

# INTERNATIONAL STANDARD

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## Plastics — Smoke generation — Determination of the corrosivity of fire effluents —

### Part 4:

Dynamic decomposition method using a  
conical radiant heater

*Plastiques — Production de fumées — Détermination de la corrosivité des  
effluents du feu —*

*Partie 4: Méthode de décomposition dynamique utilisant un radiateur  
conique*

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## Foreword

ISO (the International Organization for Standardization) is a world-wide 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.

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.

International Standard 11907-4 was prepared by Technical Committee ISO/TC61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

ISO 11907 consists of the following parts, under the general title *Plastics – Smoke generation – Determination of the corrosivity of fire effluents*:

- *Part 1: Guidance*
- *Part 2: Static method*
- *Part 3: Dynamic decomposition method using a travelling furnace*
- *Part 4: Dynamic decomposition method using a conical radiant heater*

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## Plastics — Smoke generation — Determination of the corrosivity of fire effluents —

### Part 4:

#### Dynamic decomposition method using a conical radiant heater

#### WARNINGS

##### 1 Avoidance of misleading inferences

This standard method of test should be used solely to measure and describe the properties of materials, products or systems in response to heat or flame under controlled laboratory conditions and should not be considered or used by itself for describing or appraising the fire hazard of materials, products or systems under actual fire conditions or as the sole source on which regulations pertaining to corrosivity of fire effluents are based.

##### 2 Avoidance of danger to test operators

The test procedures involve high temperatures and combustion products. Therefore, conditions exist for burns, ignition of extraneous objects or clothing, and inhalation of combustion products. Use eye protection, and use protective gloves for insertion and removal of test specimens. Do not touch either the cone heater or the associated fixtures while hot, except with the use of protective gloves.

Vent the combustion products flowing through the exposure chamber through a properly designed exhaust system. Vent the captured combustion products in a smoke hood at the end of a test.

Check the exhaust system for proper operation before testing, and discharge into a building exhaust system with adequate capacity. Make provisions for collecting and venting any combustion products that for whatever reason fail to be collected by the normal exhaust system of the apparatus.

#### 1 Scope

**1.1** This part of ISO 11907 specifies a test method for measuring the corrosive effect, by loss of metal from a target, of the combustion effluents of plastic materials or products.

**1.2** The test method is intended for the evaluation of materials or products, for additional data to assist in the design of products, and for development and research purposes.

**1.3** The method provides corrosion results for plastic materials or product specimens limited to a maximum size of 100 mm × 100 mm in area. The results of this method have not been investigated with respect to correlation to actual fires.

**1.4** The method measures the increase in electrical resistance of a metal circuit. Such increase is related to the decrease in conductive cross-sectional area resulting from the metal loss due to corrosion.

**1.5** The method should be used to measure and describe the response of materials and/or products to heat and flame under controlled conditions but should not be used to describe or appraise the fire hazard or fire risk of materials under actual fire conditions. However, results of this test may be used as elements of a fire hazard or risk assessment as they relate to a particular end use.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11907. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11907 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5660-1:1993, *Fire tests – Reaction to Fire – Part 1: Rate of heat release from building products (Cone calorimeter method)*.

ISO 11907-1:1998, *Plastics – Smoke generation – Determination of the corrosivity of fire effluents – Part 1: Guidance*.

## 3 Definitions

For the purposes of this part of ISO 11907, the following definitions apply.

**3.1 corrosion:** The reaction of a metallic material with its environment, resulting in a measurable change of the material and possibly in an impairment of the functioning of a metal part or of an entire system.

NOTE – In most cases, the reaction is electrochemical. In others, however, it may be chemical (non-electrochemical) or physical.

**3.2 corrosion damage:** The physical and/or chemical damage or impaired function caused by chemical action.

**3.3 corrosion by metal loss:** The loss of metal on a target, expressed as reduction in thickness of the target metal.

**3.4 corrosion testing device:** Equipment used to determine corrosion in this standard.

**3.5 corrosion target:** The sensor used to determine, under specified test conditions, the degree of corrosion damage.

NOTE – This sensor can be a product, a component or a reference material used to simulate them.

**3.6 irradiance (at a point on a surface):** The radiant flux incident on an infinitesimally small element of the surface containing the point, divided by the area of that element.

NOTE – The specimen, once ignited, is also heated by its own flame.

**3.7 exposure chamber:** The enclosure in which a target is exposed to combustion products.

**3.8 environmental chamber:** The enclosure used to expose the targets to high humidity and temperature after the exposure to combustion products.

**3.9 sustained flaming:** Existence of a flame on or over the surface of the specimen for a minimum period of time (over 10 s).

NOTE – For flaming of less than 10 s, the flaming is considered transitory or flashing.

**3.10 fire effluent:** The totality of gases and/or aerosols (including suspended particles) created by combustion or pyrolysis.

**3.11 fire model:** A laboratory process, including the apparatus, the environment and the test procedure, intended to represent a certain phase of a fire.

**3.12 fire scenario:** A detailed description of conditions, including environmental, of one or more stages from before ignition to completion of combustion in an actual fire at a specific location, or in a real-scale simulation.

## 4 Symbols specific to this test method

$A_0$  Initial electrical resistance of the corrosion target,  $\Omega$ .

$A_1$  Electrical resistance of the corrosion target at the end of 1 hour exposure to combustion products,  $\Omega$ .

$A_{24}$  Electrical resistance of the corrosion target at the end of 24 hours in the environmental chamber,  $\Omega$ .

$C$  Corrosion of a target, nm.

$C_1$  Corrosion of a target at the end of 1 hour exposure to combustion products, nm.

$C_{24}$  Corrosion of a target at the end of 24 hours in the environmental chamber, nm.

$m$  Specimen mass, g.

$m_i$  Initial specimen mass, g.

$m_f$  Final specimen mass, g.

$m_{70}$  70% of the total mass loss, g.

$t_d$  Sampling time, s.

$q_V$  Volumetric sampling rate of combustion products,  $\text{m}^3/\text{s}$ .

## 5 Principle

**5.1** This test method is used to determine the corrosive effect of combustion products from burning plastic materials. Corrosion is determined by the reduction in thickness of the metal on standardized targets, which is directly related to the increase in electrical resistance of the target due to the decrease in conductive cross-sectional area. These targets are not necessarily representative of the intended end use.

