



Designation: E2405 – 05

An American National Standard

Standard Test Method for Determination of Fire and Thermal Parameters of Materials Using an Intermediate Scale Test with Vertically Oriented Specimen¹

This standard is issued under the fixed designation E2405; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This fire-test-response standard determines fire properties related to piloted ignition of a vertically oriented specimen exposed to an external graduated radiant heat flux as shown in Fig. 1. This test method provides data suitable for comparing the performance of materials, which are used as the exposed surfaces of walls or other vertically orientated products in construction applications.

NOTE 1—This test method has been prepared to closely follow the test procedure of ISO 5658-4, however with additional provisions for heat release and smoke development measurements that are optional.

1.2 The fire characteristics determined by this test method include time-to-ignition, vertical flame spread rate and lateral flame spread rate. Optional measurements include heat release rates and visible smoke development rates.

1.3 The optional heat release rate is determined by the principle of oxygen consumption calorimetry, via measurement of the oxygen consumption as determined by the oxygen concentration and flow rate in the exhaust product stream (exhaust duct).

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.6 *Fire testing of products and materials is inherently hazardous, and adequate safeguards for personnel and property shall be employed in conducting these tests. This test method may involve hazardous materials, operations, and equipment. Specific information about hazard is given in Section 7.*

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:²

E176 Terminology of Fire Standards

E2257 Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies

2.2 ISO Standards:

ISO 5658-4 Reaction to Fire Tests—Spread of Flame—Part 4: Intermediate Scale Test with Vertically-orientated Specimen³

ISO/TR 14697 Fire Tests—Guidance Rules for the Choice of Substrates for Building Products³

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology E176.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *backing board, n*—a board with the same dimensions as the specimen and used to back the specimen so as to represent end-use conditions.

3.2.2 *flashing, n*—existence of flame on or over the surface of the specimen for periods of less than 1 s.

3.2.3 *irradiance, n*—quotient of the radiant flux incident on an infinitesimal element of surface containing the point, by the area of that element.

3.2.4 *product, n*—material, composite or assembly about which information is required.

3.2.5 *specimen, n*—representative piece of the product which is to be tested together with any substrate or treatment. The specimen may include an air gap. The specimen may also be tested as a stand-alone product without substrates if this is representative of end-use conditions.

¹ This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.21 on Smoke and Combustion Products.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

