INTERNATIONAL STANDARD

ISO
9150

First edition
1988-12-15

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

Protective clothing — Determination of behaviour of materials on impact of small splashes of molten metal

Vêtements de protection — Détermination du comportement des matériaux au contact avec des petites projections de métal liquide

Reference number
ISO 9150 : 1988 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9150 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Protective clothing — Determination of behaviour of materials on impact of small splashes of molten metal

0 Introduction

Clothing designed to protect the wearer against small splashes of molten metal is often submitted to high thermal loads. This International Standard forms a part of a series concerned with clothing designed to protect against heat and fire.

The diversity of the conditions in which splashes of molten metal may come into contact with materials used for protective clothing makes it difficult to evaluate the hazards that may arise under conditions of use.

Experience has shown that the most important protective function is resistance to heat transfer, through the protective clothing, from molten metal drops which impinge on but bounce off the clothing surface.

The test method described in this International Standard allows this heat transfer to be assessed.

1 Scope and field of application

This International Standard specifies a test method designed to evaluate the behaviour of materials used for protective clothing when such materials are struck by small liquid metal splashes, especially when molten steel particles are projected against the material.

It applies to any pliable material, or assembly of materials, designed to protect workers against small splashes of molten metal.

The results obtained by this method enable the behaviour of different materials which have undergone this test under standardized conditions to be compared. They do not permit conclusions with respect to contacts with large splashes of molten cast iron or other molten metal to be drawn, neither will they allow the behaviour of complete garments under industrial conditions to be predicted.

2 References

ISO 139, *Standard atmospheres for conditioning and testing.*

NF C 42-330, *Electrical measuring instruments — Platinum resistance temperature sensors — Reference table and tolerance.*

3 Definition and symbols

For the purposes of this International Standard, the following definition and symbols apply.

3.1 drop : A quantity of molten metal produced from the fusion of a metal rod by a welding torch, falling under the simultaneous action of its own weight and of the air movement produced by the welding torch.

3.2 Symbols

f Frequency of drops, expressed as number of drops per minute.

m Mass of a drop, expressed in grams.

ϱ_l Linear density of the steel rods, expressed in grams per centimetre.

X Number of 0,5 g drops, produced at the frequency of 20 per minute, required to raise the temperature of the sensor behind the test specimen by 40 K, the sensor temperature being within ± 2 K of ambient temperature at the beginning of the test.

4 Principle

Projection of molten metal drops at a point on a vertically oriented test specimen and measurement of the number of drops required to cause a 40 K temperature rise in a sensor behind the specimen.

5 Apparatus

5.1 Device for producing molten metal drops (see figure 1)

The end of a steel rod (5.5) is melted in the flame of an oxyacetylene welding-torch with orifice diameter 1,2 mm ± 0,1 mm.[1] The rod is advanced by means of a variable speed motor with a system of pulleys and a rope, and is affixed to the rod-holder which is provided with a counterweight.

The axis of the burner jet is perpendicular to the rod. The distance *d* between the rod and burner tip is adjustable (see figure 2).

The feed rates of oxygen and acetylene are controlled by flowmeters.

5.2 Drop guide (see figure 3)

This device is designed to collect the drops and to guide them towards the vertically oriented test specimen.

It comprises a funnel machined from polytetrafluoroethylene resin[1] and is provided with a support that is adjustable in all three planes. The funnel is inclined at 45° to the horizontal plane; its cylindrical part shall allow the passage of a rod with a diameter of 5 mm ± 0,2 mm.

Provide a cover on top of the drop guide and cover the drop guide when not in use.

5.3 Sensor for measuring the temperature, linked to a recording device

The sensor support block is machined from a refractory insulating material[1] having a thermal conductivity of 0,125 W/(m·K) ± 0,015 W/(m·K) at 40 °C and a specific heat capacity of 1,15 J/(g·K) ± 0,1 J/(g·K), to the dimensions shown in figure 4. Two holes near the centre serve to accept the lead wires to the sensor, and four holes at the corners are provided to attach the support block to the specimen-holding frame.

