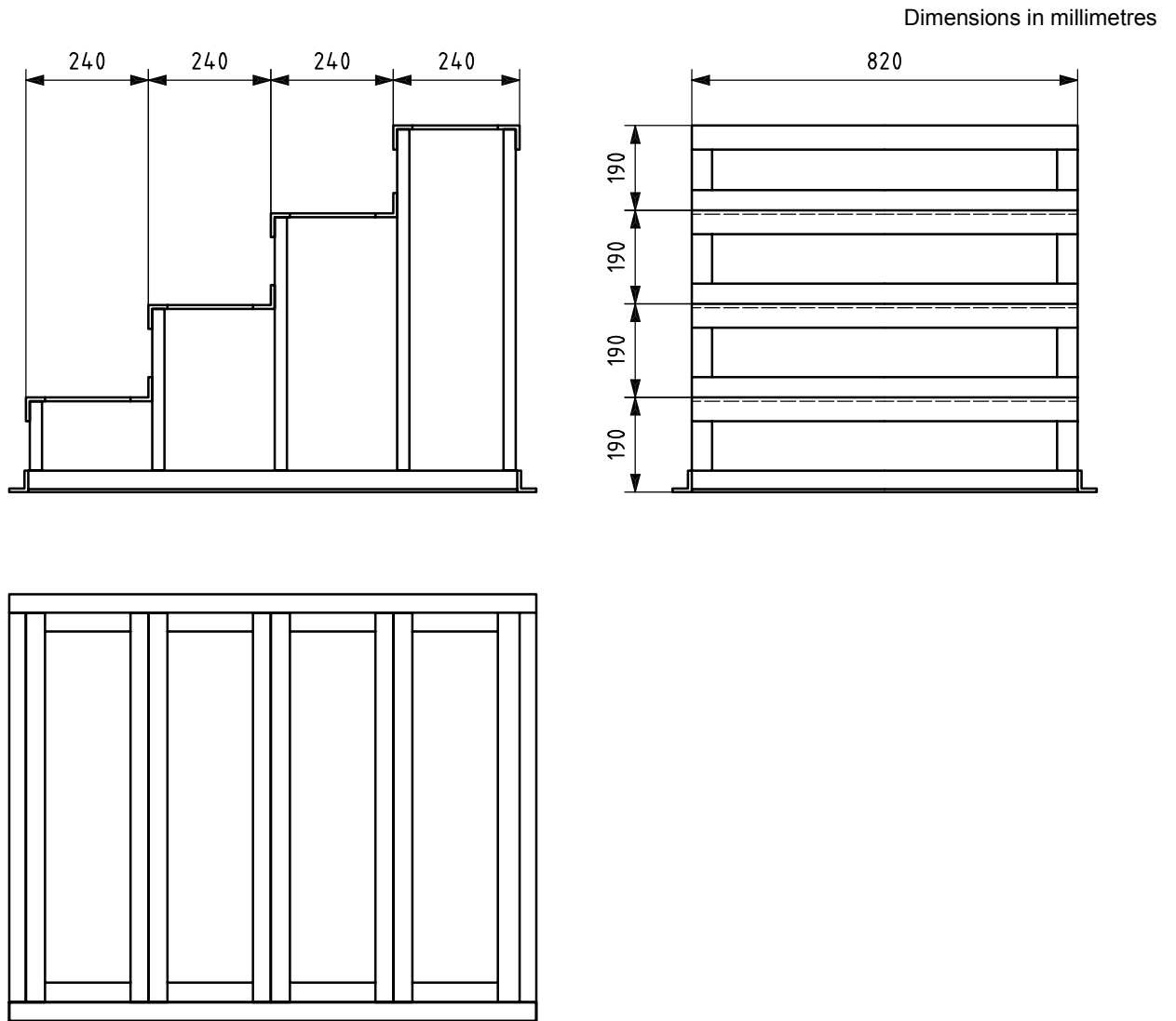