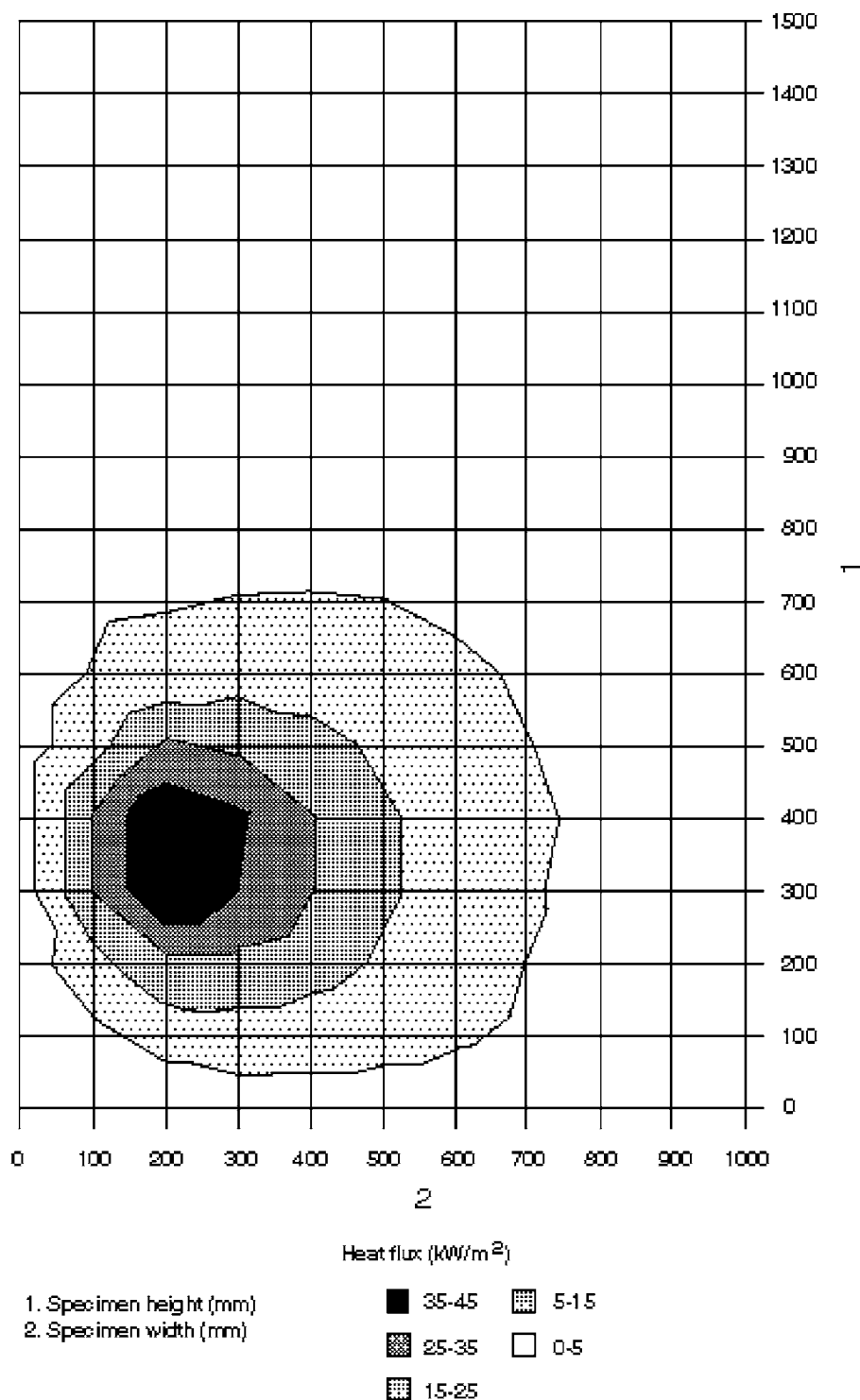


FIG. 1 Heat Flux Distribution on the Calibration Board

3.2.6 *substrate, n*—a material which is used or is representative of that used, immediately beneath a surface product in end-use, for example, skimmed plasterboard beneath a wall-covering.

3.2.7 *sustained flaming, n*—existence of flame on or over most of the specimen surface for periods of more than 4 s.

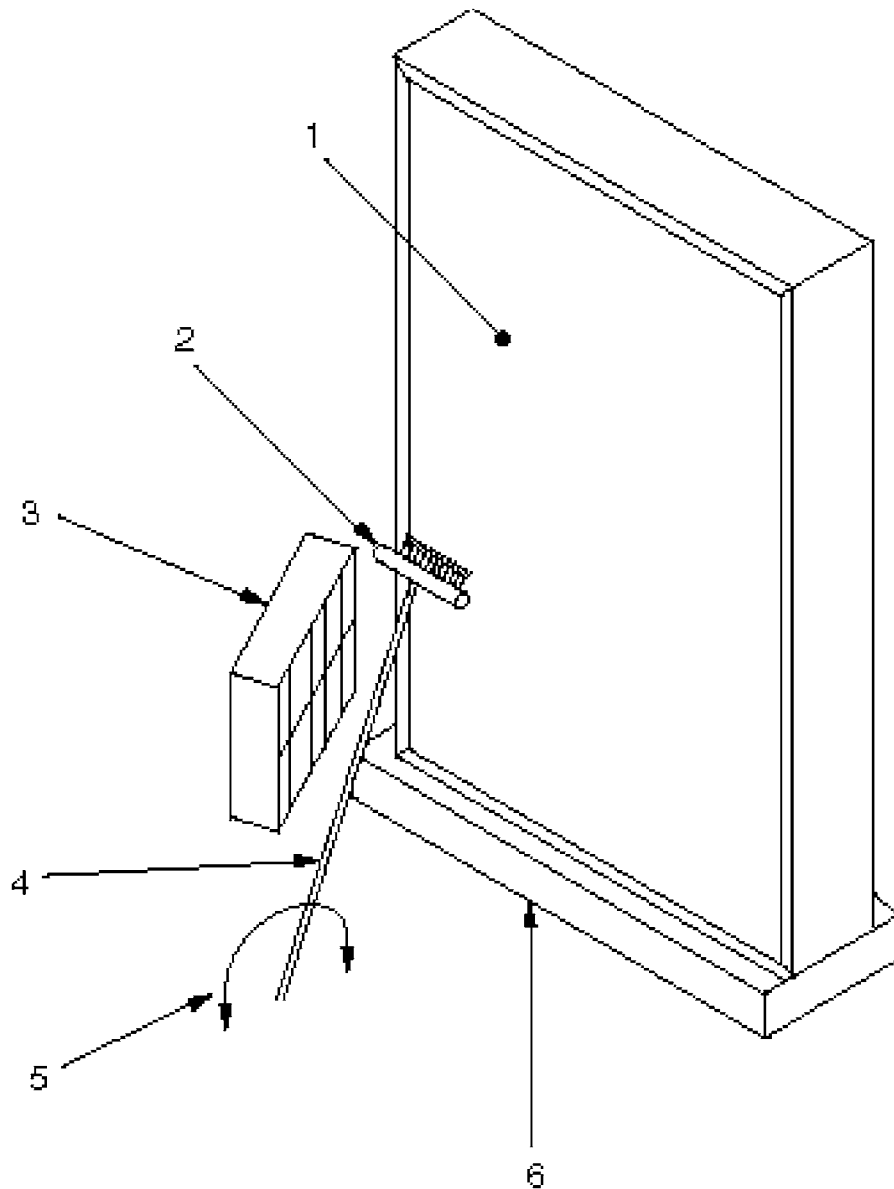
3.2.8 *transitory flaming, n*—existence of flame on or over most of the specimen surface for periods between 1 and 4 s.

