INTERNATIONAL STANDARD

ISO 15029-2

First edition
2018-04

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

Part 2: Spray test — Stabilised flame heat release method

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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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources.*

This first edition of ISO 15029-2 cancels and replaces ISO/TS 15029-2:2012 which has been technically revised. Definitions and some procedural steps have been further clarified based on comments received from the market. This method has now largely superseded the older procedure in ISO 15029-1 in specifications and fluid development. Unlike ISO 15029-1, this document is a method that can rank fluids in terms of their spray flammability and as several test rigs are available, is capable of the generation of some precision data.

A list of all parts in the ISO 15029 series can be found on the ISO website.

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

Part 2: **Spray test — Stabilised flame heat release method**

WARNING — Use of this document can involve hazardous materials, operations and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of users of this standard to ensure appropriate measures to safeguard the health and safety of personnel prior to application of the standard, and to determine the applicability of any other restrictions.

1 Scope

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 3170, *Petroleum liquids — Manual sampling*

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

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

IEC 60584-1, *Thermocouples — Part 1: EMF specifications and tolerances*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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

3.3
flame length index
function of the flame length and propane flow rate corrected to the nearest integer

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

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

Note 1 to entry: See ISO 5659-2:2017, 3.8.

4 Principle

A pre-conditioned flow 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. As a result of heat input at a steady rate from the gas flame, a stabilised spray flame (3.1) is produced so that combustion properties, such as the rate of energy release, flame length, (3.2) and smoke production (3.5) 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 can be 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. A system for ranking the performance of fire-resistant fluids based upon these measurements and computed performance indices is proposed.

5 Reagents and materials

5.1 **Propane**, high purity (minimum 98 %) grade, 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 3696:1987.

5.5 **Mono ethylene glycol**, laboratory grade (98 % purity).

5.6 A solvent compatible with the tested fluid, laboratory grade.

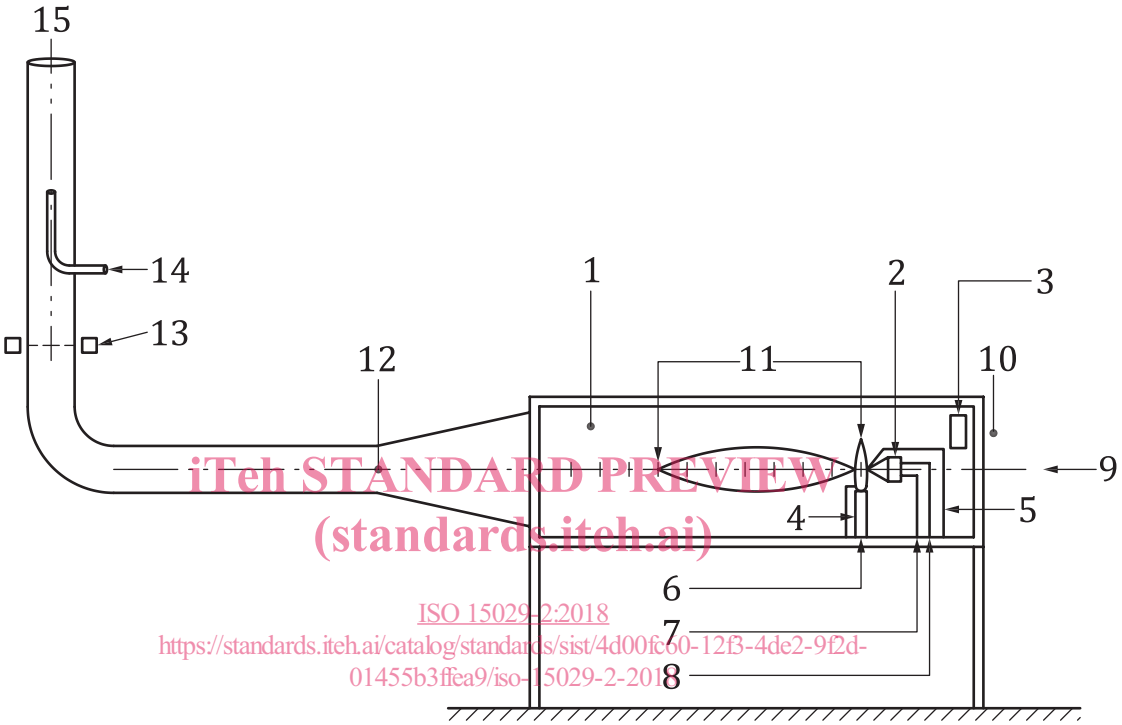
6 Apparatus

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.

