TECHNICAL SPECIFICATION

ISO/TS 15029-2

First edition
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Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids —

Part 2: Spray test — Stabilized flame heat release method

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Produits pétroliers et produits connexes — Détermination des caractéristiques d'inflammation des fluides difficilement inflammables en jet pulvérisé —

Partie 2: Essai de pulvérisation — Méthode par dégagement de chaleur d'une flamme stabilisée

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Foreword

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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 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.

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ISO/TS 15029-2:2012

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 15029-2 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

ISO/TS 15029 consists of the following parts, under the general title *Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids*:

— *Part 1: Spray flame persistence — Hollow-cone nozzle method*

— *Part 2: Spray test — Stabilized flame heat release method* [Technical Specification]

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Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids —

Part 2:
Spray test — Stabilized flame heat release method

WARNING — The use of this part of ISO 15029 may involve hazardous materials, operations and equipment. This part of ISO 15029 does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this part of ISO 15029 to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This part of ISO 15029 specifies a method by which the fire hazards of pressurized sprays of fire-resistant fluids can be compared. Two sizes of propane flame are used to ignite and stabilize combustion of an air-atomised release of fluid and measurements related to the rate of heat release, length of flame and density of smoke are taken to give quantitative information on the fire behaviour of the fluid.

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2 Normative references

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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.

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ISO 3170:2004, *Petroleum liquids — Manual sampling*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 6743-4:1999, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 9162:—[1)], *Petroleum products — Fuels (class F) — Liquefied petroleum gases — Specifications*

IEC 60584-1:1995, *Thermocouples — Part 1: Reference tables*

3 Terms and definitions

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

3.1
stabilised spray flame
point at which the rate of energy release, flame length and other combustion properties, are steady as a function of time, so that sensible time-averaged values can be calculated

3.2
flame length
distance in millimetres from the vertical centre line of the gas burner to the furthest downstream point reached by the visible flame

1) To be published (revision of ISO 9162:1989).

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3.3
flame length index
function of the flame length and propane flow rate

3.4
ignitability factor
corrected value, to the nearest integer, of a function of heat release at a specific propane flow rate

3.5
smoke density
smoke density, as a function of smoke opacity in the flue pipe before and after introduction of the test fluid

NOTE See ISO 5659-2:2012, term 3.8 “optical density of smoke”.

4 Principle

A pre-conditioned flux of the test fluid is delivered to a test chamber through a twin-fluid atomiser. Compressed air, supplied to the nozzle at a controlled rate, is used to produce an atomised spray, which is exposed to a defined flame of a gas burner present throughout the test. The gas flame acts to produce, by input of heat at a steady rate, a stabilized spray flame (3.1), so that combustion properties, such as the rate of energy release and flame length, (3.2) are sufficiently steady over time to allow time-averaged values to be measured.

Temperatures are measured both at the entry to the combustion chamber and in the exhaust, with the burner operating first without, and then with, release of the test fluid. The flame length (3.2) and smoke opacity of the exhaust are also measured. Calculations of functions, such as flame length index (3.3) ignitability factor (3.4) and smoke density (3.5) are made from these measurements. Sampling of the exhaust can enable the production rate of other combustion products to be determined. A grading system for the performance of fire-resistant fluids is developed from these determinations and calculations.

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5 Reagents and materials

5.1 Propane, high purity (minimum 98 %) grade, generally conforming to the requirements of ISO 9162.

5.2 Nitrogen, oxygen-free, commercial grade.

5.3 Compressed air.

5.4 Water, conforming to the requirements of grade 3 of ISO 3696.

5.5 Ethylene glycol, laboratory grade (mono, 98 % purity).

6 Apparatus

6.1 Test installation

6.1.1 General

The major components of the installation are described in 6.1.2 to 6.1.6.

Figure 1 gives a general layout of the test installation.