4. Summary of Test Method

4.1 This test method is designed to measure time-to-ignition and vertical and lateral rates of flame spread on a specimen

a vertical orientation. The test specimen is exposed to a graduated radiant heat flux supplied by an adjacent gas-fired radiant panel (see Fig. 2). A non-impinging line burner placed above the radiated area of the specimen (see Figs. 2 and 3)

provides piloted ignition. Following ignition, the flame front progression along the horizontal and vertical lengths of the specimen is tracked as a function of time.



1. Test specimen
2. Pilot flame burner
3. Vertical radiant panel at an angle of 35° to the specimen
4. Supply pipe
5. Direction of rotation of supply pipe
6. Debris collection tray

FIG. 2 Schematic of the Test (a)

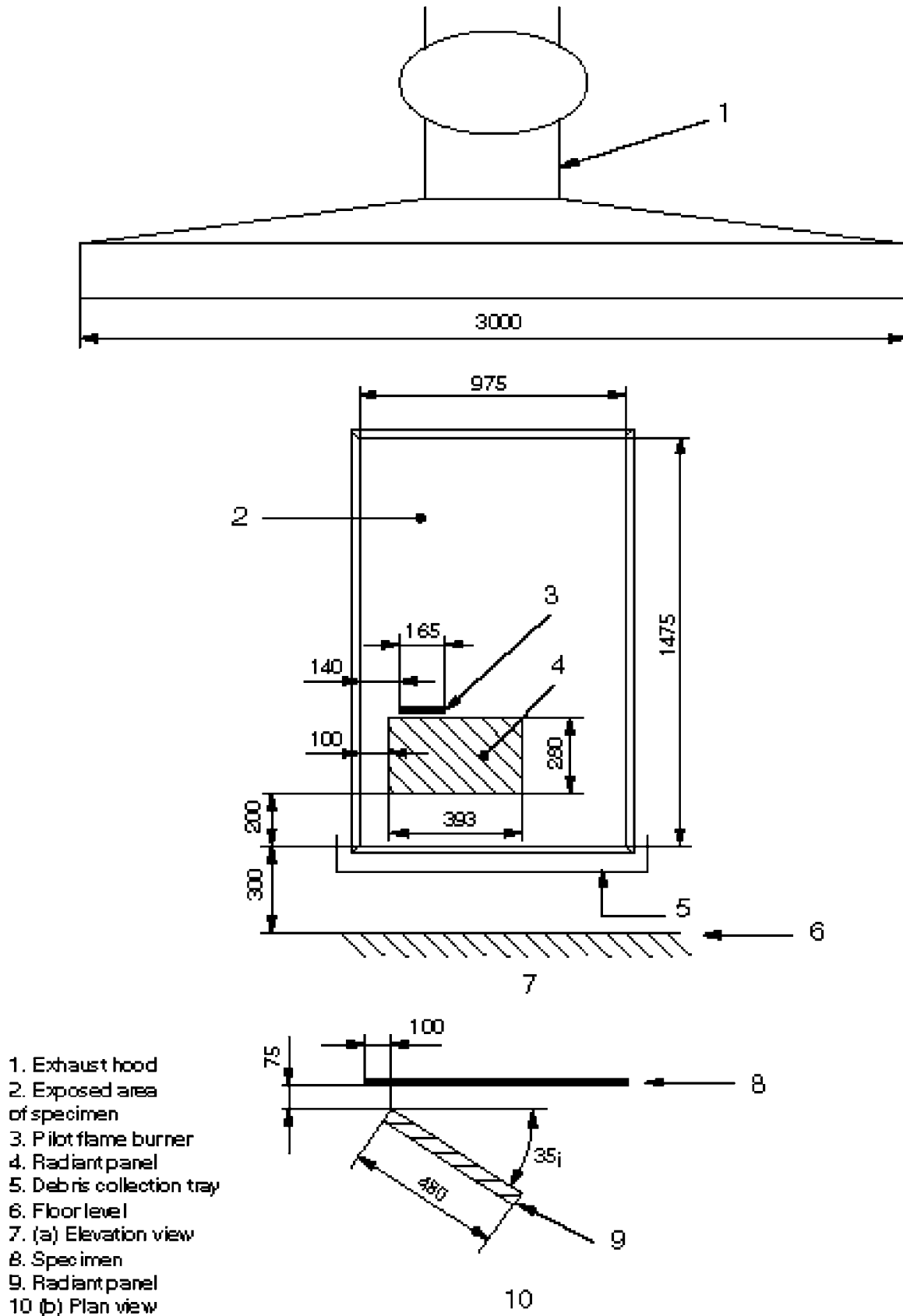


FIG. 3 Schematic of the Test (b)

4.2 The test results are reported in terms of time-to-ignition and flame spread distance as a function of time.

NOTE 2—Other fire spread effects such as flaming drips or debris can also be measured.

4.3 Optional measurements include heat release rate and smoke development rate. For these measurements however, the apparatus shall be positioned underneath a calibrated hood/duct facility as detailed in [Annex A1](#).

5. Significance and Use

5.1 This test method is used primarily to determine time-to-ignition, vertical flame spread rate, and lateral flame spread rate of materials, products and assemblies in a vertical orientation when exposed to a graduated radiant heat flux.

5.2 Optionally, this test method is suitable to measure the heat release rate and smoke development rate of materials, products and assemblies in a vertical orientation when exposed to a graduated radiant heat flux.

5.3 This test method is suitable to test materials that have a planar or nearly planar exposed surface. This test method is not intended to test materials with surface cracks, fissures or holes exceeding 8 mm in width or 10 mm in depth. Also, the total area of such cracks, fissures or holes at the surface shall not exceed 30 % of the exposed surface area of the specimen.

6. Apparatus

6.1 General:

6.1.1 The test apparatus consists of four main components: a radiant panel assembly, a specimen support trolley assembly, a specimen holder, and a pilot flame burner.

6.2 Radiant Panel Assembly:

6.2.1 The radiant panel assembly consists of a radiant panel support framework and an assembly of porous refractory tiles at the front of a plenum chamber to provide a flat radiating surface (see [Fig. 2](#)).

6.2.2 The assembled radiant panel shall provide a flat radiating surface of dimensions 480 ± 5 mm by 280 ± 5 mm. The plenum chamber shall contain baffle plates and diffusers to distribute the gas/air mixture evenly over the radiating surface.

6.2.3 The radiant panel support framework holds the refractory tiles in place and connects the air and gas pipe work to the refractory tiles. It also holds safety devices, regulators and flow meters. This support framework shall have its lower edge at least 500 mm above floor level to ensure sufficient ventilation during panel operation. The radiating face of the panel shall be vertical and the angle between the panel face and the exposed surface of the specimen shall be $35 \pm 3^\circ$, as shown in [Figs. 2 and 3](#).

NOTE 3—A wire screen fixed immediately in front of the radiating face of the panel has been found to increase the irradiance and to protect the panel from falling debris. A typical wire screen may be made from 3 mm diameter stainless steel rods to form a screen of 480 ± 5 mm by 280 ± 5 mm. A screen with 20 horizontally orientated equally-spaced rods and 4 vertically orientated equally-spaced rods, welded at all contacts and placed 15 mm from the face of the radiant panel has been found to be satisfactory.

6.3 Specimen Support Trolley Assembly:

6.3.1 This assembly incorporates the trolley and the guide rail, which are used to locate the specimen holder at the

required test position in relation to the radiant panel and the pilot flame burner as shown in [Fig. 4](#).

6.3.2 The trolley, as shown in [Fig. 4](#), shall be provided to hold the specimen holder and allow the specimen to be readily moved and positioned at the required angle of orientation with respect to the radiant panel.

6.3.3 The trolley shall also have a debris collection tray fixed below the lower edge of the specimen holder. This tray shall be 1100 ± 5 mm long by 300 ± 5 mm wide by 100 ± 5 mm deep. It shall be made of 1 mm thick steel and shall be fixed to the specimen support trolley so that the base of the tray is 50 mm below the bottom edge of the specimen holder. The tray shall contain 10 mm calcium silicate board lined with aluminum foil and with a strip of 40 mm thick by 40 mm by 1095 mm calcium silicate board wrapped in aluminum foil (see [Figs. 4 and 5](#)).