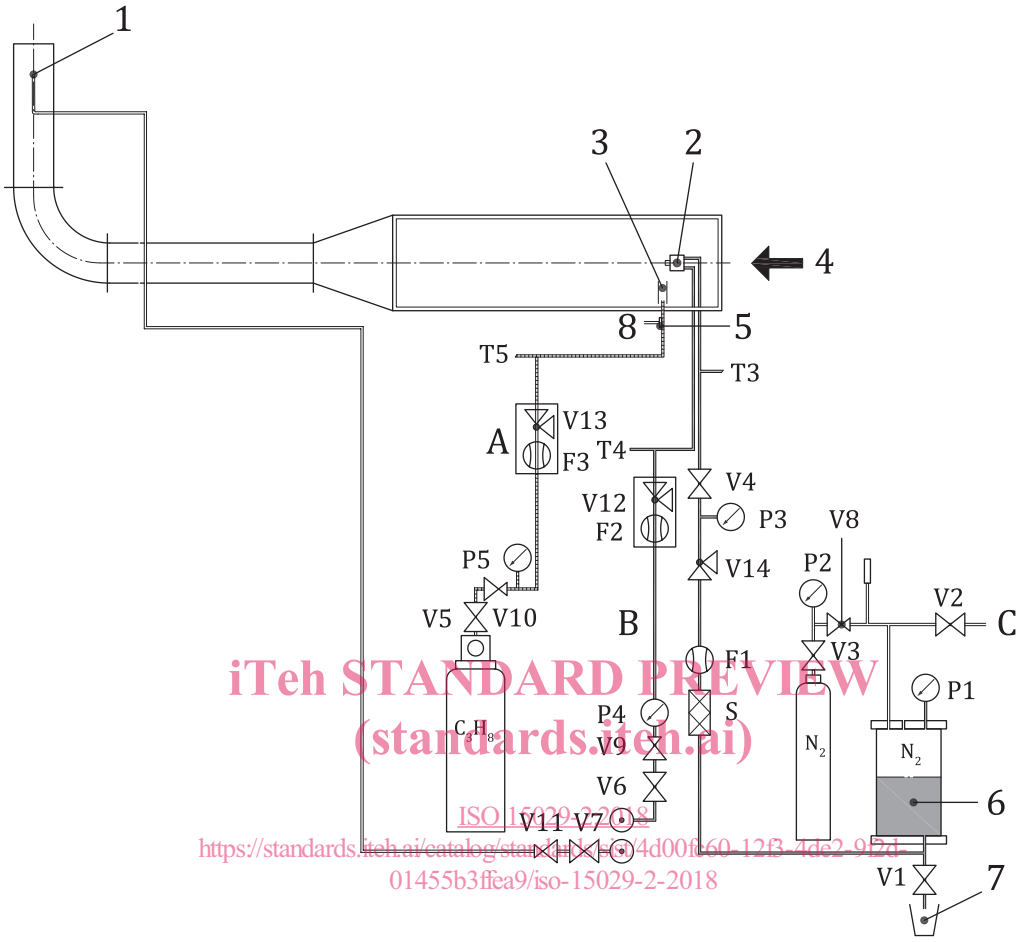


Key

1	combustion chamber	9	air flow
2	atomiser	10	air entry thermocouple (T_{A1}, T_{A2})
3	anemometer	11	flame length measurement
4	burner	12	exhaust gas thermocouple (T_P, T_{EX})
5	cowling	13	smoke opacimeter
6	propane input	14	air injection to jet pump
7	atomising air input	15	exhaust
8	fluid input		

Figure 1 — General view of installation

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. In this Figure A, B and C respectively refer to the propane, air and fluid delivery streams.