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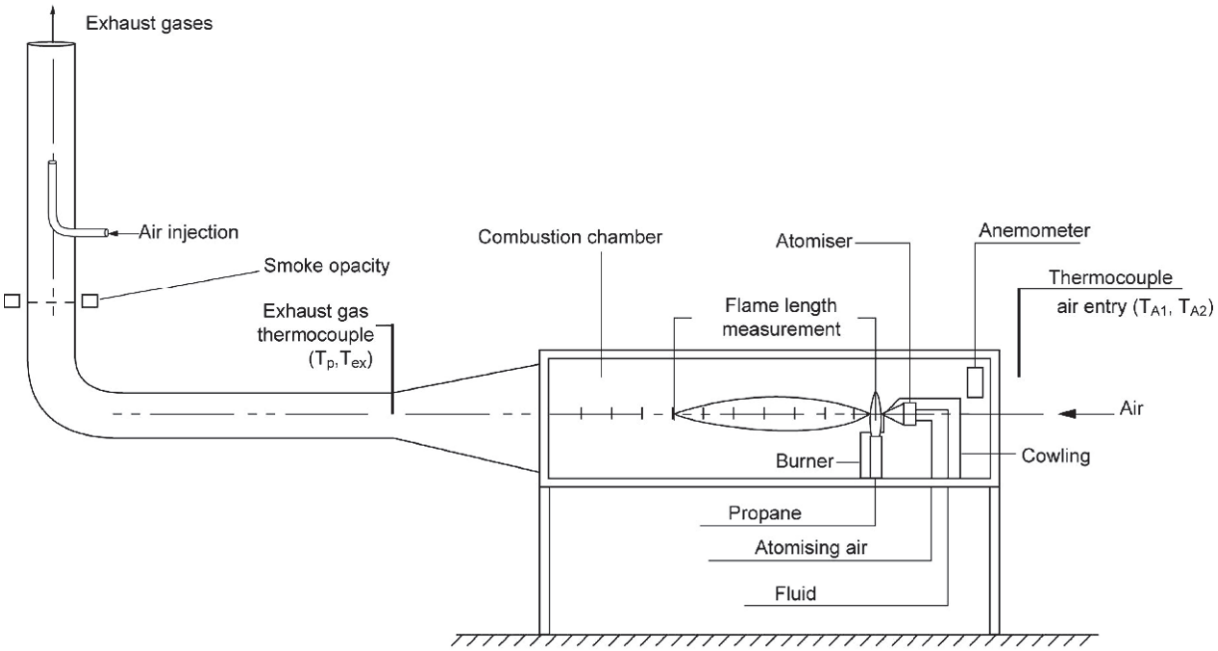

Figure 1 — General view of installation

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Figure 2 shows a schematic diagram of a suggested layout of the test equipment detailing the different input streams to the combustion chamber and exhaust duct.

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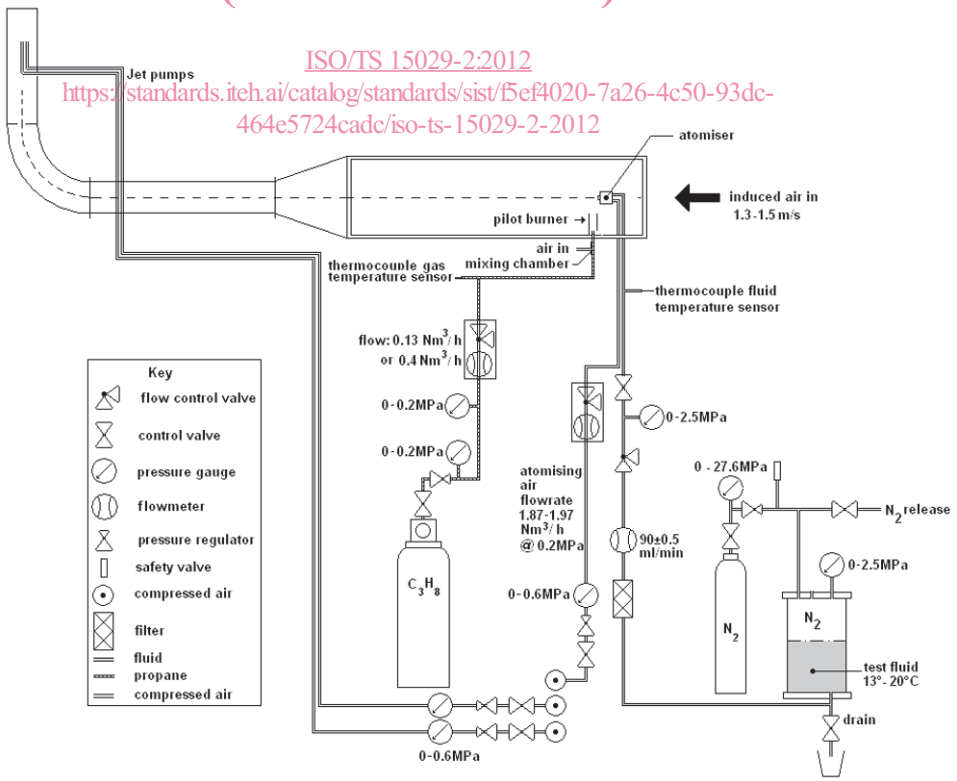