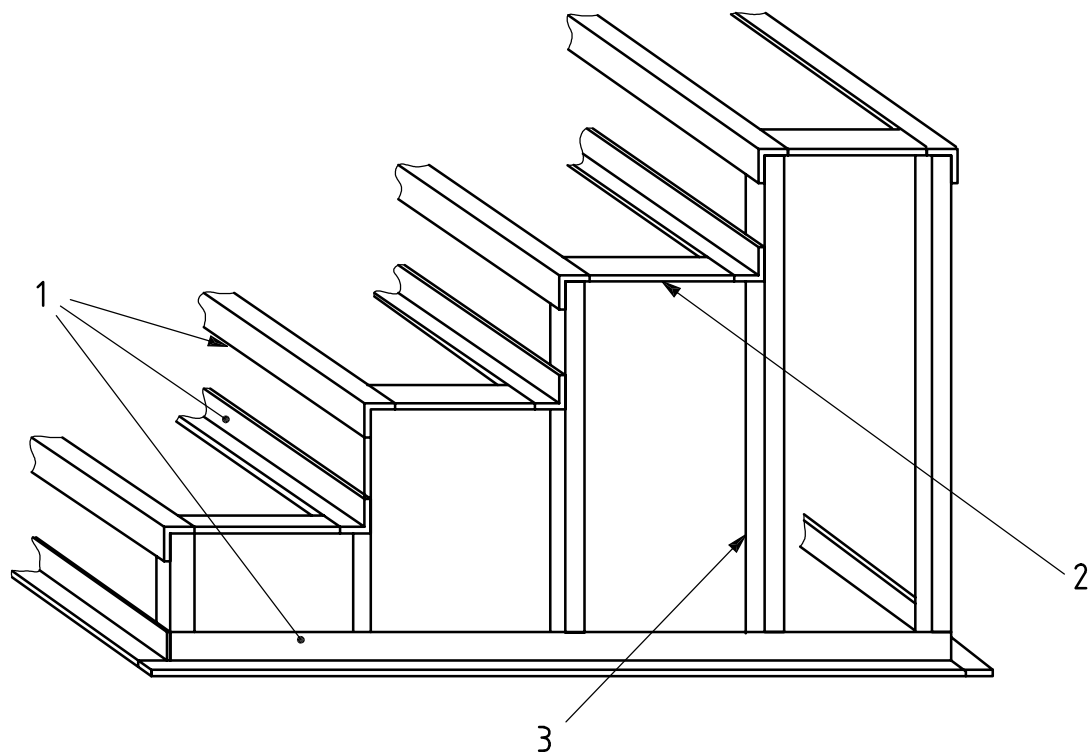


