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

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

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

*Partie 1: Persistance de flamme d'un jet pulvérisé — Méthode du gicleur  
à cône creux*



## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 ISO 15029-1 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

ISO 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*
- Part 3: *Spray test — Large scale method*

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. One type of such a liquid is fire-resistant fluid. The following International Standards are suitable for the classification, specification and guidance for use of such fluids:

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

ISO 7745:1989, *Hydraulic fluid power — Fire-resistant (FR) fluids — Guidelines for use*.

ISO 12922:1999, *Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for categories HFAE, HFAS, HFB, HFC, HFDR and HFDU*.

The following International Standard may be useful for the assessment of the flame propagation and persistence of a flame applied to the edge of a wick of non-flammable material immersed in fire-resistant fluid:

ISO 14935:1998, *Petroleum and related products — Determination of wick flame persistence of fire-resistant fluids*.

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International Organization for Standardization  
Case postale 56 • CH-1211 Genève 20 • Switzerland  
Internet iso@iso.ch

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

## Part 1:

### Spray flame persistence — Hollow-cone nozzle 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 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 hollow-cone nozzle method for the assessment of the persistence of a flame applied to various points within a pressurized spray of fire-resistant fluid.

This part of ISO 15029 is one of two basic measures of fire-resistance, and may be called up in regulations governing their use under the 7th edition of the Luxembourg Report<sup>1)</sup>.

## 2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 15029. For a dated reference, subsequent amendments to, or revisions of, the publication do not apply. However, parties to agreements based on this part of ISO 15029 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For an undated reference, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3170:1988, *Petroleum liquids — Manual sampling*.

## 3 Term and definition

For the purposes of this part of ISO 15029, the following term and definition applies.

### 3.1

#### flame persistence

maximum time, to the nearest 0,1 s, between removal of the igniting flame and extinction of combustion of the spray, at different positions along the length of a pressurized spray of fluid under the conditions specified in this part of ISO 15029

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<sup>1)</sup> Safety and Health Commission for the Mining and other Extractive Industries, Doc. No. 4746/10/91 EN (for English version, FR for French version), April 1994, *Requirements and tests applicable to fire-resistant hydraulic fluids used for power transmissions and control (hydrostatic and hydrokinetic)*, available from the Commission of the European Communities, Directorate-General V, Unit V.F.4 "Extractive, Iron and Steel Industries", Bâtiment Jean Monnet, C4/65, L-2920 Luxembourg.

## 4 Principle

A sample of fluid is pressurized and heated to a specified pressure and temperature, and then atomized through a defined nozzle. The spray produced is ignited with an oxyacetylene test flame of specified energy in succession at various points along the whole length of the spray pattern. After ignition, the test flame is withdrawn, and the time that the flame continues to burn is measured. The test result is the maximum unsupported burning time.

## 5 Reagents and materials

**5.1 Nitrogen**, of commercial quality, oxygen free. The delivery pressure shall be 7 MPa  $\pm$  0,3 MPa.

**5.2 Oxygen**, of commercial quality. The delivery pressure shall be 20 kPa or 30 kPa, depending on the blowpipe design used (see 6.6).

**5.3 Acetylene**, of commercial quality. The delivery pressure shall be 20 kPa or 30 kPa, depending on the blowpipe design used (see 6.6).

## 6 Apparatus

The general arrangement of the spray-generating apparatus is illustrated in Figure 1.

**6.1 Pressure-control system**, for the nitrogen, consisting of a high-pressure gauge of up to 31,5 MPa, a pressure-reducing valve, and a low-pressure gauge capable of reading up to 10 MPa.

**6.2 Pressure vessel**, of approximately 1,5 litre capacity, capable of withstanding a hydraulic pressure of at least 15 MPa. It shall be fitted with a valve at the top for filling and pressurization, a variable-pressure relief/control valve on the upper curved surface, and a drain/shut-off valve connected to a bottom exit taken through the wall of the heating device (6.3).

**6.3 Heating device**, fitted with an electric heater of 1 200 W to 1 800 W capacity. It shall be insulated so that no part of the surface exceeds a temperature of 40 °C. A heater of minimum 2 litre capacity filled with water, or other suitable heating devices, can be used.