Figure 2 — Schematic diagram of suggested test rig layout

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6.1.2 Combustion chamber

This shall be fabricated from steel sheet, 8 mm thick, of square cross-section with internal dimensions of (2 000 ± 5) mm x (490 ± 5) mm x (490 ± 5) mm. The inner and outer surfaces shall be painted with black heat-resistant paint. A clear window of heat-resistant glass, 8,5 mm thick, shall be located in one side of the chamber. The glass shall be (1 920 ± 10) mm x (525 ± 10) mm providing an open area of the window of (1 880 ± 10) mm x (480 ± 10) mm. The window is hinged from below to allow access to the chamber. The window shall be clamped shut during use and sealed with mineral fibre tape to avoid ingress of air (See Figure 3).

6.1.3 Extraction system

The combustion chamber exit shall be connected to a contraction fabricated from steel sheet 1 mm thick, providing a transition from the square to a circular cross-section with an internal diameter of 250 mm ± 4 mm. This contraction, 750 mm ± 10 mm long, is connected to a horizontal section of flue pipe 1 400 mm ± 10 mm in length which, in turn, may be connected to further exhaust ducting or clearing system that shall be designed to provide stable conditions in the combustion chamber during a test.

The air flow through the chamber is produced by a jet pump mounted in the exhaust duct, producing an air velocity of 1,4 m/s ± 0,1 m/s measured 50 mm ± 2 mm inside the combustion chamber inlet. The temperature of the air entering the chamber shall be sufficiently constant within the range 10 °C to 25 °C, such that the temperature variation over a period of 30 s shall not exceed 1 °C. The relative humidity of the air shall lie between 40 % and 80 %.

6.1.4 Spray delivery system

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6.1.4.1 Reservoir. The test fluid shall be contained in a steel reservoir of minimum capacity 3 l, designed for an internal pressure of 2,5 MPa at 20 °C. The flow of fluid from the reservoir is provided by means of pressurized nitrogen (5.2) supplied to the upper part of the reservoir, with a valve situated in the nitrogen supply pipe. Means shall be provided to permit complete drainage of the system.

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6.1.4.2 Test fluid delivery. The fluid volume flow rate can be measured with a suitable flowmeter and controlled to 90 ± 0,5 ml/min by means of a needle valve. The fluid temperature is maintained between 10 °C and 25 °C, and measured by a thermocouple located immediately before the fluid nozzle. The fluid is delivered to the atomiser[2)] through nylon and/or steel piping with an internal diameter of 7,5 mm ± 2,5 mm, rated at 2 MPa and the flowmeter shall be located 350 mm ± 150 mm downstream of the valve.

6.1.4.3 Compressed air. Compressed air shall be supplied, via a suitable mesh filter to remove droplets and particulates at a steady flow rate of 1,92 Nm^3/h ± 0,05 Nm^3/h at a pressure of 0,2 MPa. The flow rate shall be measured by a variable area flowmeter having a flow range of 0,4 Nm^3/h to 3,0 Nm^3/h, located 3 500 mm ± 500 mm before the spray jet at a pressure of 0,2 MPa, and controlled by a valve installed downstream of the flowmeter. The temperature of the atomising air shall be between 10 °C and 25 °C.