**5.2** The test is conducted in two parts.

In the first part, two weight loss tests are conducted by exposing the test specimen to a recommended irradiance of  $50 \text{ kW/m}^2$ , or to other heating fluxes up to  $100 \text{ kW/m}^2$  relevant to particular scenarios. A spark igniter is used to ignite the combustible vapours. The combustible mass loss is determined as the average mass loss of the two tests.

In the second part, the specimen is subjected to the same irradiance as before. The products of decomposition or combustion are channeled through a funnel, and a portion of the products continuously flows through an exposure chamber, which holds the corrosion targets, until the specimen has lost 70 % of the loss measured in the two preliminary tests. The corrosion of the corrosion target is determined by exposure of the target to combustion products for 1 hour, followed by 24 hour exposure of the corrosion target to a controlled humidity and temperature environment in a separate chamber. The increase in electrical resistance of each target is monitored and the reduction in thickness of the metal on the target is calculated from the increase in electrical resistance. This reduction in thickness is referred to as corrosion by metal loss.

**5.3** Additional guidance for testing is given in annex A and in ISO 11907-1.

## **6 Apparatus**

### **6.1 Corrosion-testing device**

#### **6.1.1 General**

The corrosion-testing device consists of the following main components: a cone-shaped radiant electric heater, a temperature controller, an exhaust system, a specimen holder and mounting, an ignition circuit, a load cell, a heat flux meter and a gas-sampling system as detailed below.

A general view of the corrosion-testing device is shown in figure 1 and typical dimensions are shown in figures 1 to 8.

The cone calorimeter test equipment described in ISO 5660-1 may be used as a corrosion-testing device, provided that it is equipped with a gas-sampling system as described in 6.1.9.

#### **6.1.2 Conical heater**

The active element of the heater consists of an electrical heater rod, rated at 5 000 W/240 V, tightly wound into the shape of a truncated cone (see figure 2). The heater is encased on the outside with a double-walled stainless-steel cone, and packed with a refractory fibre material of approximately 100 kg/m<sup>3</sup> density.

The heater is capable of producing an irradiance on the surface of the specimen of up to 100 kW/m<sup>2</sup> with a uniformity of  $\pm 2\%$  within the central 50 mm  $\times$  50 mm area of the specimen.

The irradiance from the heater is held at a preset level by means of a temperature controller and three type K stainless-steel-sheathed thermocouples having an outside diameter of 1,5 mm to 1,6 mm and with an unexposed hot junction. Alternatively, either 3 mm outside diameter sheathed thermocouples with an exposed hot junction or 1 mm outside diameter sheathed thermocouples with an unexposed hot junction are suitable. They are symmetrically disposed and in contact with, but not welded to, the heater element (see figure 2). The thermocouples are of equal length and wired in parallel to the temperature controller.

#### **6.1.3 Temperature controller**

The temperature controller, which shall be capable of holding the heating-element temperature steady to within  $\pm 2\text{ }^{\circ}\text{C}$ , has a temperature input range of 0 to 1 000  $^{\circ}\text{C}$ , a set scale with a resolution of 2  $^{\circ}\text{C}$ , and automatic cold junction compensation. The controller uses a zero crossing type thyristor unit and is equipped with a safety feature such that, in the event of an open circuit in the thermocouple line, it will cause the temperature to fall to near the bottom of its range.

NOTE – A suitable temperature controller system is a "3-term" controller (proportional, integral and derivative) with a thyristor unit capable of switching currents up to 25 A at 240 V.

### 6.1.4 Device for monitoring the heater temperature

This device shall have a resolution of 2 °C.

### 6.1.5 Exhaust system

The exhaust-gas system consists of a high-temperature centrifugal exhaust blower, a hood, intake and exhaust ducts for the fan, and an orifice plate flow meter (see figure 3).

The orifice plate flow meter consists of a sharp-edged orifice (57 mm inside diameter) located in the exhaust stack, at least 350 mm downstream from the fan.

In other details, the geometry of the exhaust system is not critical. Where necessary, small deviations from the recommended dimensions given in figure 3 are allowed. For example, it is permissible for the inner diameter of the duct and the orifice plate to be slightly different (tolerance:  $\pm 2$  mm). The fan shall be located 900 mm to 1 200 mm downstream of the hood in such a way that the flow of air to the measurement orifice is uniformly mixed.

### 6.1.6 Load cell

The load cell has an accuracy of 0,1 g, a measurement range of at least 500 g, and a mechanical tare adjustment range of 3,5 kg. The general arrangement of the load cell with the conical heater is shown in figure 4.

The load cell shall be connected to a data acquisition system capable of displaying the sample mass at intervals of 5 s or less.

### 6.1.7 Specimen holder assembly

The specimen holder assembly consists of a specimen holder, an edge frame and retaining pins as shown in figure 5. The specimen holder is constructed from 2 mm nominal stainless steel and has outside dimensions of 111 mm  $\times$  111 mm  $\times$  24 mm high ( $\pm 2$  mm). It is lined with a layer of a low-density (nominal density 65 kg/m<sup>3</sup>) refractory ceramic fibre blanket with thickness of at least 13 mm.

The edge frame is constructed from 2 mm nominal stainless steel with outside dimensions of 116 mm  $\times$  116 mm  $\times$  56 mm high ( $\pm 2$  mm). The frame has an 8 mm lip on the top to provide an opening of 100 mm  $\times$  100 mm on the top. There are two 3 mm  $\pm$  0,5 mm diameter  $\times$  130 mm  $\pm$  3 mm long retaining pins to lock the test specimen in the edge frame.

### 6.1.8 Ignition circuit

The external ignitor is a spark plug with a gap of 3 mm, powered from a 10 kV transformer. The transformer is of a type specifically designed for spark-ignition use and has an isolated (ungrounded) secondary to minimize interference with the data-transmission lines. The electrode length and location of the spark plug is such that the spark gap is located 13 mm above the centre of the specimen.

### 6.1.9 Gas-sampling system

This consists of the following components and is shown schematically in figure 1.

#### 6.1.9.1 Gas-collecting device

The gas-collecting device (see figure 6) is a truncated cone constructed from stainless steel and having a larger diameter of (173  $\pm$  5) mm, a smaller diameter of (60  $\pm$  5) mm and a height of (97  $\pm$  5) mm.