Figure 4 — Dimensions of steps on full-scale stairs

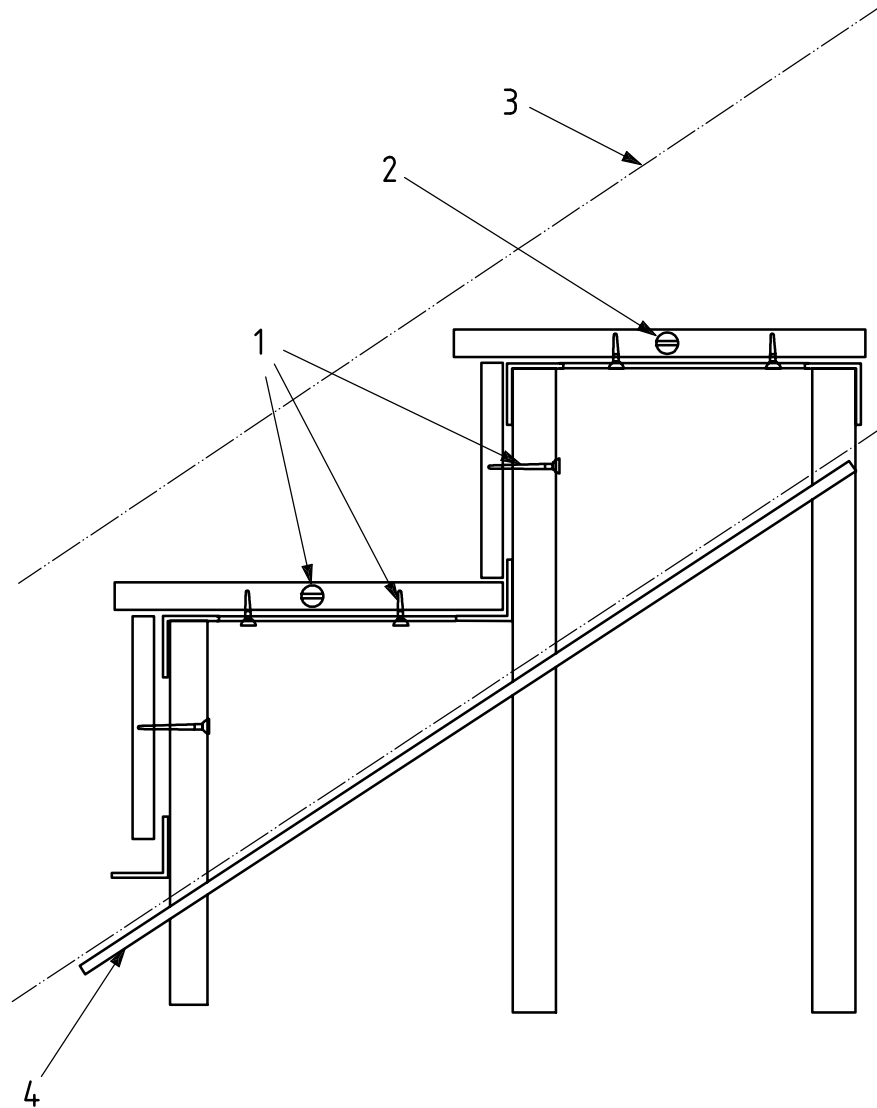
Dimensions in millimetres



Key

- 1 40 × 40 × 40 steel angle
- 2 50 × 50 steel plate
- 3 40 × 40 hollow section steel supports

**Figure 5 — Perspective view showing apparatus construction for full-scale stairs
(side frame now shown)**



Key

- 1 self-tapping screws or similar
- 2 stringboard screwed to end of treads
- 3 stringboard
- 4 supporting rail (adjustable height)

Figure 6 — Suggested fixing of treads, risers and stringboards

Annex A (informative)

Ignition sources

A.1 General

A variety of ignition sources may be used in this test procedure according to the risk envisaged in the actual use of the stairs. Three ignition sources are detailed in this Annex. Sources A and B represent primary ignition sources of (8 ± 1) kW intensity arising from a deliberate or accidental fire from combustibles such as paper, plastic packaging or textiles. Source A (softwood crib) is easy to position on a step, but can be more prone to variation than source B (propane burner), which requires a specific construction to produce flames attacking the tread of a step.

If the fire hazard to be simulated is caused by a more severe ignition source, such as a liquid accelerant poured onto a carpet on the lower landing of the stairs, due to an arson attack, a 100 kW propane line burner (such as source C) should be used.

A.2 Wood crib source A

The crib shall be constructed from (126 ± 4) g softwood (such as *Pinus silvestris*) to form a square-sectioned crib with the $(12,5 \pm 0,5)$ mm \times $(12,5 \pm 0,5)$ mm wood sticks glued together (see Reference [1]).