2) Type 1/4JBC-12B, manufactured by Spraying Systems Co. (http://www.spray.com) and supplied by CT Limited, Guildford, Surrey, UK is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 15029 and does not constitute an endorsement by ISO of this product.

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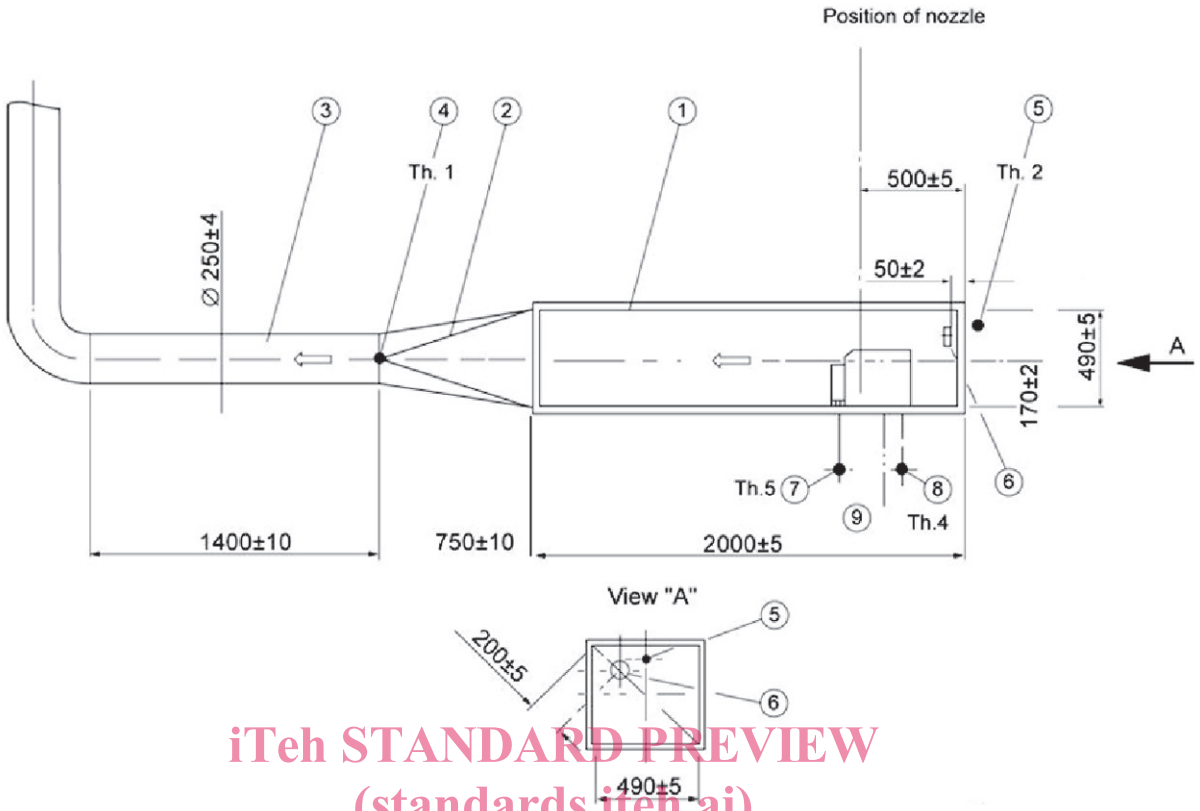
Dimensions in millimetres



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Key

1 combustion chamber
2 contraction
3 flue pipe
4 exhaust gas thermocouple
5 ambient air thermocouple
6 anemometer
7 propane gas thermocouple
8 atomizing air thermocouple
9 fluid inlet pipe

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Figure 3 — Combustion chamber and exhaust system