**6.4 Temperature sensors**, consisting of thermometers or thermocouples capable of reading the temperature of the test fluid to  $\pm$  0,2 °C. Measuring devices shall be located in the fluid under test.

NOTE T-Type Cu-CuNi thermocouples conforming to IEC 60879:1986, *Performance and construction of electric circulating fans and regulators* (this replaced IEC 385:1972) are suitable.

**6.5 Spray nozzle**, of 80° hollow-cone type, rated at 9,5 l/h at 700 kPa pressure.

NOTE Type F 80° 2,5 PL, manufactured by Monarch<sup>2)</sup> have been found to be suitable.

**6.6 Blowpipe**, with a supply system for oxygen and acetylene.

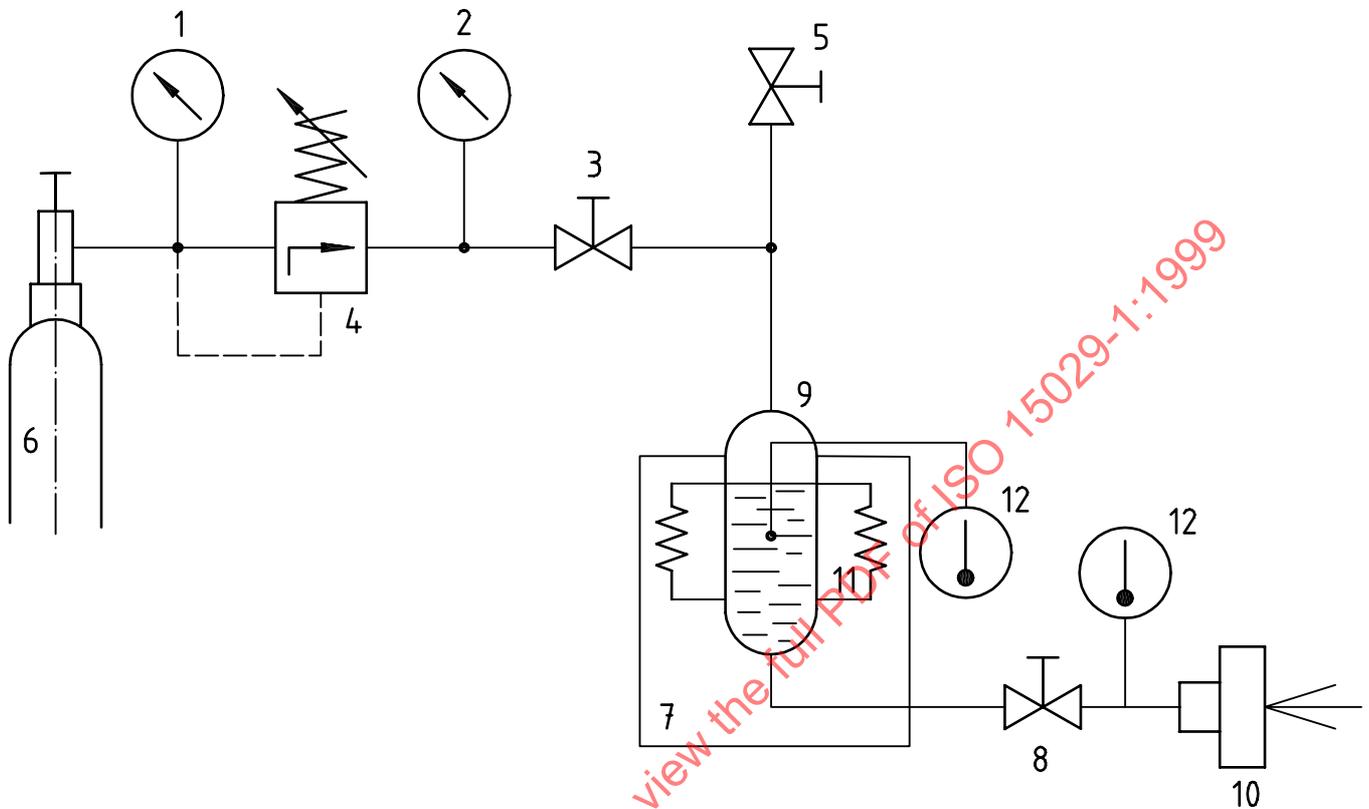
NOTE A high-pressure model DH with a No. 10 nozzle, for both gases at 20 kPa, or a "Saffire" lightweight model with a No. 10 nozzle for both gases at 30 kPa pressure<sup>3)</sup>, are suitable.

