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# International Standard



# 3014

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## Aviation turbine fuels — Determination of smoke point

*Carburants aviation pour moteurs à réaction — Détermination du point de fumée*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

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.

International Standard ISO 3014 was developed by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

This second edition was submitted directly to the ISO Council, in accordance with clause 5.10.1 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the first edition (i.e. ISO 3014-1974), which had been approved by the member bodies of the following countries :

Australia	India	South Africa, Rep. of
Belgium	Iran	Spain
Brazil	Israel	Sweden
Bulgaria	Mexico	Thailand
Canada	Netherlands	Turkey
Chile	New Zealand	United Kingdom
Czechoslovakia	Norway	USA
France	Poland	USSR
Germany, F. R.	Portugal	
Hungary	Romania	

No member body expressed disapproval of the document.

# Aviation turbine fuels — Determination of smoke point

## 1 Scope and field of application

This International Standard specifies a method for the determination of smoke point of aviation turbine fuels.

## 2 Definition

**smoke point** : The maximum height, in millimetres, of flame that can be obtained without smoking when a petroleum distillate is burned in a standardized lamp under standardized conditions.

## 3 Principle

Burning a sample in an enclosed lamp provided with a scale. Estimation of the maximum flame height of a carefully defined flame that can be achieved without smoking.

## 4 Reference fuel blends

The materials used to make the reference fuel blends shall be the knock test reference fuels : reference fuel grade toluene grade 1 according to ISO 5272 and knock-test grade *iso*-octane, for which details of the essential requirements are

given in the annex. The composition and smoke points of these blends are given in table 1.

Table 1 — Reference fuel blends

Toluene % (V/V)	<i>iso</i> -octane % (V/V)	Standard smoke point, at 1,013 bar mm
40	60	14,7
25	75	20,2
15	85	25,8
10	90	30,2
5	95	35,4
0	100	42,8

The blends shall be made very accurately. The use of either calibrated pipettes or burettes is recommended. Calibrated flasks shall not be used.

## 5 Apparatus

**5.1 Smoke point lamp**, as shown in figure 1, complying with the dimensional requirements given in tables 2 and 3 and as shown in figures 2 and 3.

The use of a sighting device is convenient for eliminating parallax but is not essential. A sight-gauge or other suitable flame measuring device, accurate to 0,5 mm, is satisfactory. A medium density cobalt glass may be used to reduce eye fatigue when viewing the flame. The following essential requirements shall be met :

- 1) The top of the wick guide shall be exactly level with the zero mark on the scale.
- 2) The scale shall be marked in white lines on black glass on each side of a white or black strip, 2 mm in width. It shall have a range of 50 mm graduated in 1 mm intervals, figured at each 10 mm and with longer lines at each 5 mm.
- 3) An efficient device for raising or lowering the flame shall be provided. The total distance of travel shall be not less than 10 mm and the movement shall be smooth and regular.
- 4) The glass window of the door shall be curved to prevent the formation of multiple images.
- 5) The joint between the base of the candle and the candle body shall be oil-tight.