Key

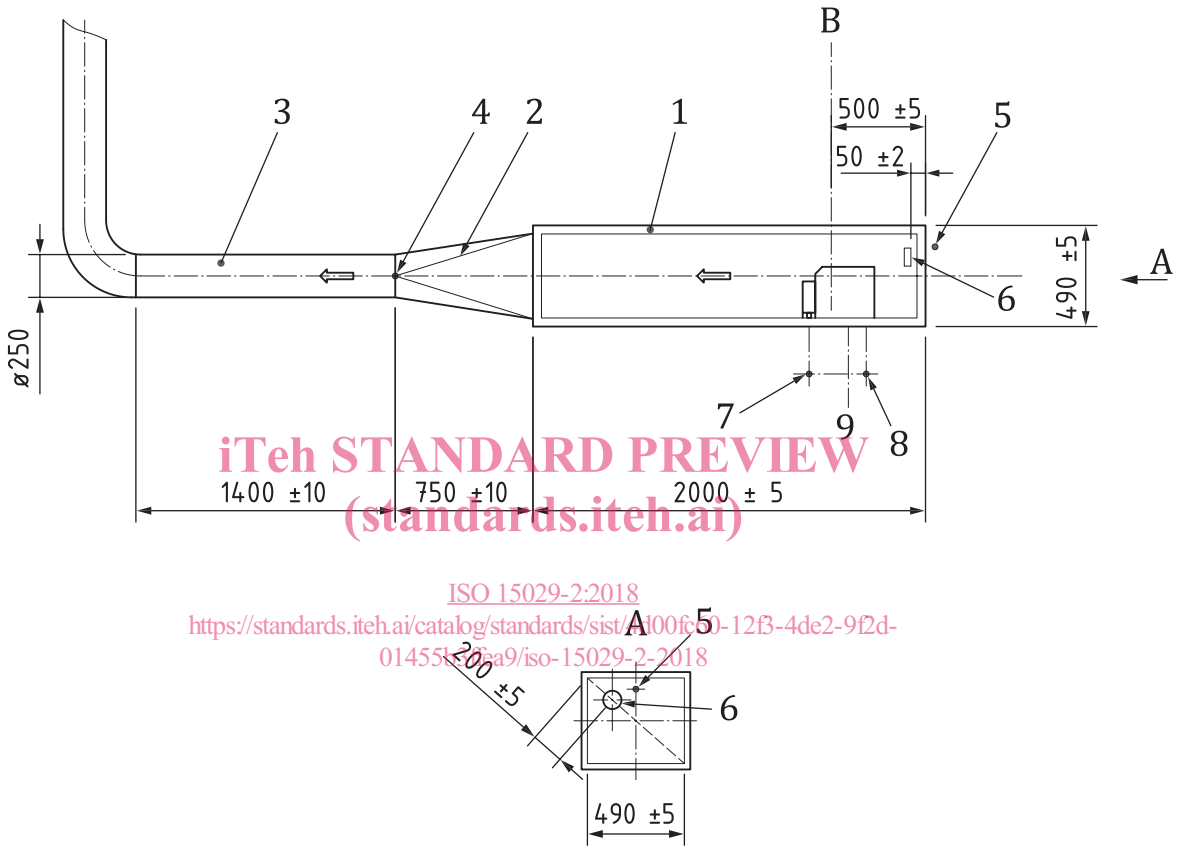
1	jet pump	P1	pressure gauge 0 MPa to 2,5 MPa
2	atomiser	P2	pressure gauge 0 MPa to 27,6 MPa
3	pilot burner	P3	pressure gauge 0 MPa to 2,5 MPa
4	induced air input 1,3 m/s to 1,5 m/s	P4	pressure gauge 0 MPa to 0,6 MPa
5	mixing chamber	P5	pressure gauge 0 MPa to 0,2 MPa
6	test fluid 13 °C to 25 °C	F1	liquid flow meter 90 ml/min ± 0,5 ml/min
7	drain	F2	variable area flow meter or equivalent 0,4 Nm^3/h to 3,0 Nm^3/h
8	air in	F3	variable area flow meter or equivalent 0,1 Nm^3/h to 0,5 Nm^3/h
T3	fluid thermocouple	V1–7	shut-off valves
T4	atomising air thermocouple	V8-V11	pressure regulators
T5	propane gas thermocouple	V12-V14	flow control valves
S	fluid filter		

Figure 2 — Schematic diagram of suggested test rig layout

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 × (490 ± 5) mm × (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 × (525 ± 10) mm providing an open area of the window of (1 880 ± 10) mm × (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).

Dimensions in millimetres



Key

1	combustion chamber	6	anemometer
2	contraction	7	propane gas thermocouple
3	flue pipe	8	atomising air thermocouple
4	exhaust gas thermocouple	9	fluid inlet pipe
5	ambient air thermocouple	B	end of fluid delivery nozzle

Figure 3 — Combustion chamber and exhaust system

6.1.3 Extraction system

The combustion chamber exit (Figure 3) 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, connected to a horizontal section of flue pipe 1 400 mm ± 10 mm in length that in turn may be connected to further exhaust ducting or a 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 open end of the combustion chamber inlet, and 200 mm ± 5 mm along the entry plane diagonal from one upper corner of the test chamber (Figure 3). 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

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 pressurised 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.

6.1.4.2 Test fluid delivery

The fluid volume flow rate can be measured with a suitable flowmeter and controlled to 90 ml/min ± 0,5 ml/min by means of a needle valve or other equivalent device. 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[1)] 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. A standard oil filter can be incorporated in the line.