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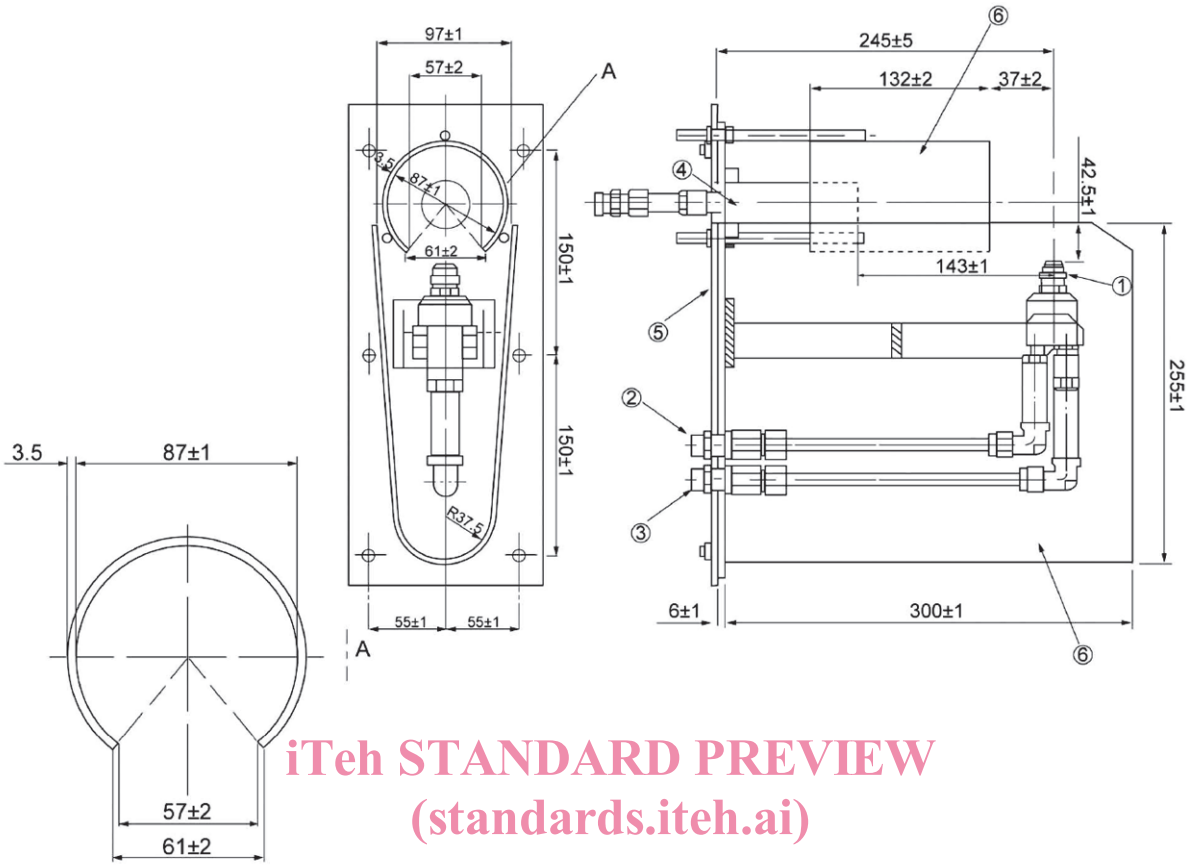
Dimensions in millimetres



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Key

1	spray nozzle	4	propane burner
2	fluid supply	5	base plate
3	air supply	6	cowling

Figure 4 — Atomizer and burner system

6.1.5 Burner system

6.1.5.1 System design. The gas burner, constructed of brass and illustrated in Figure 4, provides a continuous ignition source using propane (5.1) pre-mixed with air (5.3). It incorporates a nozzle[3)], drilled to a diameter of 0,68 mm, and two mixing chambers, the whole mounted rigidly on to a steel base plate of 6 mm thickness (see Figure 4). The exit of the 26 mm internal diameter mixing chamber shall be 143 mm ± 1 mm below the centre line of the atomiser, and a distance of 42,5 mm ± 1 mm downstream of the atomiser orifice. If required, the burner can be manufactured from the illustration given in Figure 5.