As the sensor, use a platinum resistor[1] conforming to NF C 42-330 (100 Ω at 0 °C, flat, dimensions 12,5 mm × 10 mm, polytetrafluoroethylene coated).

On the outer surface of the sensor support block, provide a recess of 13,5 mm × 11 mm just deep enough to imbed the sensor so that its surface protrudes 0,5 mm ± 0,2 mm. Attach the sensor in the recess by means of a heat-resistant adhesive.

Connect the sensor to an appropriate electronic device which converts the resistance change to temperature difference. It shall be capable of discriminating ± 0,5 K.

5.4 Holding frame for the test specimen

The specimen-holding frame also supports the sensor (5.3). It allows the specimen to be maintained under tension by a system of pulley-clamps and by a counterweight (see figure 5).

Use counterweights of 175 g ± 5 g on both sides of the test specimen or, alternatively, fix one end of the test specimen in a clamp and attach a 175 g ± 5 g counterweight to the other. The position of the specimen-holder is adjustable horizontally and vertically.

5.5 Steel rods

Steel rods of linear density ϱ_l = 0,5 g/cm ± 0,2 g/cm.

6 Specimen

Cut test specimens measuring 120 mm × 20 mm from the laboratory sample at a distance of at least 50 mm from the edges of the sample. Fold over the edges of the test specimen at a distance of 15 mm from both ends and staple them so as to enable the specimen to be fastened to the clamps (see figure 6).

Cut at least 10 test specimens.

Condition the test specimens for 24 h in accordance with ISO 139 : 1973, option 2.2.1 (65 % RH ± 2 % RH at 20 °C ± 2 °C).

7 Procedure

WARNING : Health and safety of operators

On exposure to molten metal, organic materials may pyrolyse with formation of toxic or noxious products. Therefore, tests according to this method shall be carried out in an enclosure where adequate air extraction is available upon completion of each test.

Protective gloves shall be worn when handling hot objects. If close-up inspection of apparatus or test specimen is required during testing, eye and face protection should be provided.

Catch metal drops in a suitable receptacle underneath the specimen holder.

7.1 Test conditions

Perform the test in a draught-free room without any source of heat other than that required for the test. The temperature of the test room should not vary by more than ± 5 K during tests

1) Information on commercially available devices may be obtained from the secretariat of ISO/TC 94 (BSI).

on each sample. Before performing the test, bring the temperature of the sensor (insulating support and probe) to ± 2 K of the ambient temperature.

7.2 Preparation and adjustment of metal rod

Set the motor speed so that the steel rod (5.5) is fed at the rate of 10 g/min ± 1 g/min. Adjust the welding torch position and gas flow to produce drops of mass m at frequency f.

Determine the mass of a drop m by weighing the rod before and after melting 20 drops and dividing the mass difference by 20.

Determine the frequency by recording with a stop-watch the time necessary to produce a given number of drops, the first drop being excluded from the count.

For the determination (7.3) the mass of a drop m and the frequency f shall be as follows :

m = 0,50 g ± 0,03 g

f = 20 drops per 60 s ± 3 s

For guidance, the following may be used as a starting point :

oxygen pressure = 250 kPa;[1)]

acetylene pressure = 50 kPA;

distance from rod to burner jet = 12 mm;

length of dark-blue cone of flame = 8 mm.

Aim at the lowest practical gas flow rate so as to minimize the risk that metal drops are blown away or spattered in the flame. Position the rod so that it is at the hottest point of the flame, i.e. just beyond the tip of the dark-blue cone.

7.3 Determination

Position the specimen holder (5.4) so that the vertical distance between the centre of the burner jet and the horizontal centre-line of the sensor (5.3) is 110 mm ± 10 mm. Adjust the distance between the axis of the rod and the vertical plane of the face of the sensor to 60 mm ± 10 mm. Adjust the distance between the axis of the rod and the plane through the vertical centre-line of the sensor perpendicular to its face to 15 mm ± 10 mm on the side opposite to the burner jet (see figure 1).