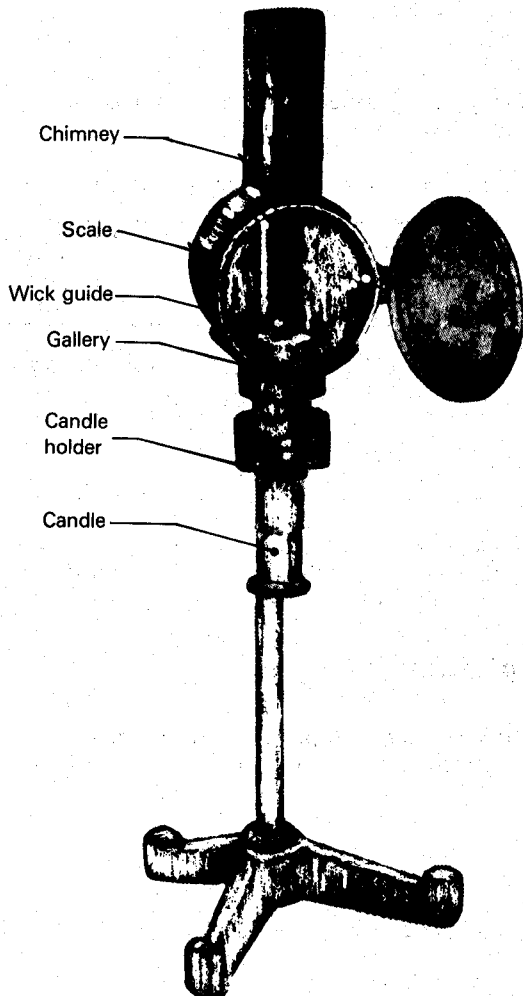


Figure 1 – Smoke point lamp

Dimensions in millimetres

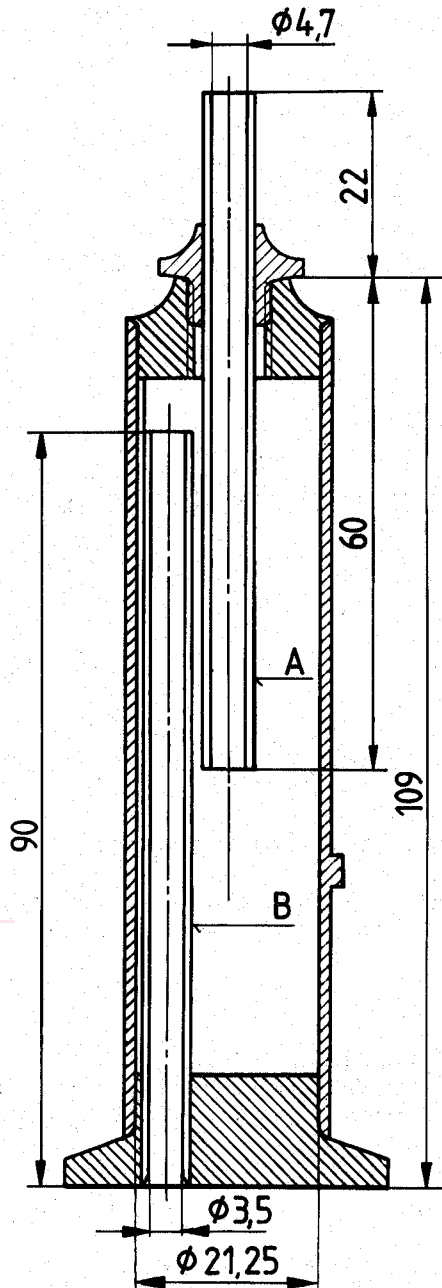


Figure 2 – Candle

Table 2 – Critical dimensions of candle for smoke point lamp (figure 2)

Dimensions in millimetres

<b>Candle body</b>	
internal diameter	21,25 ± 0,05
external diameter	sliding fit in candle holder
length, without cap	109,0 ± 0,05
thread on cap	φ 9,5, screwed 1,0 pitch
<b>Wick tube (A)</b>	
internal diameter	4,7 ± 0,05
external diameter	close fit in wick guide
length	82,0 ± 0,05
<b>Air vent (B)</b>	
internal diameter	3,5 ± 0,05
length	90,0 ± 0,05