### 6.1.9.2 Rigid tubing

The rigid tubing is a  $(675 \pm 75)$  mm long stainless-steel tube with an outside diameter of 6,3 mm which draws a gas sample from the combustion stream. One end of the tube is bent with the open end of the tube facing upwards and away from the specimen surface to avoid soot deposition. This end of the tube is  $(255 \pm 10)$  mm from the specimen surface. The other end is connected to flexible tubing. The arrangement of the rigid tube with the funnel is shown in figure 6.

### 6.1.9.3 Means of heating the rigid tubing

The means of heating (for example electric heating tape) shall be capable of maintaining the minimum temperature of the rigid tubing, and shall be capable of providing temperatures of up to 120 °C.

### 6.1.9.4 Flexible tubing

The flexible tubing consists of 6,3 mm outside diameter and  $(255 \pm 10)$  mm long heat-resistant tubing. It is used to connect the rigid tubing to the exposure chamber.

## 6.1.10 Corrosion-resistant exposure chamber

The exposure chamber (see figure 7) consists of a  $(0,0112 \pm 0,0005)$  m<sup>3</sup> chamber containing a corrosion target support stand and smoke baffle. The chamber has an O-ring seal plus inlet and outlet ports.

The corrosion target support stand (see figure 8) is constructed from a corrosion-resistant material.

### 6.1.11 Pump

The pump shall be capable of extracting a gas sample at a rate of  $7,5 \times 10^{-5}$  m<sup>3</sup>/s (4,5 l/min).

### 6.1.12 Filter

The filter is used to protect the pump from smoke particulates. Use the pump manufacturer's instructions to provide a suitable filter element.

## 6.2 Corrosion target and instrumentation

### 6.2.1 Corrosion target

The target shall be designed to be able to connect to a corrosion-measuring instrument and is composed of two circuit elements of identical material assembled on a non-reactive substrate. One circuit element is the active circuit element used for measuring corrosion and the other, with a protective coating, is used as a reference. Both of the elements of the target are exposed to combustion products during the test. A schematic diagram of a target from Rohrback Cosasco<sup>1</sup> (Model 030788-S0.35-8061) is depicted in figure 9.

### 6.2.2 Corrosion-measuring instrument

The corrosion-measuring instrument consists of a Kelvin bridge modified for measurement of the change in electrical resistance of corrosion targets and with a resolution, for measuring changes in thickness of the target, of not worse than 5 nm.

<sup>1</sup> Rohrback Cosasco systems, Inc., 11841 East Smith Avenue, Santa Fe, CA 90670, USA. Also Rohrco House, Worton Grange, Imperial Way, Reading, RG2 OTD, UK.

This information is given for the convenience of users of this part of ISO 11907 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

### 6.2.3 Flow meter

A flow meter having a measurement range from 0 to 5 l/min, with resolution of 0,5 l/min and an accuracy of 2 % of full-scale reading, or an equivalent flow meter may be used, to monitor and maintain a constant flow throughout the sampling part of the test.

### 6.2.4 Environmental chamber

The chamber shall be capable of being maintained at  $(23 \pm 2)^\circ\text{C}$  and  $(75 \pm 5)\%$  RH.

## 7 Test specimens

There shall be five specimens measuring 100 mm  $\times$  100 mm  $\times$  6 mm thick. Other thicknesses may be used if agreeable to all parties. However, the maximum thickness shall not exceed 12 mm. The specimens shall be cut from a representative sample of the material or end product. Clause 11 describes the preparation of the specimens for testing.

## 8 Conditioning

Unless otherwise agreed by the parties concerned, condition the specimens for at least 24 hours at  $(23 \pm 2)^\circ\text{C}$  and  $(50 \pm 5)\%$  RH.

## 9 Calibration of apparatus

### 9.1 Heater calibration

At the start of each test day or after changing to a new irradiance level, set the temperature controller at an irradiance of 50 kW/m<sup>2</sup>, or another irradiance agreed by the parties concerned, using the heat flux meter. Operate the cone heater for at least 10 min and ensure that the controller is within  $\pm 5\%$  of the desired setting.

During start-up of the heater or when changing the heat flux, place a shield on the load cell to avoid excessive heating of the cell. Remove the shield prior to inserting the heat flux meter in the calibration position.

### 9.2 Load cell calibration

Calibrate the load cell each day of testing using standard weights in the range of the test specimen mass.

### 9.3 Corrosion instrument calibration

Calibrate the corrosion instrument each test day in accordance with the manufacturer's instructions.

## 10 Equipment preparation

**10.1** Carry out the preparation under laboratory conditions of  $(23 \pm 2)^\circ\text{C}$ , and  $(50 \pm 5)\%$  RH.

**10.2** Put an empty specimen holder (or other shield) in place during warm-up and in between tests to avoid excessive heat transmission to the load cell.

**10.3** Turn on the power to the cone heater, the exhaust blower and the load cell.

NOTE – It is important not to turn off the power to the load cell on a daily basis.

**10.4** Ensure that the exhaust flow rate is  $(0,024 \pm 0,002) \text{ m}^3/\text{s}$ .

**10.5** Perform the calibration procedures specified in clause 9.

**10.6** Ensure that the collection device, the exposure chamber, all sampling lines and the filter are clean and clear of any residual matter.

**10.7** Check the sampling system for leaks. This is done with the pump operating and after the specified flow rate has been established. Shut off the flow through the flexible tubing immediately before the exposure chamber. The system is airtight if the flow meter flow drops to zero. If the flow does not drop to zero, then leaks are present within the system. Locate and correct such leaks.

## 11 Specimen preparation

**11.1** For sheet or moulded specimens, cut the specimen to a size of  $100 \text{ mm} \times 100 \text{ mm}$ . Wrap the specimen in a single layer of aluminium foil. Place the edge frame over the specimen and cut the aluminium foil along the open edges at the top of the edge frame to expose the test specimen. If necessary, fill the edge frame below the specimen with refractory blanket to the level of the retaining pins. Lock the assembly with retaining pins and place assembly on the bottom specimen holder.