Incline the drop guide (5.2) at an angle of 45°; ensure that the metal drops are easily collected and that they impinge on the test specimen at the level of the sensor. Set the distance between the external face of the test specimen and the tip of the guide at 1,5 mm ± 1 mm (see figure 1).

Attach the test specimen to the specimen holder by means of the clamps so that the sensor is entirely covered. Attach the counterweight(s). If the test specimen has an external face, this face shall be exposed to the drops.

For each test, note the number of drops, X, required to raise the temperature on the internal face of the test specimen by 40 K. Test a total of 10 test specimens.

To obviate clogging of the drop guide with the first drop (which may be oversized if the rod has cooled from the previous test with a drop about to fall) it is advisable to use a paddle or shutter to deflect the initial drop away from the chute. Commence the test with the next drop.

8 Test report

The test report shall include the following particulars :

a) reference and description of the sample from which the test specimens were taken, in particular its surface density, in grams per square metre;

b) a reference to this International Standard;

c) the results obtained on each of the test specimens and the mean value of the results;

d) observations of any noteworthy phenomena (smoke, flames, etc.);

e) procedural details not specified in this International Standard as well as any incident noticed which may have affected the test results or which may represent an aggravation of possible hazards.

1) 1 kPa = 10^3 N/m^2.

Dimensions in millimetres

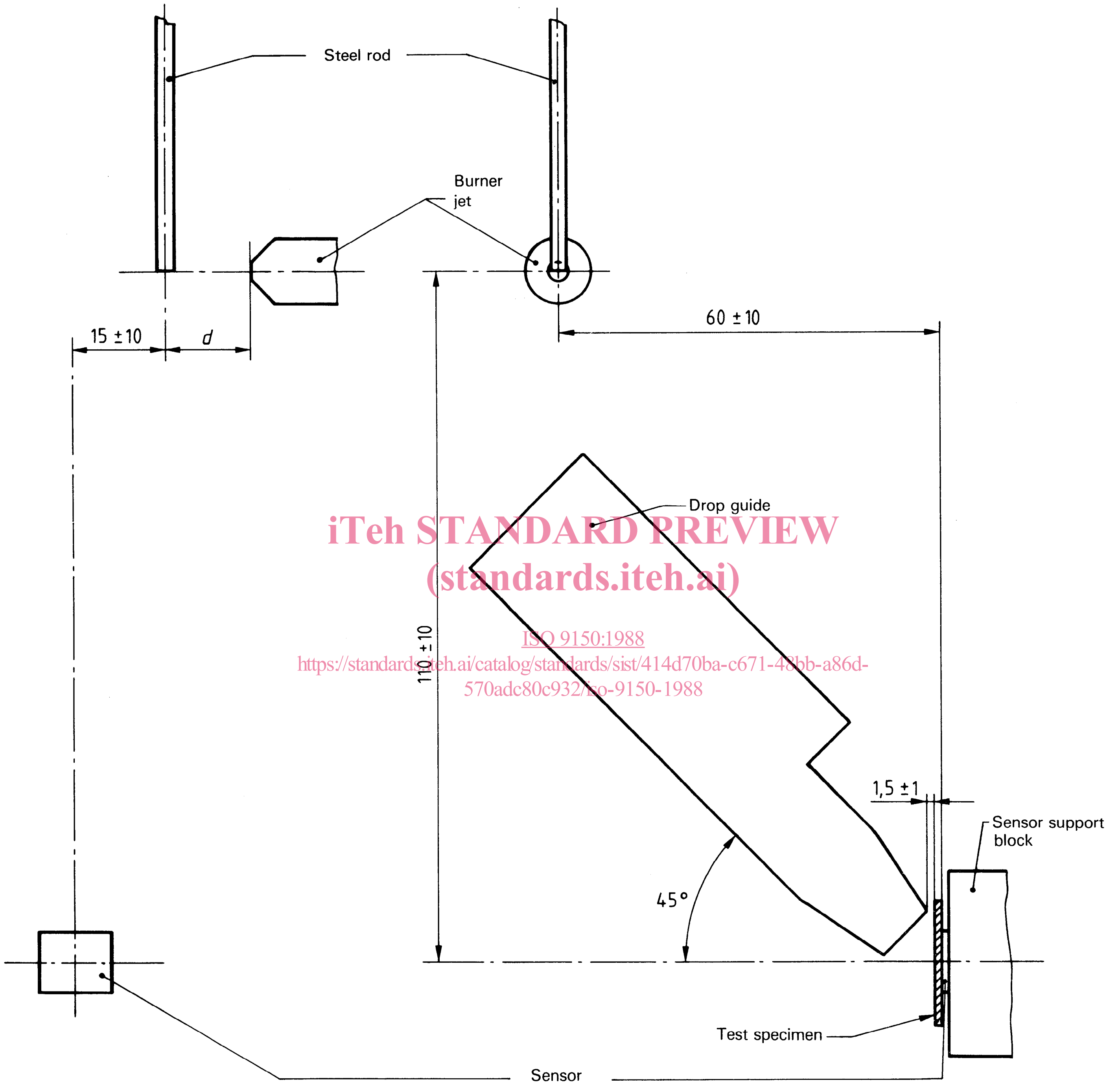


Figure 1 — General arrangement of apparatus for producing molten metal drops

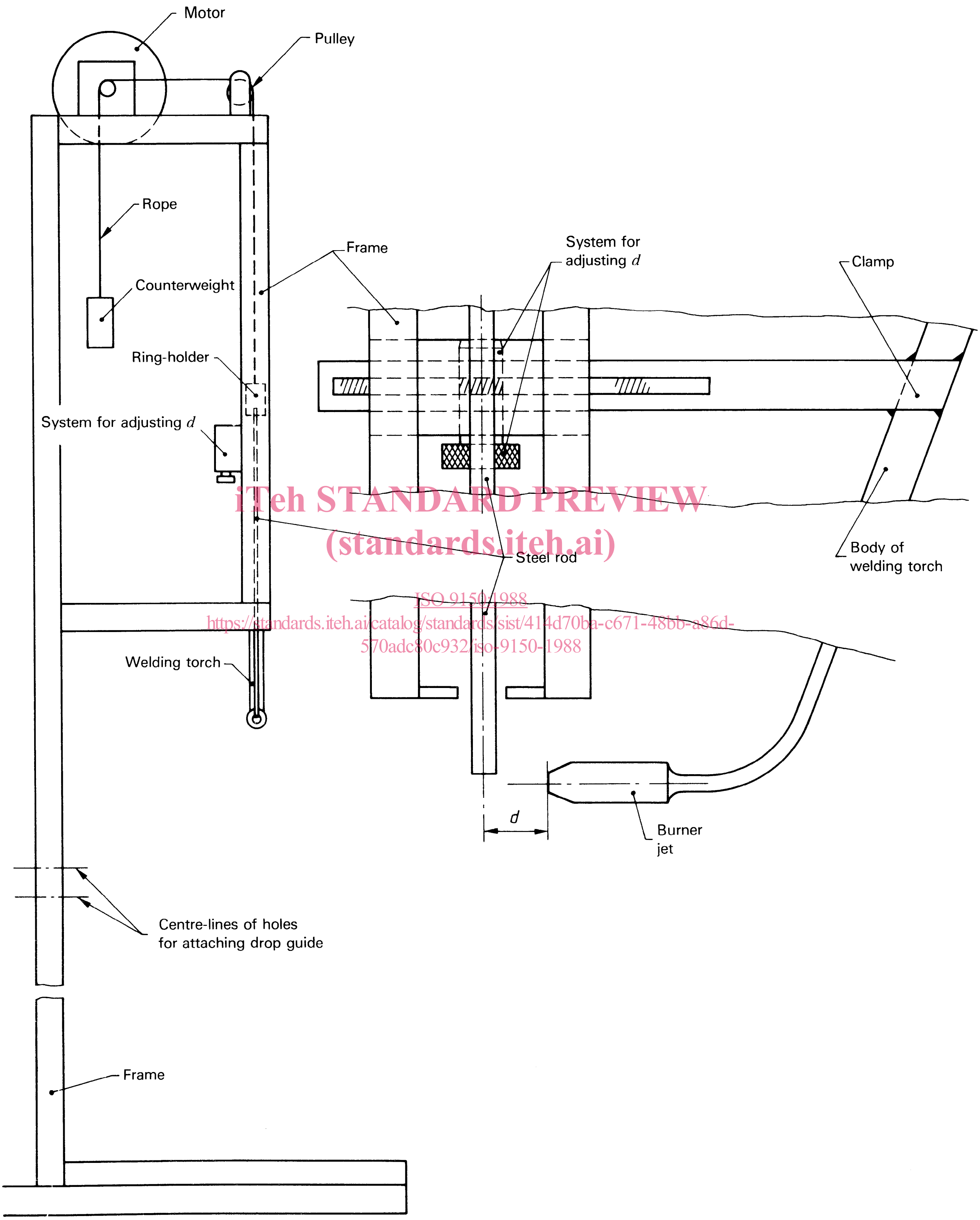
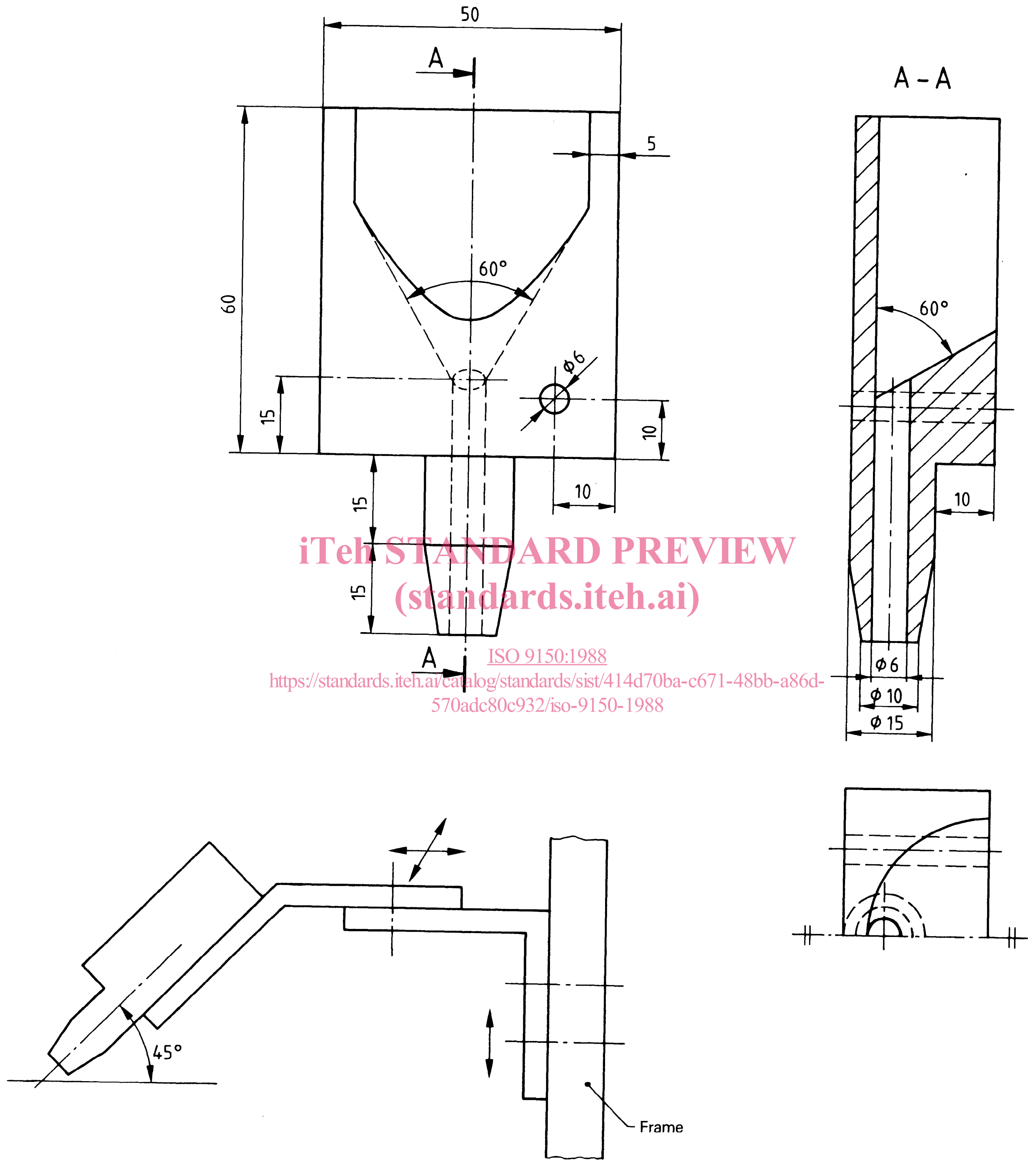