Dimensions in millimetres

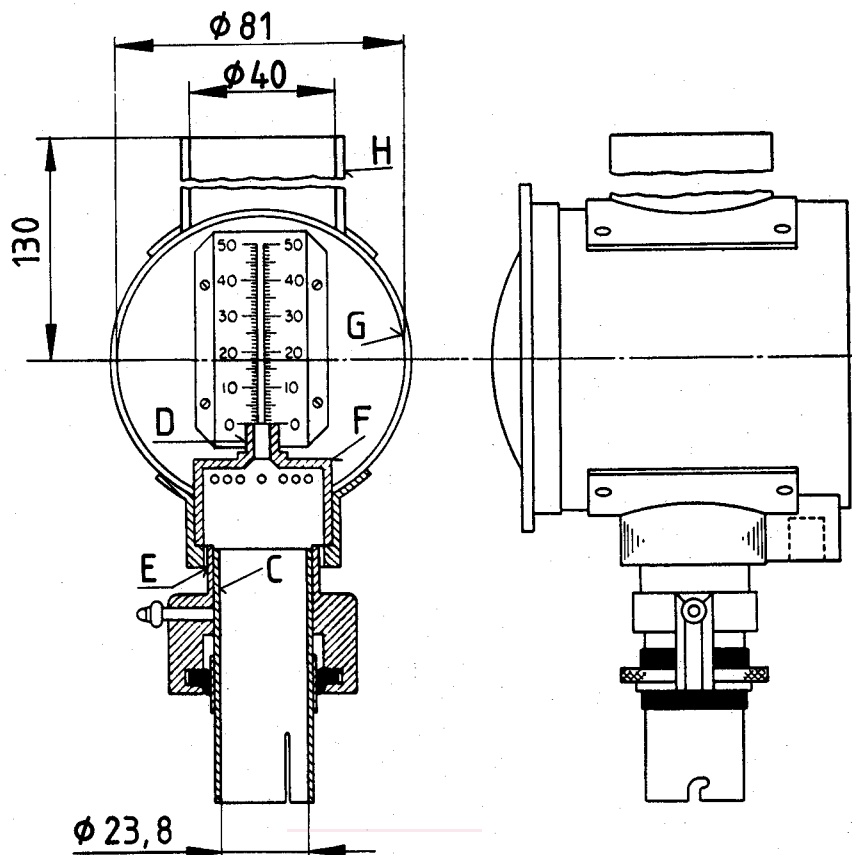


Figure 3 — Lamp body

Table 3 — Critical dimensions of body for smoke point lamp (figure 3)

Dimensions in millimetres

<b>Candle holder (C)</b> internal diameter	23,8 ± 0,05
<b>Wick guide (D)</b> internal diameter	6,0 ± 0,02
<b>Air inlets (E)</b> 20 in number, diameter	2,9 ± 0,05
<b>Gallery (F)</b> external diameter	35,0 ± 0,05
air inlets (20), diameter	3,5 ± 0,05
<b>Lamp body (G)</b> internal diameter	81,0 ± 1,0
internal depth	81,0 ± 1,0
<b>Chimney (H)</b> internal diameter	40,0 ± 1,0
height, from top to centre of lamp body	130,0 ± 1,0

**5.2 Wick**, woven solid circular cotton of ordinary quality, having the following characteristics :

- casing : 17 ends, 66 tex X 3
- filling : 9 ends, 100 tex X 4
- weft : 40 tex X 2
- picks : 6 per centimetre

Other wicks which give similar results are acceptable.

## 6 Preparation of apparatus

**6.1** Place the lamp in a vertical position in a room where it can be completely protected from draughts. Carefully inspect each new lamp to ensure that the air holes in the gallery and the air inlets to the candle socket are all clean, unrestricted, and of proper size. The gallery should be so located that the air holes are completely unobstructed. Slight variations in these items all have a marked effect on the precision of the result obtained.

NOTE — If the room is not completely draught-free, place the lamp in a vertical position in a wooden or hard asbestos sheet box open at the front. The top of the box should be at least 150 mm above the top of the chimney and the inside of the box should be painted dull black.

**6.2** Extract all wicks, either new or from a previous determination, for at least 25 cycles in an extractor using a mixture of equal volumes of toluene and anhydrous methyl alcohol. Allow the wicks to dry partially in a hood before placing in the oven, or use a forced draught and explosion-proof oven for drying wicks, or both. Dry for 30 min at 100 to 110 °C and store in a desiccator until used.

NOTE — Other mixtures of solvents can be used to extract wicks if equivalent results are obtained.

## 7 Sample

Use the sample as received. Allow all samples to come to ambient temperature (without artificial heating). If the sample is hazy or appears to contain foreign material, filter through qualitative filter paper.

## 8 Calibration of apparatus

**8.1** Calibrate the apparatus by testing two of the reference fuel blends specified in clause 4, using the procedure specified in clause 9, and, if possible, bracketing the smoke point of the sample. If this is not possible, use two blends having smoke points nearest to the smoke point of the sample.

Determine the correction factor for the apparatus from the formula

$$\frac{(A_s/A_d) + (B_s/B_d)}{2}$$

where

$A_s$  is the standard smoke point of the first reference fuel blend;

$A_d$  is the determined smoke point of the first reference fuel blend;

$B_s$  is the standard smoke point of the second reference fuel blend;

$B_d$  is the determined smoke point of the second reference fuel blend.

If the determined smoke point of the test fuel exactly matches the determined smoke point of a reference fuel blend, use as the second bracketing reference fuel the reference fuel blend with the next higher smoke point if there is one; otherwise, use the one with the next closest smoke point.

**8.2** The required reference fuel blends shall be tested each day by each operator. A test on a given reference fuel blend need not be repeated on any given day unless a change in the apparatus or operator is made, or a change of more than 0,007 bar occurs in the barometric pressure reading.