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 with a variable area flowmeter or other equivalent device having a 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.

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. It incorporates a nozzle, 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 5). 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.

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.

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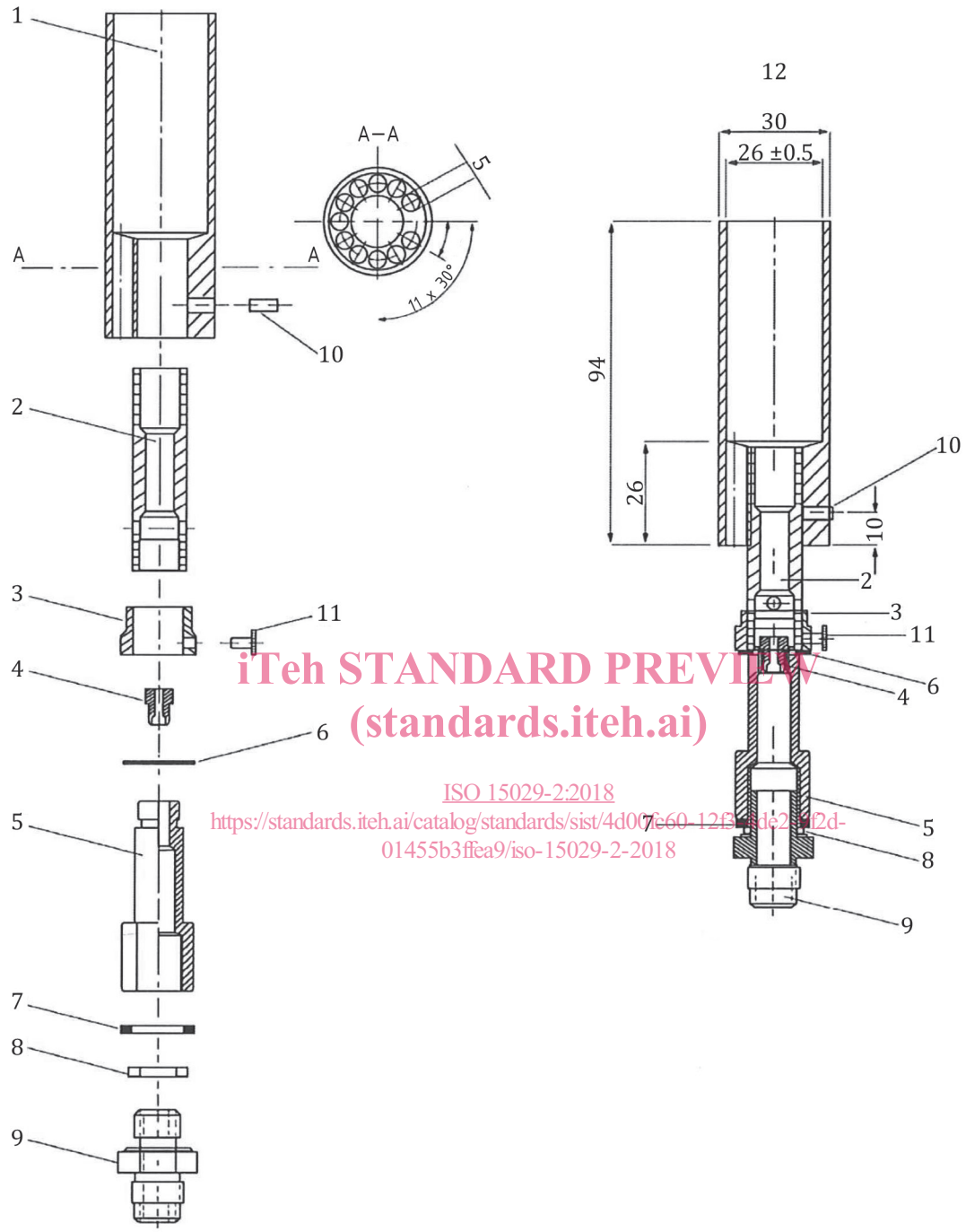
1) Body type B1/4JB-BSS with SU12-22 manufactured by Spraying Systems Company (http://www.spray.com) is an example of a suitable product available commercially. This information is for the convenience of users of this part of ISO 15029 and does not constitute an endorsement by ISO of this product.

6.1.5.2 System verification

Upon 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. This should be done at least annually or if it is suspected that the burner characteristics 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. The flame characteristics can be adjusted by positioning of the regulation collar in relation to the burner air inlet port (Figure 4).

Dimensions in millimetres



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	12	completed assembly

Figure 4 — Propane burner