**11.2** For tubular specimens, cut them to  $100 \text{ mm}$  lengths to fill the specimen holder. The number of lengths required equals  $100$  divided by the outside diameter (in mm). Seal the ends using an adhesive ceramic cement. Apply the adhesive cement to the ends such that there are no visible air holes in the coating and there is no cement overlapping on the ends. Wrap the tubular specimens in a single layer of aluminium foil. Place the edge frame over the tubular specimens and cut the aluminium foil along the open edges at the top of the edge frame to expose the specimens.

If necessary, fill the edge frame below the specimens with a refractory blanket to the level of the retaining pins. Lock the assembly with the retaining pins and place the assembly on the bottom specimen holder.

NOTE – Dimensionally unstable products, for example products that warp or shrink during testing, should be restrained against excessive movement.

## 12 Procedure

### 12.1 Measurement of initial mass

Measure the initial mass of each of the test specimens and calculate the average initial mass of the five specimens. The initial mass of each specimen shall be within  $10\%$  of the average initial mass.

Record the initial mass of each test specimen.

### 12.2 Intumescence specimens

Specimens that intumesce or deform so that they contact the spark plug prior to ignition, or the underside of the cone heater after ignition, shall be tested with a separation of  $60 \text{ mm}$  between the baseplate of the cone heater and the upper surface of the specimen. In this case, the heater calibration (see 9.1) shall be performed with the heat flux meter positioned  $60 \text{ mm}$  below the cone heater baseplate. It is stressed that the time to ignition measured with this separation is not comparable to the one measured with the separation of  $25 \text{ mm}$ .

### 12.3 Mass loss determinations prior to conducting corrosion tests

#### 12.3.1 Remove the empty specimen holder.

**12.3.2** Start the determination by placing the specimen, held in the specimen holder (holder initially at room temperature), on the load cell in such a way that the distance between the bottom of the radiant heater and the top of the edge frame is adjusted to  $(25 \pm 1)$  mm using the sliding height-adjustment device (see figure 2). Simultaneously start the ignition timer and the mass-loss and time-recording systems. Collect the data at intervals of 5 s or less. Move the spark plug into place over the test specimen, and turn on the spark power.

**12.3.3.** Record the times when flaming occurs for less than 10 s (flashing or transitory flaming) and the time when sustained flaming occurs.

**12.3.4** Collect the mass loss data until one of the following occurs:

a) the average mass loss over a 1 minute period has dropped below 1,5 g;

or

b) 60 minutes have elapsed.

**12.3.5** Remove the specimen holder.

**12.3.6** Repeat the procedures specified in 12.3.2 to 12.3.5 for a second specimen.

**12.3.7** From the mass loss data from the two determinations, determine the average 70 % of total mass loss for the corrosion test, as follows:

$$m_{70} = 0,5[0,7(m_i - m_f)_1 + 0,7(m_i - m_f)_2]$$

where subscript 1 denotes the first determination and subscript 2 denotes the second.

#### **12.4 Corrosion gas sampling test**

**12.4.1** Conduct three corrosion gas sampling tests after determining the average 70 % of total mass loss.

**12.4.2** When ready to test, first remove the empty specimen holder.

**12.4.3** Set the minimum temperature of the rigid stainless-steel tubing to 105 °C.

**12.4.4** Record the initial resistance of the corrosion target,  $A_0$ .

**12.4.5** Place the corrosion target in the exposure chamber. Seal the exposure chamber, and check for leakage as described in 10.7.

**12.4.6** Start the gas sampling for corrosion testing and ensure a continuous sampling rate of  $(7,5 \times 10^{-5})$  m<sup>3</sup>/s (4,5 l/min).

**12.4.7** Start the test by placing the test specimen, held in the specimen holder, on the load cell and start data collection. Collect the data at intervals of 5 s or less. Start the timer. Move the spark plug into place over the test specimen, and turn on the spark power.

**12.4.8** Stop the sampling flow when the specimen has lost 70 % of its mass, as determined in 12.3.7, or when 60 minutes have elapsed after start of the test, and record the sampling time.

**12.4.9** Combustion product exposure: Seal off the inlet and outlet sampling lines of the exposure chamber using clamps, and allow the combustion products to react with the corrosion targets for a total of 1 hour measured from the start of the test.

**12.4.10** Open and vent the exposure chamber under a smoke hood.

**12.4.11** Remove the target from the exposure chamber and record the electrical resistance  $A_1$ .

**12.4.12** Post-test exposure: Within 10 minutes of removal from the exposure chamber, place the target in an environmental chamber maintained at  $(23 \pm 2)^\circ\text{C}$  and  $(75 \pm 5)\%$  RH for 24 hours.

**12.4.13** After 24 hours in the environmental chamber, remove the target and record the final electrical resistance  $A_{24}$ .

**12.4.14** After the test, clean thoroughly the exposure chamber, the corrosion target support stand and baffle, the O-ring seal and any other components exposed to combustion products using a commercial cleaner. Rinse the components with distilled water, and clean a second time using isopropyl alcohol. Air-dry and assemble the components for the next test. Discard the rigid and flexible tubes after each specimen run.

**12.4.15** Discard the corrosion targets after post-test exposure and measurement.

### **13 Validity of the test results**

Discard the test data if any of the following occur:

- Leakage occurs between the sampling point and the exit of the exposure chamber which could cause a dilution of the gases.
- The specimen swells sufficiently prior to ignition to touch the spark plug, or swells into the plane of the heater baseplate during combustion.
- There is highly localized corrosion on the target.
- There is visual degradation of the reference circuit caused by the attack of combustion products on or under the protective coating.
- The specimen drips off the specimen holder or falls out of the specimen holder such that the specimen is not subjected to the test exposure conditions.

### **14 Calculation**

**14.1** Calculate the change in electrical resistance after the 1 hour test exposure and after the 24 hour post-test exposure.

**14.2** Use the guidelines set by the manufacturers of the targets and the corrosion instrument to determine the corrosion value corresponding to the metal loss at the end of the 1 hour exposure ( $C_1$ ), and at the end of the 24 hour post-test exposure ( $C_{24}$ ).

### **15 Precision**

The precision of this test method is not known because inter-laboratory data are not available. Inter-laboratory data are being obtained and a precision statement will be added at the following revision.