## 9 Procedure

**9.1** Soak a piece of extracted and dried wick, not less than 125 mm long, in the sample and place it in the wick tube of the candle. Carefully ease out any twists arising from this operation. It is advisable to resoak the burning-end of the wick in the sample after the wick is inserted in the wick tube.

NOTE — In cases of dispute, or for referee tests, always use a new wick, prepared in the manner prescribed in 6.2.

**9.2** Introduce 20 ml of the prepared sample, at room temperature, into the clean, dry candle.

NOTE — If less than 20 ml of the sample is available, as little as 10 ml may be used.

**9.3** Place the wick tube in the candle and screw home. Take care that the candle air vent is free from fuel. Cut the wick horizontally and trim it free of frayed ends so that 6 mm projects from the end of the candle. Use a new and clean razor blade or other sharp instrument. Insert the candle into the lamp.

NOTE — Some razor blades have a protective coating which should be removed with a solvent.

**9.4** Light the candle and adjust the wick so that the flame is about 10 mm high and allow the lamp to burn for 5 min. Raise the candle until a smoky tail appears, then lower the candle slowly through the following stages of flame appearances :

- a) a long tip, smoke slightly visible, erratic and jumpy flame;
- b) an elongated pointed tip with the sides of the tip appearing concave upward as shown in figure 4, A;

c) the pointed tip just disappears leaving a very slightly blunted flame as in figure 4, B. Jagged, erratic, luminous flames are sometimes observed near the true flame tip. These shall be disregarded;

d) a well-rounded tip as shown in figure 4, C.

Estimate the height of flame B (see figure 4) to the nearest 0,5 mm. Record the smoke point as observed.

To eliminate errors due to parallax (see the note), the eye of the observer shall be slightly to one side of the centre line, so that a reflected image of the flame is seen on the scale on one side of the central vertical white line, and the flame itself is seen against the other side of the scale. The reading for both observations shall be identical.

NOTE — A sighting device may also be used to eliminate parallax and to facilitate reading the flame height.

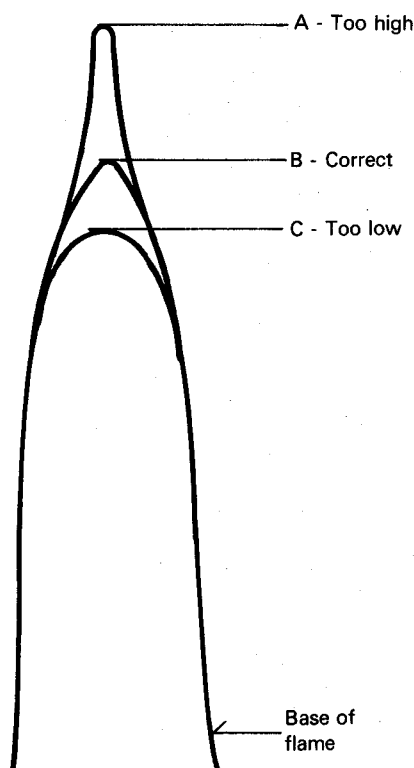


Figure 4 — Typical flame appearances

9.5 Make three separate observations of the smoke point by repeating the flame appearance sequence specified in 9.4. If these values vary over a range greater than 1,0 mm, repeat the test with a fresh sample and another wick.

9.6 Remove the candle from the lamp, rinse with a volatile naphtha, and purge with air to make ready for re-use.

## 10 Expression of results

### 10.1 Calculation

The smoke point, in millimetres, is given by the formula

$$L \times f$$

where

$L$  is the average flame height in three individual observations, in millimetres;

$f$  is the correction factor determined in clause 8.

Report as the smoke point the value thus obtained rounded to the nearest 0,1 mm.

### 10.2 Precision<sup>1)</sup>

The precision of the method, as obtained by statistical examination of inter-laboratory test results, is as follows.

#### 10.2.1 Repeatability

The difference between successive test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, differ by no more than 2 mm only in one case in 20.

#### 10.2.2 Reproducibility

The difference between two single and independent results, obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method, differ by more than 3 mm only in one case in 20.

## 11 Test report

The test report shall contain at least the following information :

- the type and identification of product tested;
- a reference to this International Standard;
- the result of the test (see 10.1);
- any deviation, by agreement or otherwise, from the procedure specified;
- the date of the test.

1) Precision values were determined by a joint ASTM/IP programme in 1972; six ASTM *iso*-octane/toluene reference fuel blends and ten Jet A and Jet B fuels were tested covering a range of smoke points from 15 to 45.