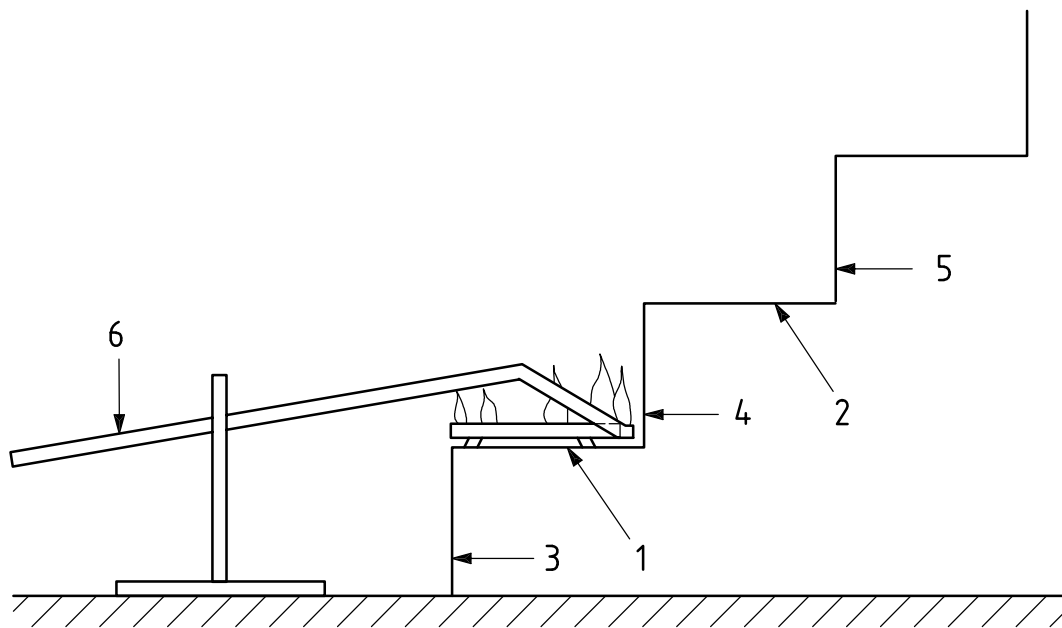
Place the wood crib ignition source A centrally on the lowest tread (tread 0) so that the crib is in contact with the next riser (riser 1).

NOTE: This crib will burn for (6 ± 1) min with a flame height of 350 mm to 500 mm and generate a heat flux of (25 ± 5) kW/m².

A.3 Gas burner source B

The square-sided propane gas burner B illustrated in Figure A.1 shall be used. This burner is similar to that used for testing seats (see References [6], [7], [8]). The burner is made of a stainless steel tube with external diameter $(14,0 \pm 0,1)$ mm and internal diameter $(9,0 \pm 0,1)$ mm, ending in a terminal square part of (115×115) mm side, angled at 35° relative to the tube. A series of holes are drilled with different orientations (as specified in Reference [8]), so that they provide flames of an overall intensity equivalent to those from the combustion of a lightly compressed ball of 100 g newspaper. The burner shall be supported on an arm that can pivot in a vertical plane, such that the plane of movement of the burner shall coincide with the vertical plane of the centre line of the lowest stair tread (tread 0). A special spacer, attached by screws to the base of the burner, allows a separation distance of 10 mm below the underside of the burner and the upper surface of the stair tread.

NOTE: With a propane gas flow of 5 l/min, gas burner source B gives a heat output of 7 kW. It shall be applied to the stair tread for 10 min.