## 16 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 11907;
- b) the specimen identification code or number;
- c) the composition or generic identification of the test specimen;
- d) the specimen dimensions and the number of products or product pieces used per specimen;
- e) the specimen thickness (mm);
- f) the initial specimen mass (g);
- g) the test room temperature (°C) and relative humidity (% RH);
- h) the irradiance (kW/m<sup>2</sup>);
- i) complete identification of the corrosion target;
- j) the span (measurement range) of the corrosion target (nm);
- k) the volumetric sampling rate  $q_V$  (m<sup>3</sup>/s);
- l) the time to sustained flaming (s);
- m) the tabulated mass loss data (g);
- n) the average 70 % of total mass loss (g);
- o) the sampling time (min);
- p) the calculated change in electrical resistance at the end of the 1 hour exposure ( $\Omega$ );
- q) the calculated change in electrical resistance at the end of the 24 hour post-test exposure ( $\Omega$ );
- r) the calculated metal loss at the end of the 1 hour exposure (nm);
- s) the calculated metal loss at the end of the 24 hour post-test exposure (nm);
- t) the date of the test.

## Annex A (informative)

### Background information

#### A.1 Introduction

This annex is provided

- a) to give some insight into the development of the test method;
- b) to describe the rationale of various features of the gas-sampling apparatus;
- c) to describe the use of the data.

#### A.2 Corrosion measurements

**A.2.1** The type of corrosion damage identified is an increase in electrical resistance due to conductive-metal loss. To measure this increase, resistance targets have been found to be useful. In these targets, the electrical resistance increases as metal is lost due to corrosion. The increase in electrical resistance is expressed in this part of ISO 11907 as metal loss, with the assumption that metal is lost uniformly along the electrical circuit.

**A.2.2** The type of target used is determined by the application and the range of corrosion. Two copper targets from Rohrback Cosasco have been used to develop data on the corrosivity of combustion products. The Model 610 target has a nominal span (measurement range) of 250 nm, and has been found to be susceptible to complete corrosion (target goes off scale) by combustion products from a number of products and materials. To measure corrosion in excess of 250 nm, the Model 030788-S0.35-8061 target with a span of 4 500 nm is recommended in addition to, or instead of, the 250 nm target. The Model 610 target metal loss values are different from those of the Model 030788-S0.35-8061 for the same experiment. Data from each target is to be considered separately, and not combined in reporting results for a material or product without appropriate reference to the target used.

The corrosion caused by materials is influenced by many factors. These include:

- a) the composition and concentration of the combustion products, which is influenced in turn by the amount of material consumed during the combustion process;
- b) the exposure time;
- c) the level of condensation on the target.

These factors are important in designing a test since the targets need to be exposed to combustion products for a certain length of time in order to measure corrosion. An exposure time of 1 hour under specified laboratory conditions has been found to be suitable for the purposes of this test method.

Transport and decay of corrosion products are important considerations. Smoke particulates are deposited along the walls of the heated stainless-steel tube and the exposure chamber. Gaseous products may react with the surfaces of the equipment.

Environmental conditions such as temperature and relative humidity are also important in promoting corrosion. Thus it is desirable to conduct post-test exposure of targets at a high humidity to observe the

effect on the target after the combustion products have been vented. This is relevant since actual fires are usually suppressed with water, and the resulting post-fire environment is one of high humidity.

**A.2.3** This test does not prescribe the irradiance levels to be used. These should be determined for each type of material, using data on the total heat flux from fire scenarios and large-scale tests. 25 kW/m<sup>2</sup> and 50 kW/m<sup>2</sup> are recommended, since these irradiance levels are consistent with low-intensity and high-intensity flaming fires, respectively, as described by the international fire community.

**A.2.4** The size of the test specimen for this test is limited to a maximum of 100 mm x 100 mm in area and 12 mm thickness. Corrosion results from a specimen that is a mock-up or portion of a product should not be construed as being representative of the product performance without investigating the relationship between the specimen performance and the product performance.

**A.2.5** The results of the test method have not been investigated with respect to correlation to actual fires.

### **A.3 Gas-sampling system design**

**A.3.1** The design of the gas-sampling system needs to address the following basic questions:

- a) the location of the sampling point;
- b) the sampling rate;
- c) the exposure chamber volume;
- d) the gas-sampling schedule.

The combustion products are sampled at the small opening of the funnel, with the sampling tip facing downstream. The location of the sampling point was selected to avoid the dilution of combustion products by the exhaust flow used in the corrosion-testing device. The funnel is used to channel the combustion products to the sampling point.