**6.7 Timing device**, electronic or manual, reading to  $\pm$  0,1 s with an accuracy of 0,1 % over 10 min.

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<sup>2)</sup> Supplied by PP Controls Ltd., Cross Lances Rd, Hounslow, Middlesex, UK. 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.

<sup>3)</sup> Supplied by British Oxygen Ltd. 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.

**Key**

- 1 Pressure gauge: 31,5 MPa
- 2 Pressure gauge: 10,0 MPa
- 3 Shut-off valve
- 4 Variable-pressure relief/control valve
- 5 Filling valve
- 6 Cylinder of compressed nitrogen
- 7 Heating device
- 8 Drain and shut-off valve
- 9 Pressure vessel
- 10 Spray nozzle
- 11 Electric heater: 1 200 W to 1 800 W
- 12 Fluid-temperature measuring points in the pressure vessel and before the spray nozzle

**Figure 1 — General arrangement of spray-generating apparatus**

**6.8 Beaker**, of borosilicate glass, of 1,5 litre capacity.

**6.9 Hotplate**, capable of heating the beaker (6.8) filled with fluid at a rate of 3 °C/min to the specified test temperature.

## 7 Samples and sampling

**7.1** Unless otherwise specified, samples shall be taken in accordance with the procedures specified in ISO 3170 or an equivalent National Standard.

**7.2** Laboratory samples shall be examined for homogeneity and clarity before taking the test portion. Sediment and/or free water shall be removed by filtration or decantation, and the presence shall be noted on the test report.

**7.3** Samples shall be stored at a temperature of between 0 °C and 30 °C before use.

## 8 Procedure

**8.1** If analysing a different sample to the one that was previously tested using the spray-generating apparatus, rinse the pressure vessel (6.2) and the various parts of the spray nozzle (6.5) several times with a suitable solvent or with boiling water to which a cleansing agent has been added. Remove any remaining solvent. Then carefully flush the dry test apparatus with the fluid under test.

**8.2** Place 1 100 ml of test fluid in the beaker (6.8), and place the beaker on the hotplate (6.9). Heat the fluid at 3 °C/min  $\pm$  0,5 °C/min until the test temperature is reached (see 6.4). For water-based fluids, or emulsions containing water, the test temperature shall be 65 °C  $\pm$  5 °C; for other fluids, the test temperature shall be 85 °C  $\pm$  5 °C. Note any changes to the appearance of the fluid during this heating period.

**8.3** Place the pressure vessel (6.2) in the heating device (6.3) and make a connection from the bottom exit to the drain and shut-off valve.

**8.4** Transfer the heated test fluid to the pressure vessel through the filling valve (see 6.2), and establish the test temperature. If necessary, raise the temperature to the test temperature with the filling valve open.

**8.5** Close both shut-off valves and the filling valve, switch on the nitrogen supply (5.1) and adjust the test pressure to 7 MPa  $\pm$  0,3 MPa on the variable-pressure relief/control valve (see 6.2).

**8.6** When the test conditions are established, open both shut-off valves and start the spray. The test shall be carried out at an air flow rate of 0,2 m/s to 0,3 m/s in the same direction as the atomized jet. When the spray pattern has stabilized, apply the igniting flame to a point of consistent pattern furthest from the spray source.

**8.7** When burning of the spray is established, remove the igniting flame and simultaneously start the timing device (6.7). Measure the time between removal of the igniting flame and extinction of combustion of the spray.

**8.8** Repeat 8.6 and 8.7 at not less than five different positions along the complete spray length, working towards the spray source. Record the times.

## 9 Expression of results

Report the highest time recorded in 8.7, to the nearest 0,1 s, as the spray flame persistence.

Report the presence of sediment and/or free water in the sample, if observed in 7.2.

Report any change in condition of the fluid during the heating period (8.2).