Figure 2 — Device for producing molten metal drops

Dimensions in millimetres



NOTE — It is recommended to fabricate the funnel and guide tube portions separately and to press-fit them together.

Figure 3 — Drop guide

Dimensions in millimetres

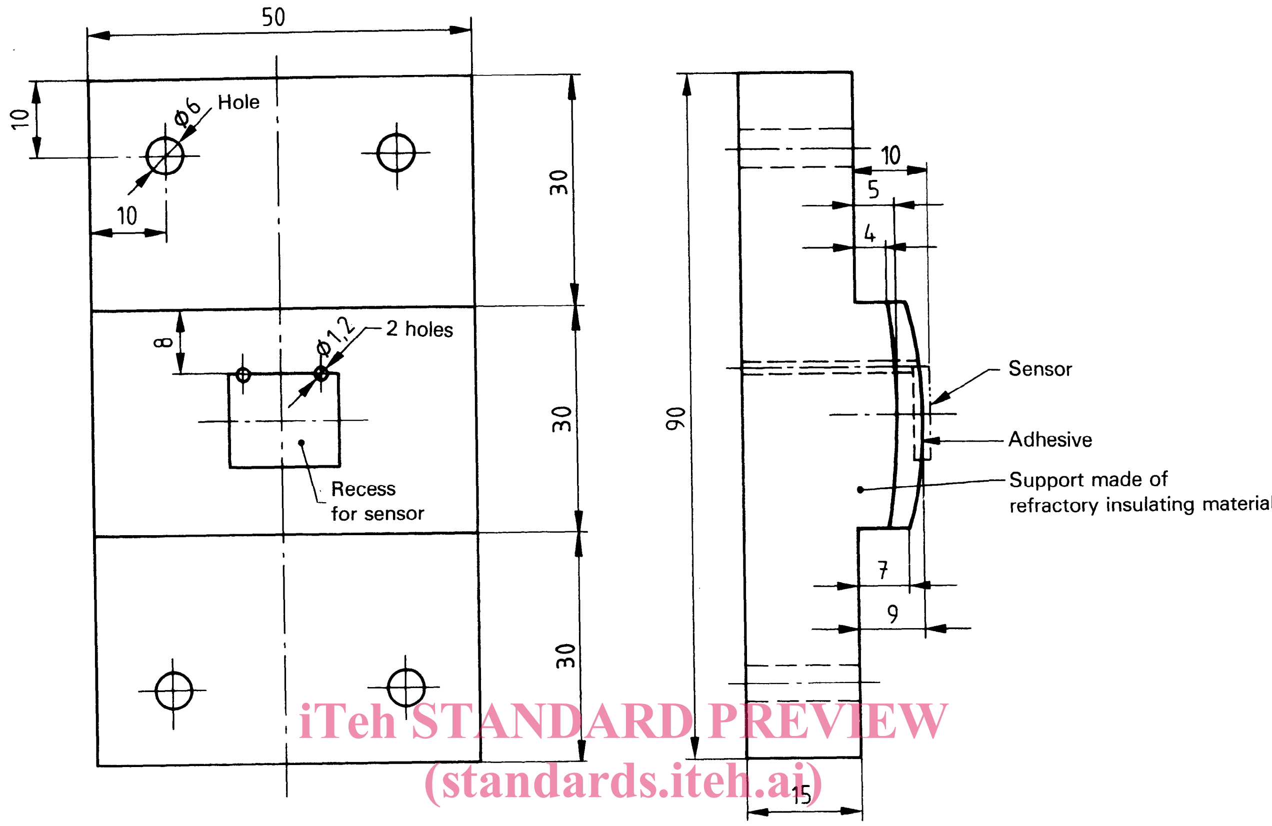


Figure 4 — Sensor support block

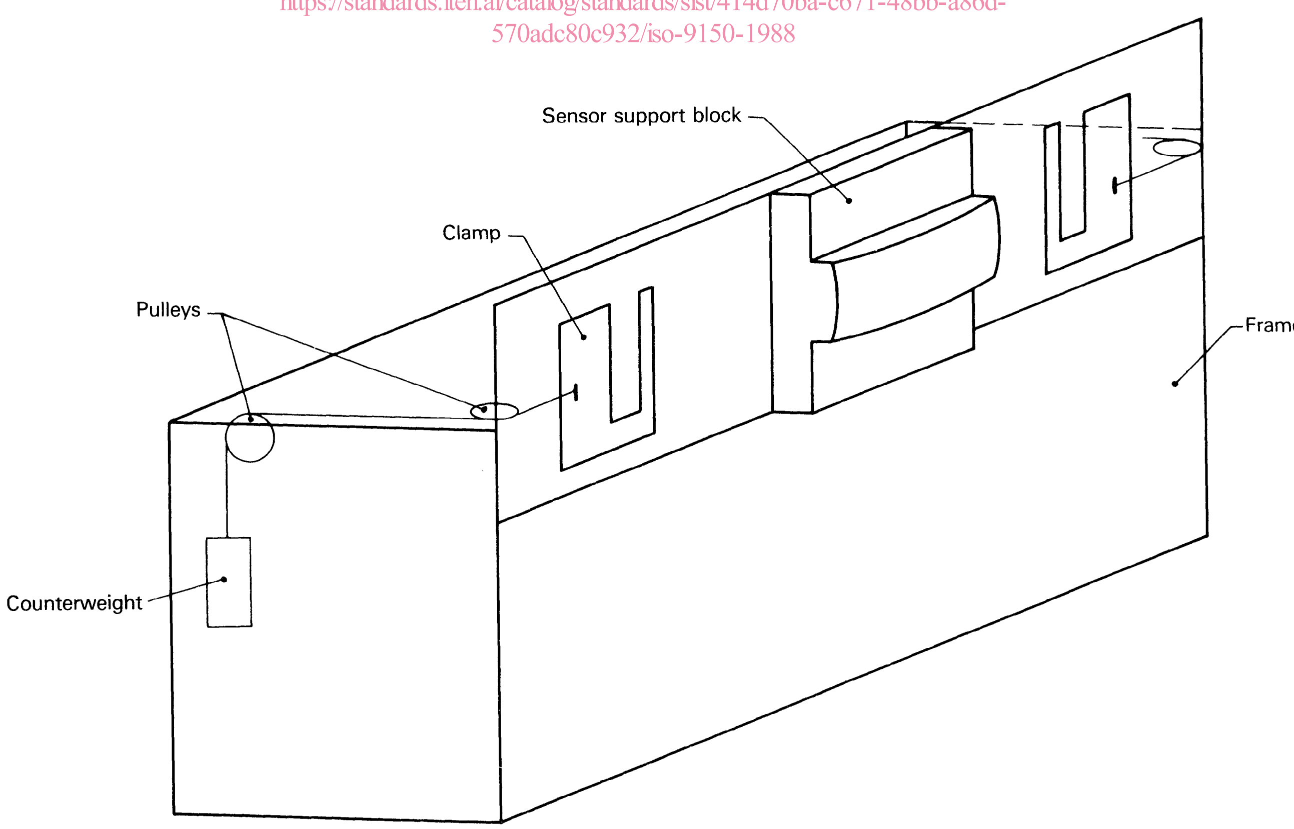


Figure 5 — Specimen support