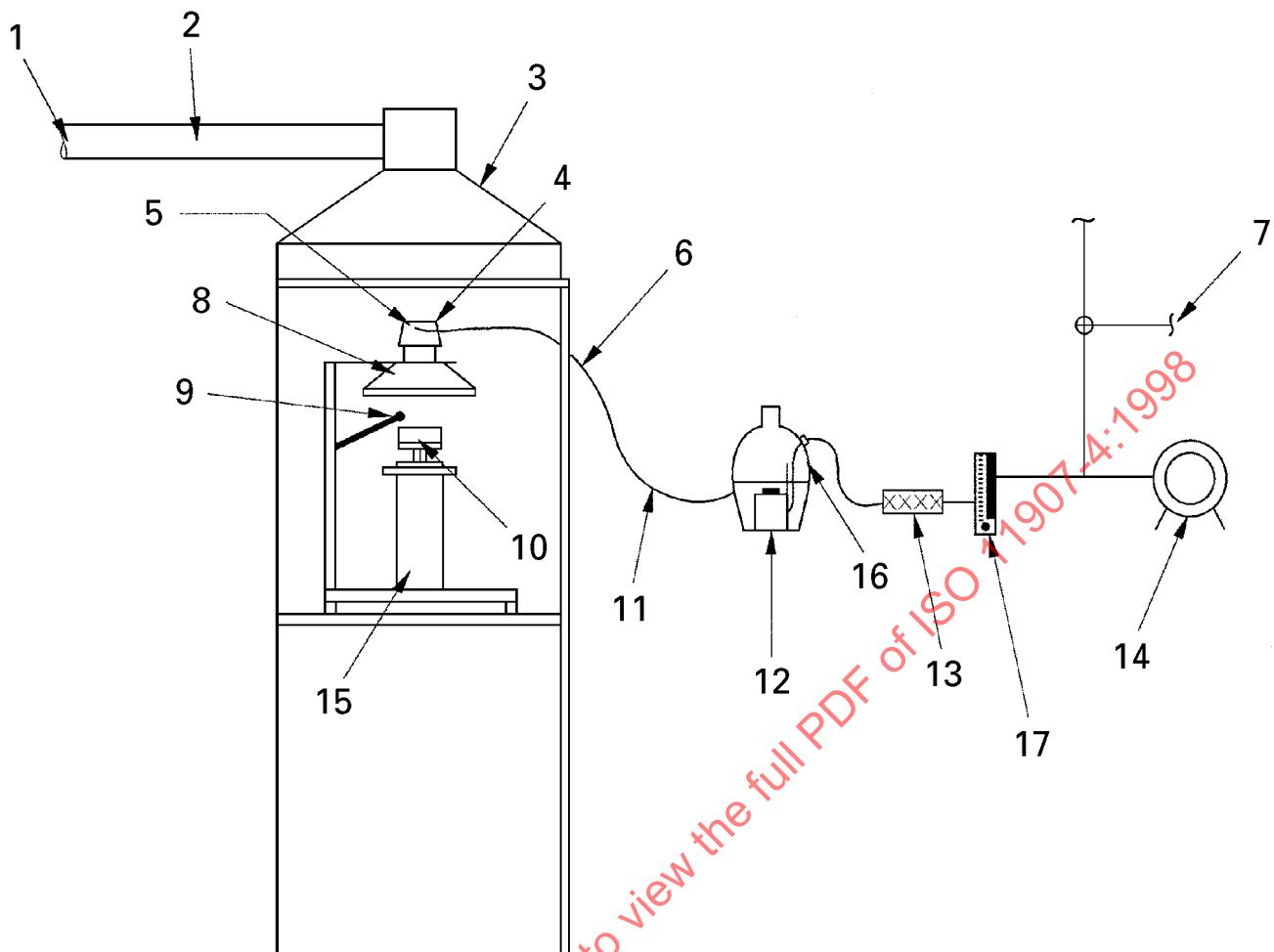
The ratio of the mass sampling rate to the mass of air in the exposure chamber is one of the design parameters of the gas-sampling system. This ratio, known as the time constant of the system, is approximately 150 s for the gas-sampling system described.

Based on the analysis of experiments on various plastic materials, the procedure requires sampling of the combustion products until 70 % of total sample mass loss (determined as an average of two tests) has occurred. This provides a very specific end point for gas sampling and also prevents dilution of the combustion products in the exposure chamber.

### **A.4 Use of data**

**A.4.1** The corrosion data is expressed as a metal loss.

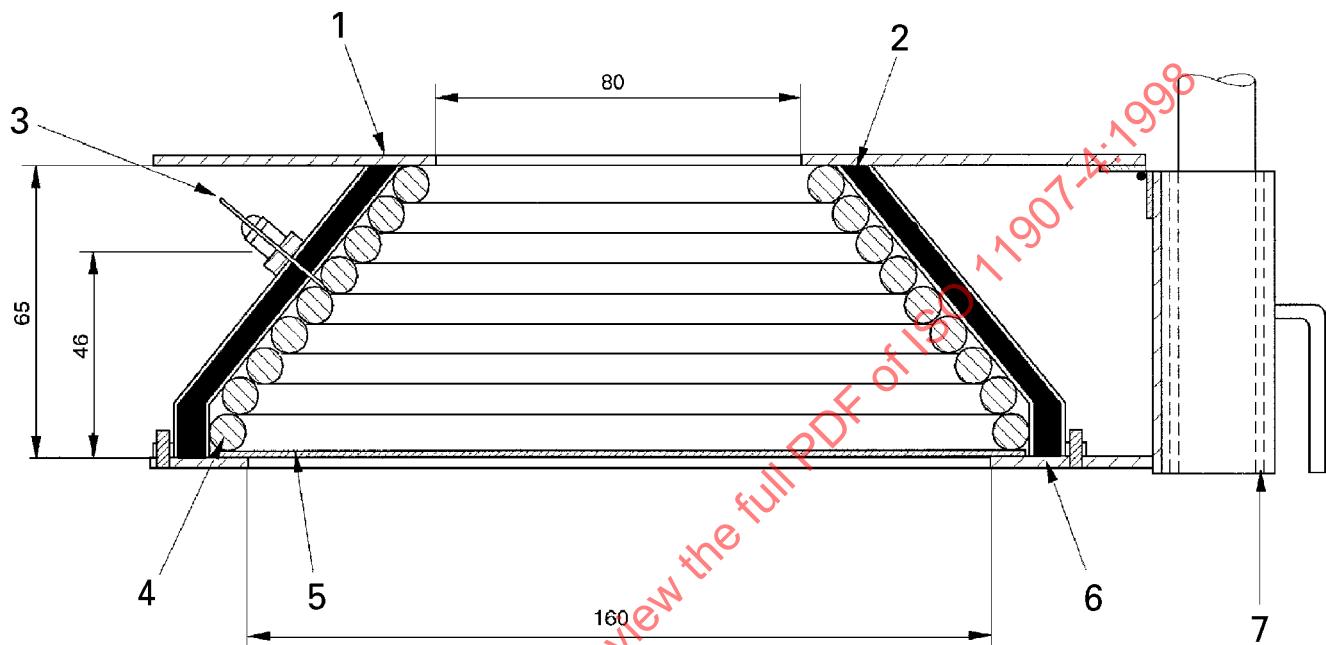
**A.4.2** In determining the suitability of a material or product for a specific application, it is strongly recommended that corrosion data obtained from this test be used with other fire data such as ignitability, heat release and smoke release in a fire hazard assessment.