6.3.4 The trolley shall be moved by sliding on a guide rail to consistently achieve the required tolerances (see [Fig. 4](#)).

NOTE 4—The specimen holder transport system may be manually or automatically operated to achieve this requirement.

6.4 Specimen Holder:

6.4.1 The specimen holder assembly is shown in [Fig. 6](#). Make the specimen holder from 2 ± 0.5 mm thick stainless steel to the dimensions given in [Fig. 6](#) so that the exposed surface of the specimen is 1475 ± 25 mm high by 975 ± 25 mm wide. The test specimen shall be held pressed against the front flanges of the specimen holder by use of a quick action clamping device.

NOTE 5—To test specimens thicker than 200 mm, a modified specimen holder and a wider debris tray is required. The debris tray should extend 100 mm in front of the specimen base (see [Fig. 5](#)).

6.5 Pilot Flame Burner:

6.5.1 The pilot burner shall be a 160 ± 5 mm long stainless steel tube with an internal diameter of 10 ± 1 mm and an external diameter of 12 ± 1 mm. The tube shall have 15 evenly spaced 1 mm diameter holes positioned radially along the centerline (see [Fig. 7](#)).

6.5.2 The pilot burner shall be mounted so that its position relative to the face of the test specimen is in line with the top of the radiant panel (see [Fig. 3](#)). The distance between the burner tube and the face of the specimen shall be 25 ± 1 mm (see [Fig. 8](#)).

6.5.3 The gas used for the pilot burner shall be commercial grade propane with a heating value of approximately 83 MJ/m³.

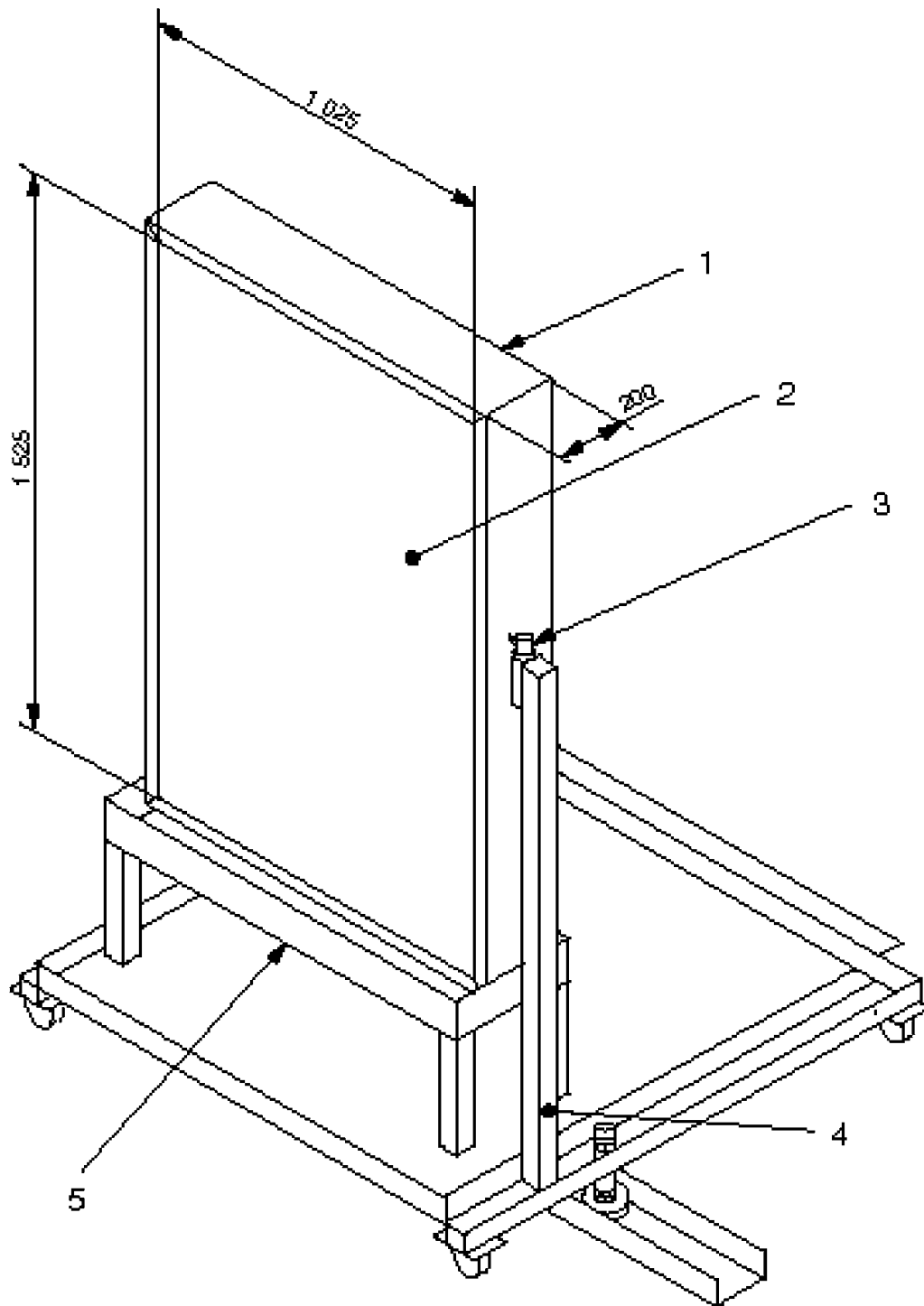
6.5.4 The flow rate to the pilot burner shall be adjusted to about 0.6 l/min.