Propane, at a minimum pressure of 0,25 MPa, shall be supplied through 4 000 mm ± 1 000 mm of flexible tubing of 6 mm ± 2 mm bore, to an assembly of a pressure gauge, flowmeter and valve. Further flexible and/or metal tubing, 2 500 mm ± 500 mm in length and of a minimum bore of 6 mm, is installed between the valve in the assembly and the gas burner.

3) Type t1700 fine flame gas nozzle, supplied by Applications des Gaz, Paris, France (now part of the Coleman Group; http://www.coleman-eur.com) is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 15029 and does not constitute endorsement by ISO of this product.

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At a controlled pressure of 0,2 MPa, the propane flow rate shall be either 0,13 Nm^3/h ± 0,005 Nm^3/h, or 0,40 Nm^3/h ± 0,005 Nm^3/h, depending upon specific test requirements. The flow rate shall be measured with a variable area flowmeter having a range of 0,10 Nm^3/h to 0,50 Nm^3/h and of suitable resolution. The temperature of the propane on entering the burner shall be between 10 °C and 25 °C.

6.1.5.2 System verification. On installation the system shall be verified for conformity to the standard design. Annexes A and B describe protocols for checking the control systems and flame characteristics, respectively. At intervals of 12 months, or if it is suspected that the characteristics of the burner have changed, the burner may be checked by sampling the flame temperature at a few selected locations and comparing the measurements with the standard values given in Annex B.

6.1.6 Burner and atomiser mounting

6.1.6.1 Mounting. The atomiser and burner assembly, on the steel base plate, is protected by a cowling fabricated from 1 mm thick sheet steel bent into the form shown in Figure 4, with a height of 300 mm ± 1 mm, overall width of 97 mm ± 1 mm, and overall length of 255 mm ± 1 mm. The burner shall also be protected from the surrounding air flow by a cylindrical cowling of 87 mm ± 1 mm diameter, containing a vertical slot with an external opening of 61 mm ± 2 mm on its upstream face. Three threaded supports provide a means of elevation of this cowling, with its upper part at a distance of 37 mm ± 2 mm from the horizontal plane passing through the atomiser axis.

6.1.6.2 Placement. The base plate is positioned on the floor of the combustion chamber with the atomiser orifice 500 mm ± 5 mm downstream of the combustion chamber inlet orifice. Connections through the base plate and combustion chamber floor shall be provided for the supply of air, propane and test fluid to the burner and atomiser as appropriate.

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6.2 Instrumentation

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6.2.1 Temperature sensors

Five T-type Cu-CuNi thermocouples with an outer diameter of 1,5 mm, conforming to the requirements of IEC 60584-1, or temperature measurement devices of equivalent precision and accuracy, are positioned as illustrated in Figure 2. The third thermocouple is positioned in the test fluid reservoir with at least 50 mm of sheath completely immersed in the fluid, and not in contact with the vessel wall. All the thermocouples shall be used with 0 °C reference junctions in accordance with IEC 60584-1. Measurement accuracy shall be ± 0,5 °C over the range 15 °C to 200 °C, and the temperature resolution shall be 0,1 °C.

The accuracy of the test result is highly dependent upon the accurate positioning of the exhaust gas thermocouple. This shall be located with an accuracy of ± 0,5 mm and checked before the commencement of each new series of tests.

Where a computer is used, both this and the data acquisition system shall be capable of calculating averages of at least 100 values of each temperature measured over 120 s.

6.2.2 Anemometer

The air flow velocity in the combustion chamber is measured using a rotating vane anemometer with a vane diameter of 95 mm ± 30 mm located as illustrated in Figure 2 (including section "A").[4)]

6.2.3 Humidity sensors

The relative humidity of the incoming air used in each test series shall be measured and recorded at the beginning and end of each day of testing.

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4) A suitable instrument is manufactured by Testo Limited. This information is given for the convenience of users of this part of ISO 15029 and does not constitute an endorsement by ISO. Equivalent products may be used if they can be shown to lead to the same results.