**Key**

- 1 To exhaust blower
- 2 Exhaust duct
- 3 Exhaust hood
- 4 Gas-sampling collection device
- 5 Gas-sampling tip
- 6 Heated stainless-steel tube
- 7 Ambient-air bleed
- 8 Radiant cone heater
- 9 Spark plug
- 10 Test specimen
- 11 Flow rate 4,5 l/min
- 12 Corrosion target, support stand and smoke baffle
- 13 Filter
- 14 Pump
- 15 Load cell
- 16 11,2 litre exposure chamber
- 17 Flow meter

**Figure 1 – Typical corrosion-testing device**

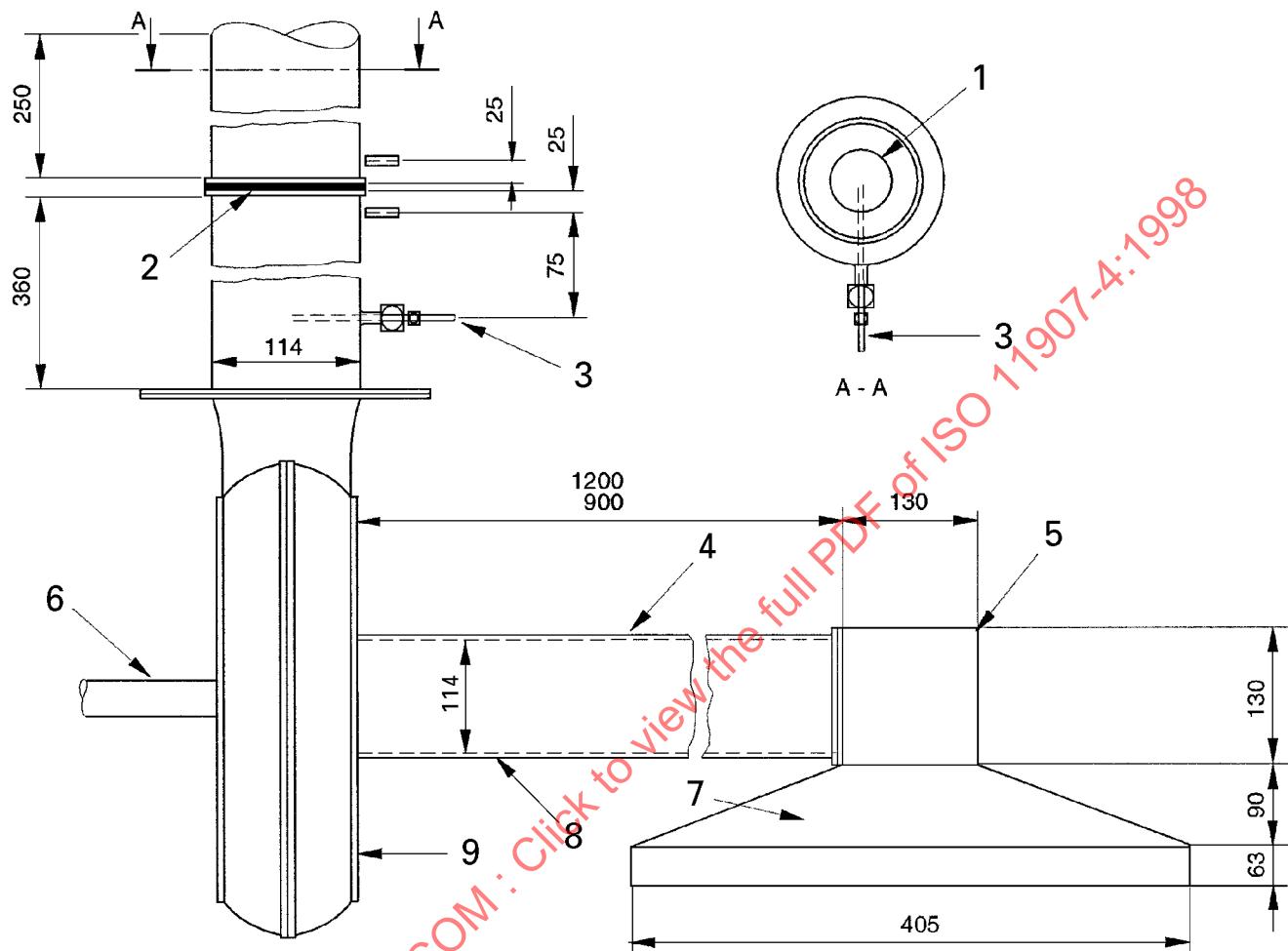
Dimensions in millimetres

**Key**

- 1 Outer shell
- 2 Inner shell
- 3 Thermocouple
- 4 Heater element
- 5 Spacer block
- 6 Ceramic-fibre packing
- 7 Cone hinge and sliding height-adjustment device

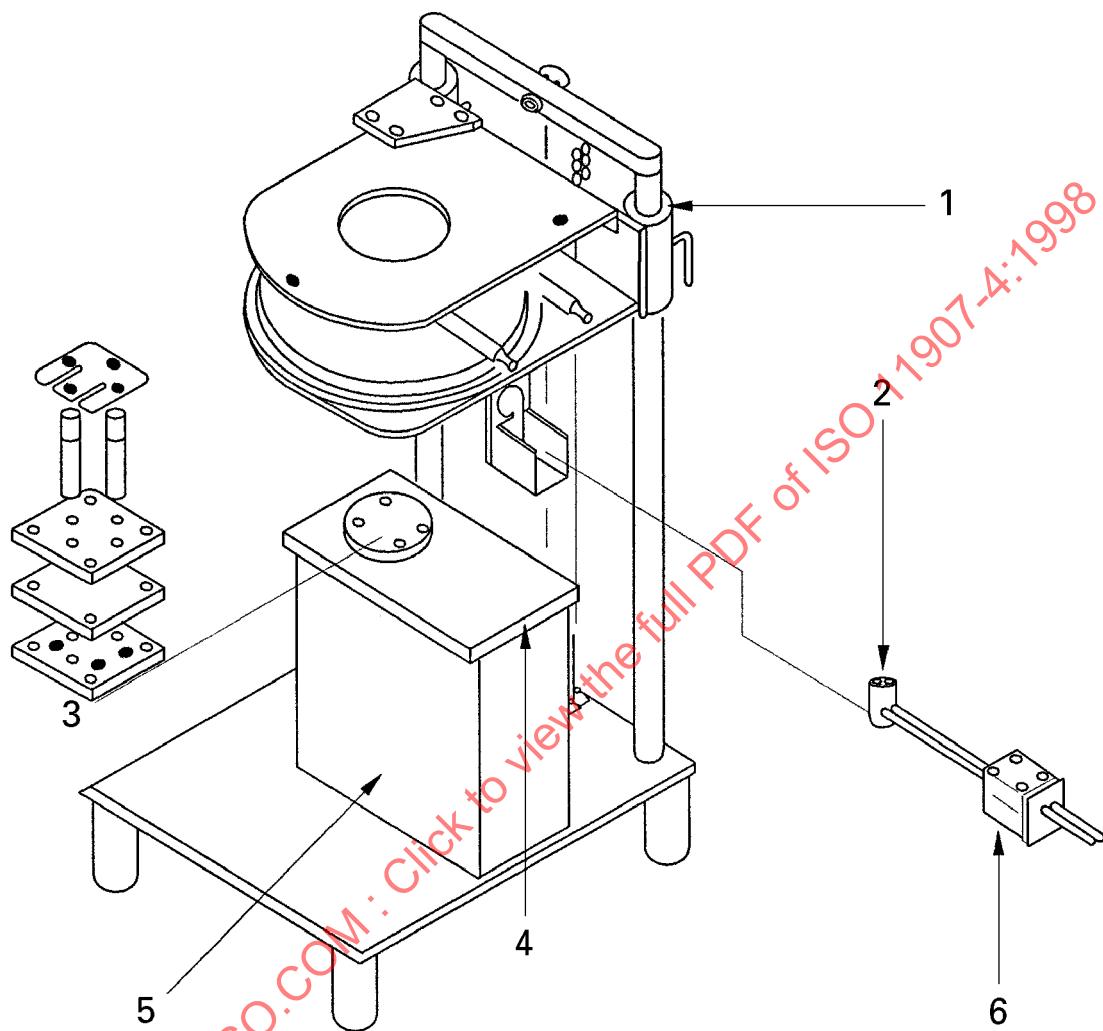
**Figure 2 – Cross-section through a typical conical heater**