6.6 Gas and Air Supplies:

6.6.1 The combustion gas and air shall be fed to the radiant panel via suitable pressure and flow regulators, and flow meters. A suitable supply system includes the following:

6.6.1.1 A supply of natural gas, methane or propane with a flow rate of at least 0.3 l/s at a pressure sufficient to overcome friction losses through the supply lines and the radiant panel,

6.6.1.2 An air supply with a flow rate of at least 5 l/s at a pressure sufficient to overcome the friction losses through the supply lines and the radiant panel.



1. Specimen holder
2. Test specimen
3. Tapered fitting on each side of specimen holder locates with sockets on the trolley framework

4. Trolley framework supporting the specimen holder
5. Debris collection tray

FIG. 4 Typical Specimen Holder and Trolley Assembly

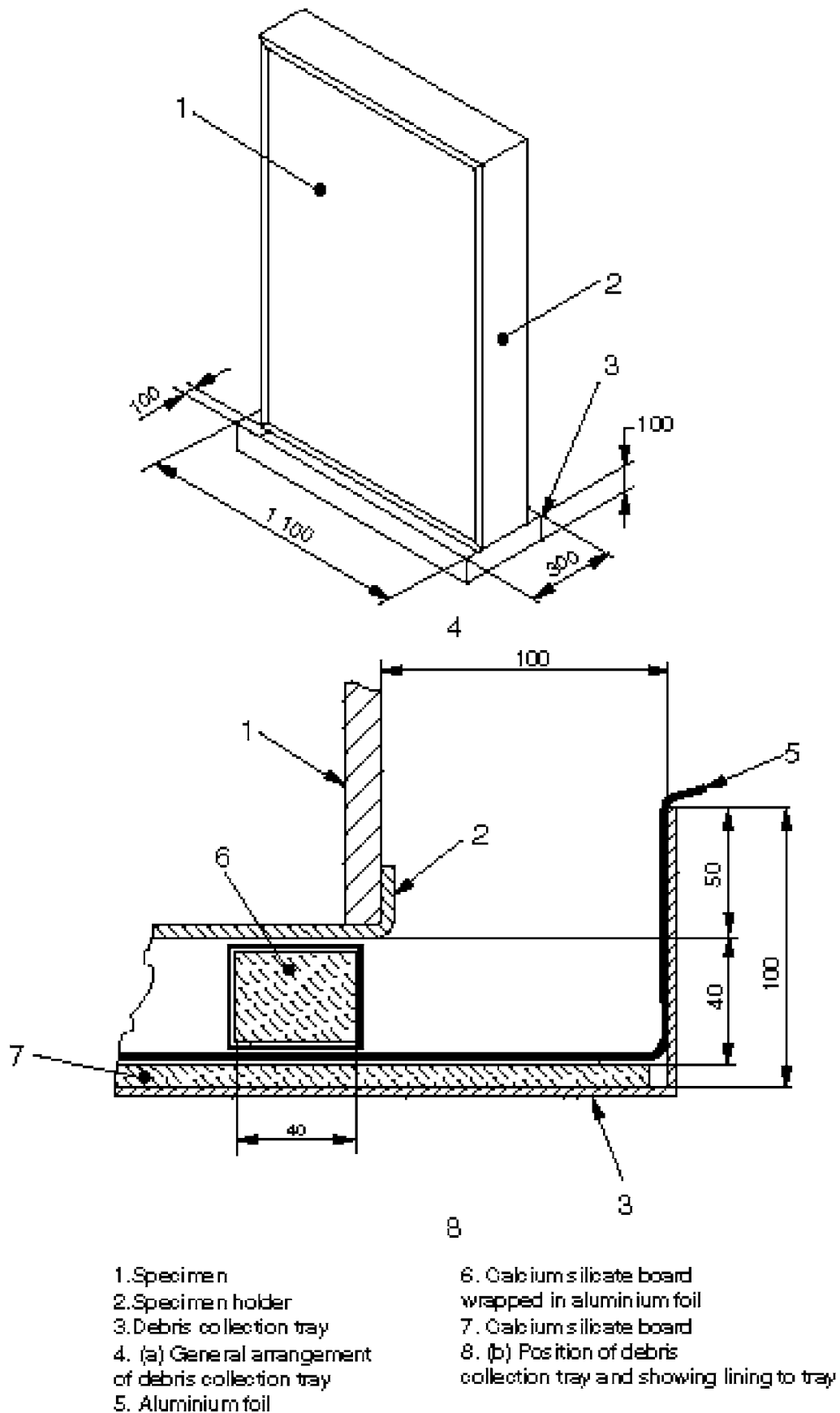


FIG. 5 Debris Collection Tray

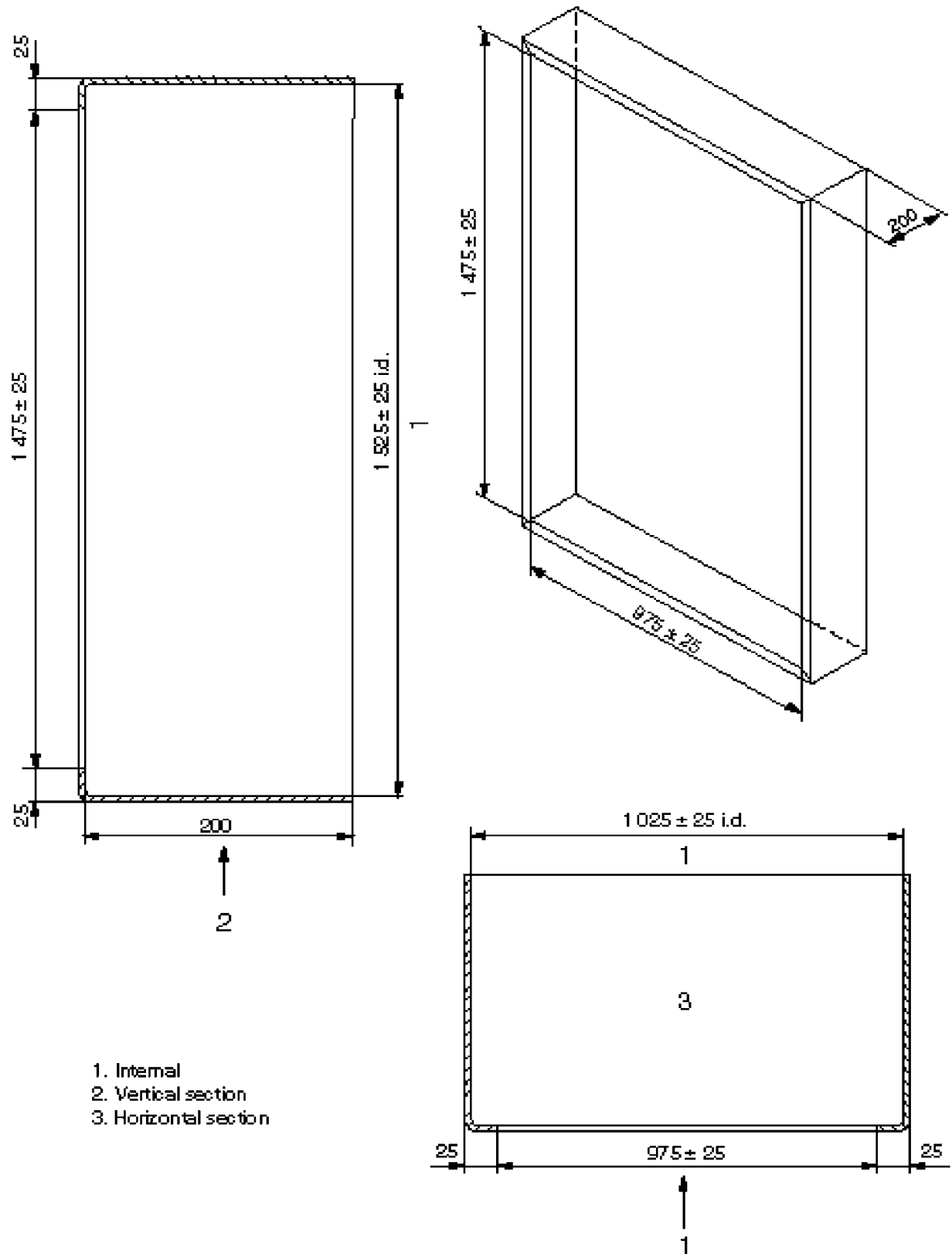


FIG. 6 Typical Specimen Holder

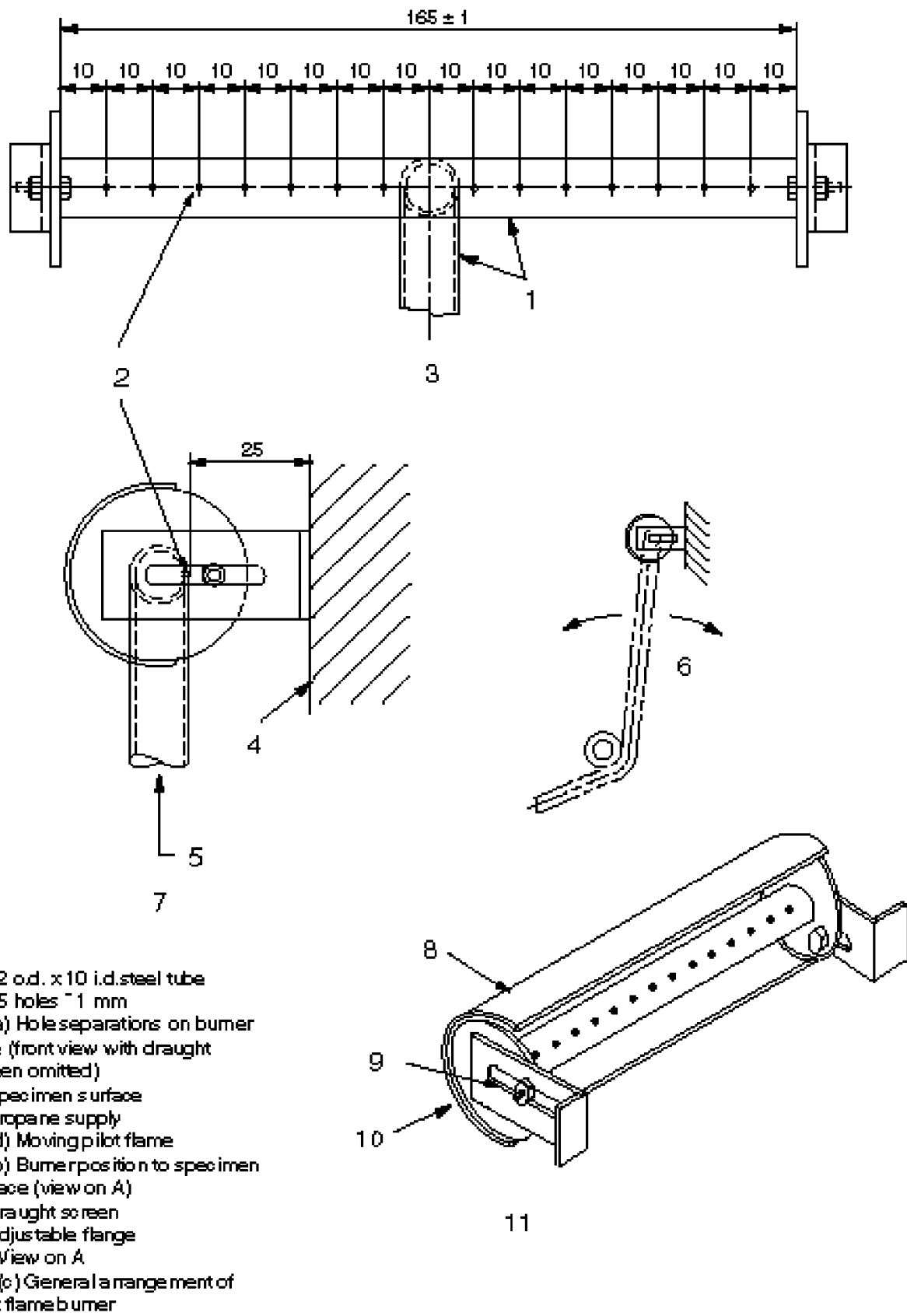


FIG. 7 Pilot Flame Burner