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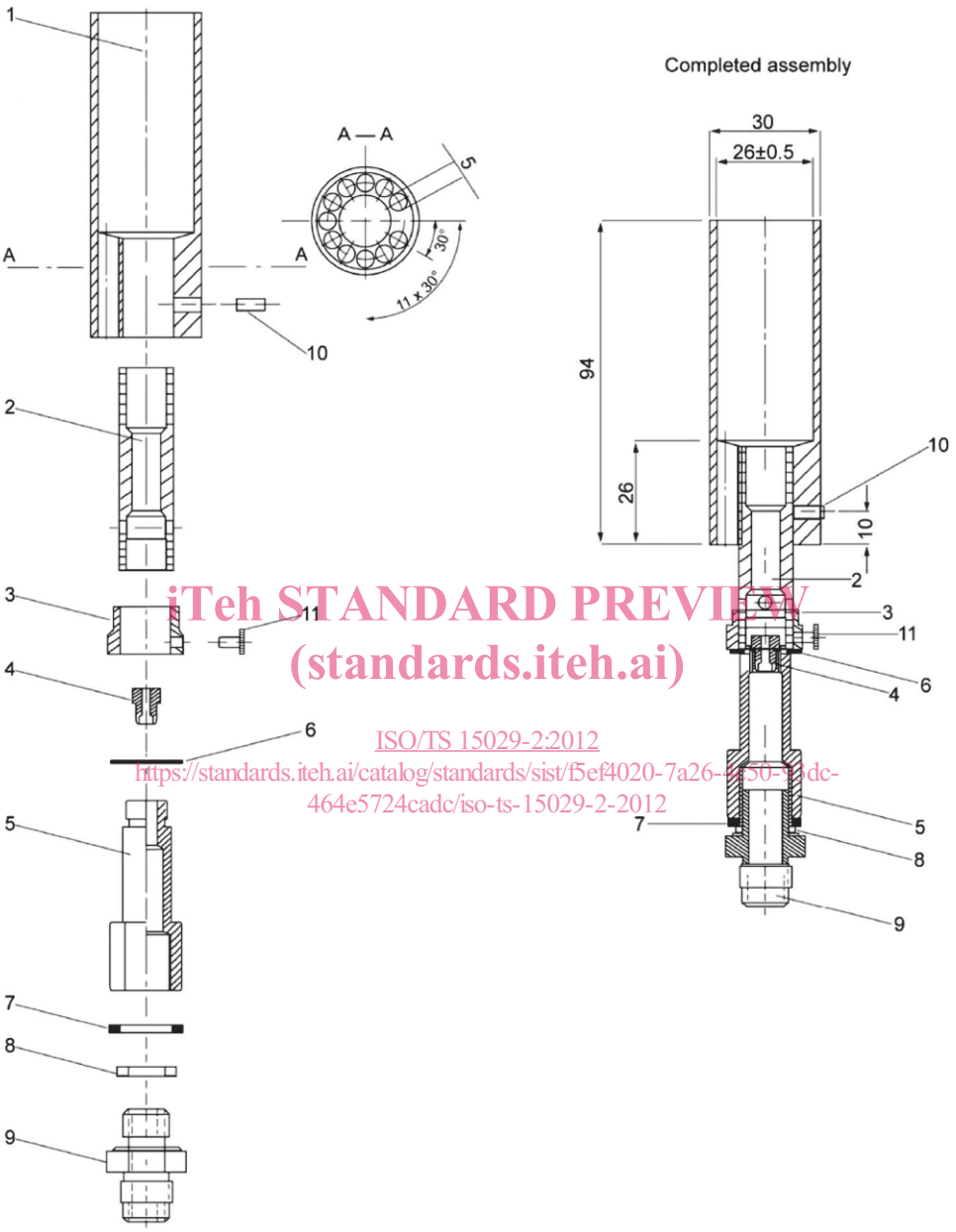
6.2.4 Flame length scale

A linear scale of at least 1 m in length, with a resolution of no greater than 10 mm, shall be attached to the combustion chamber side window.

Dimensions in millimetres



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Key

1	mixing chamber 1	5	nozzle holder with flash-back unit	9	straight male adaptor
2	mixing chamber 2	6	washer	10	locking screw
3	regulation collar	7	washer	11	locking screw
4	burner nozzle	8	sealing ring		

Figure 5 — Propane burner

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