Dimensions in millimetres

**Key**

- 1 57 mm internal diameter hole
- 2 Orifice plate, 1,59 mm thick
- 3 Thermocouple
- 4 Exhaust duct
- 5 Exhaust hood
- 6 To blower motor
- 7 Hood
- 8 Stainless-steel tube, internal diameter 114 mm, wall thickness 0,6 mm
- 9 Blower

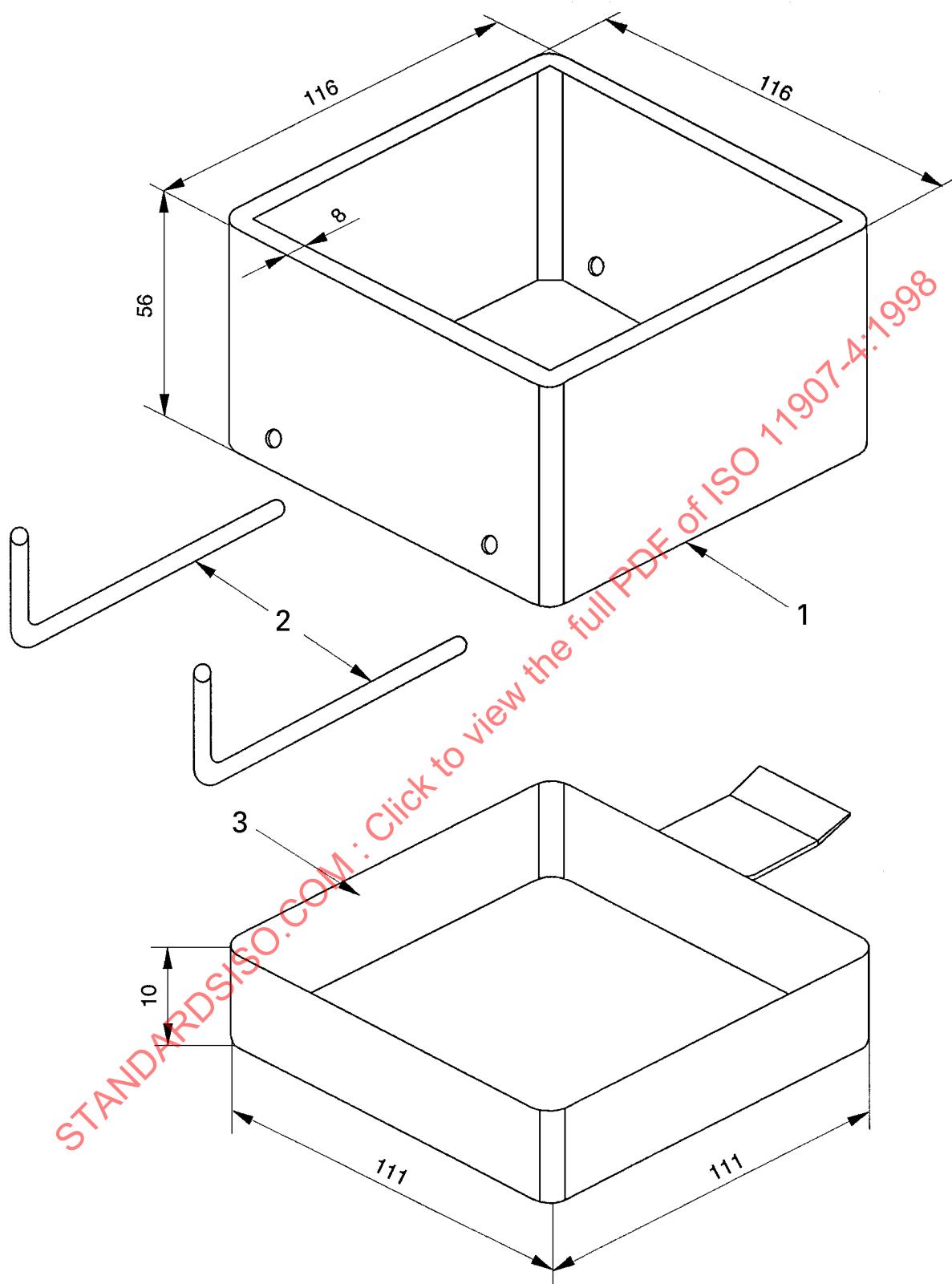
**Figure 3 – Typical exhaust system**

**Key**

- 1 Cone hinge and sliding height-adjustment device
- 2 Flux meter
- 3 Specimen mount assembly
- 4 13 mm calcium silicate heat shield
- 5 Load cell
- 6 Flux meter mount

**Figure 4 – Exploded view of a typical load cell and conical heater**

Dimensions in millimetres

**Key**

- 1 Edge frame
- 2 Retaining pins
- 3 Specimen holder

**Figure 5 – Typical specimen holder assembly**