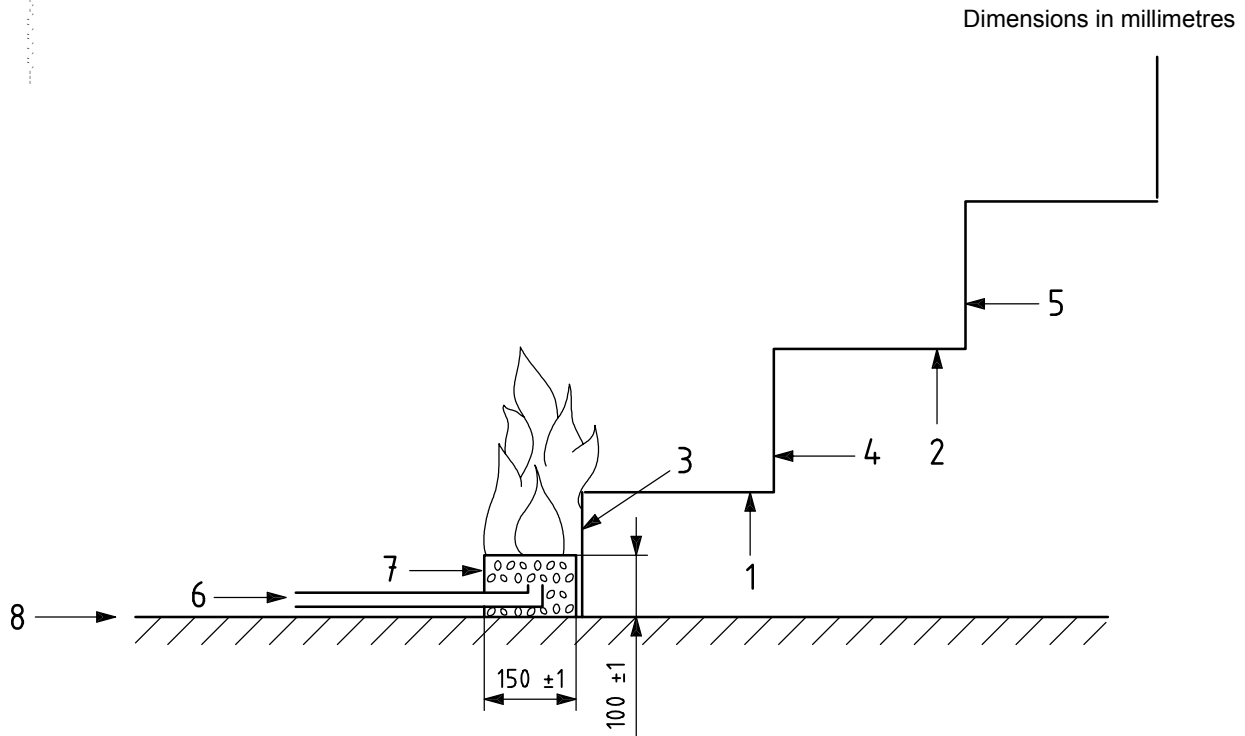
Key

- 1 tread 0
- 2 tread 1
- 3 riser 0
- 4 riser 1
- 5 riser 2
- 6 pivot-arm and propane inlet of square-sided burner B

Figure A.1 — Test position for square-sided gas burner B

A.4 Gas burner source C

The propane gas burner detailed in ISO 13785-1 is constructed from a rectangular metal box with a top surface layer of a porous, inert material (e.g. sand). The size of the burner box shall be reduced to $(800 \pm 5) \text{ mm} \times (100 \pm 1) \text{ mm} \times (150 \pm 1) \text{ mm}$, so that it will fit along the bottom riser of the stairs. The construction shall be such that an even gas flow is achieved over the entire opening area. The burner shall be placed on the floor lengthwise below the stairs specimen with the back wall of the burner lined up with riser 0 of the test specimen (see Figure A.2). The burner shall be supplied with natural grade propane (95 % purity). The gas flow to the burner shall be measured with an accuracy of at least $\pm 3 \%$. The heat output from the burner shall be $(100 \pm 5) \text{ kW}$ throughout the test. The burner shall be applied to the stairs for 10 min.



Key

- 1 tread 0
- 2 tread 1
- 3 riser 0
- 4 riser 1
- 5 riser 2
- 6 propane inlet
- 7 propane sand burner C
- 8 floor level

Figure A.2 — Test position for propane sand burner C

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