

British Standard Methods of test for

Petroleum and its products

Part 0. General introduction

Addendum 1. Standard reagents and thermometers

(Identical with appendix A of 'IP Standards : Part 1')

Méthodes d'essai du pétrole et des produits pétroliers

Partie 0. Introduction générale

Additif 1. Réactifs et thermomètres normalisés

Verfahren zur Prüfung von Erdöl und Erdölprodukten

Teil 0. Allgemeine Einführung

Ergänzung 1. Standardreagenzien und -thermometer

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Foreword

BS 2000 comprises a series of test methods for petroleum and its products that have been published previously by the Institute of Petroleum (IP) and have been accorded the status of British Standards. Part 0 is a general introduction which gives details of the BSI/IP agreement for publication of the series, lists more than 60 methods scheduled to be published in this way in 1982 and 1983, and provides general information on safety precautions, sampling and other matters.

Many of the IP methods make reference to appendix A of the 'IP Standards for petroleum and its products, Part 1, Methods for analysis and testing' in which details are given of standard reagents and thermometers required for the tests, with notes on care and use of liquid-in-glass thermometers. The purpose of this Addendum is to give British Standard status to this material.

NOTE 1. In the tabulated thermometer specifications 'emergent stem' should be replaced by 'emergent column' in line with the usage in 2.12.

NOTE 2. Table 1 is not part of the IP text but has been included for the convenience of readers.

NOTE 3. The titles of the publications referred to in this Part of this British Standard are listed on the inside back cover.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Table 1. Reference numbers and names of standard thermometers

IP reference	Name	Numbers of Parts of BS 2000 requiring the use of the thermometer	IP reference	Name	Numbers of Parts of BS 2000 requiring the use of the thermometer
1C 1F	Cloud and pour	15, 219	45C	Refractometer	
2C 2F	Low cloud and pour	15, 219	46C 46F	Westphal balance	
3C 3F	Demulsification	19	47C	Loss on heating	45
4C	Crude oil distillation	143	48C	Tank low	
5C	Distillation, low	123, 191	49C	Tank medium	
6C	Distillation, high	13, 27, 123	50C	Tank high	
8C	Flushing case, low	72	51C	Tank heated fuel	
9C	Flushing case, medium		52C	Tank bitumen	
14C	Aviation fuel, freezing point		53C	Tank cargo	
15C 15F	Low Pensky-Martens	34, 35, 280 (15C)	54C-58C	Angle stem	
16C 16F	High Pensky-Martens	34, 35	59C	High aniline point	2
17C 17F	Wax melting point		60C	Softening point, low	58
18C 18F	Congealing point	76	61C	Softening point, high	58
20C	Low aniline point	2	62C 62F	Partial immersion	132, 195
21C	Medium aniline point	2, 135	63C	Petrolatum melting point	133
22C	Oxidation	48	64C	Density, wide range	146, 154, 230, 313
23C 23F	Reid vapour pressure	69 (23C)	64F	Relative density, wide range	146, 154
24C 24F	Oxidation stability	139, 142	65C 65F	Kin visc low	71
	Abel water bath, C and F	33	66C 66F	Kin visc 50 °C (122 °F)	71
	Abel oil cup, C and F	33	67C 67F	Kin visc -17.8 °C (0 °F)	71
28C 28F	Cleveland open		68C 68F	Kin visc -40 °C (-40 °F)	71
29C 29F	Kin visc 20 °C (68 °F)	71	69C 69F	Kin visc -53.9 °C (-65 °F)	71
30C 30F	Kin visc 25 °C (77 °F)	71	71C 71F	Kin visc -26.1 °C (-15 °F)	
31C 31F	Kin visc 37.8 °C (100 °F)	71	72C 72F	Oil in wax	
32C 32F	Kin visc 98.9 °C (210 °F)	71	73C 73F	Partial immersion	
33C 33F	Kin visc 0 °C (32 °F)	71	74C 74F	Abel oil cup, wide range	170
34C 34F	Kin visc 54.4 °C (130 °F)	71	75C 75F	Abel water bath, wide range	170
35C 35F	Kin visc 60 °C (140 °F)	71	76C	Engler viscosity	
36C 36F	Kin visc 93.3 °C (200 °F)	71	77C-88C	Solvents distillation	195, 230 (77C) 280 (81C)
37C	Sludge		89C 89F	Softening point (bitumen) wide range	
38C	Pen	49, 357	90C	Kin visc 82.2 °C (180 °F)	71
39C	Density		91C	Rapid flash	
39F	Relative Density		92C	Kin visc 40 °C	71
40C	Drop point, low		93C	Kin visc 135 °C	71
41C	Drop point, high		94C-97C	Brookfield viscosity	
42C	Breaking point		98C	Rapid flash (high)	
43C 43F	FP cutback (int)	113	99C	Kin visc -20 °C	71
44C 44F	FP cutback (ext)	113	100C	Kin visc 80 °C	71
			101C	Medium Pensky Martens	

NOTE. In a few cases, the method listed refers to the Celsius thermometer but makes no reference to the corresponding Fahrenheit thermometer.

APPENDIX A

SPECIFICATIONS

NORMAL HEPTANE¹

Property	Value	Method
Density at 20°C, g/ml	0.68380 ± 0.00015	ASTM D1217
Refractive index at 20°C	1.38770 ± 0.00015	ASTM D1218
Freezing point, °C	−90.710 min	ASTM D1015
Distillation:		
50% recovered, °C	98.427 ± 0.025	²
Differential 80% recovered minus 20% recovered, °C	0.020 max	²

NOTE to reagent specifications.
Corresponding BS methods are listed below.

ISO-OCTANE¹

Property	Value	Method
Density at 20°C, g/ml	0.69193 ± 0.00015	ASTM D1217
Refractive index at 20°C	1.39145 ± 0.00015	ASTM D1218
Freezing point, °C	−107.442 min	ASTM D1015
Distillation:		
50% recovered, °C	99.238 ± 0.025	²
Differential 80% recovered minus 20% recovered, °C	0.020 max	²

PETROLEUM SPIRIT – 40/60

Property	Value	Method
Relative density at 60/60°F (15.5/15.5°C)	0.640 to 0.660	IP 160, 189, or 190
Distillation range:		ASTM D86–IP 123
I.B.P.	35°C min	
90% min	Between 40° and 60°C	
F.B.P.	65°C max	
Existent gum	2 mg/100 ml max	ASTM D381–IP 131
Bromine number	1 max	IP 129
Doctor test	Negative	IP 30
Colour	Water white (1.0)	IP 17

BS 4714 = ISO 3675
BS 2000 : Part 123

BS 4348 = EN 5
BS 2000 : Part 129

PETROLEUM SPIRIT – 60/80

Property	Value	Method
Relative density 60/60°F (15.5/15.5°C)	0.680 to 0.690	IP 160, 189, or 190
Distillation range:		ASTM D86–IP 123
I.B.P.	55°C min	
90% min	Between 60° and 80°C	
F.B.P.	90°C max	
Existent gum	2 mg/100 ml max	ASTM D381–IP 131
Bromine number	1 max	IP 129
Doctor test	Negative	IP 30
Colour	Water white (1.0)	IP 17

BS 4714 = ISO 3675
BS 2000 : Part 123

BS 4348 = EN 5
BS 2000 : Part 129

¹ Barrel quantities of *n*-heptane and iso-octane, engine reference grade, are obtainable from Phillips Petroleum (UK) Ltd, Cory House, High Street, Bracknell, Berkshire. Smaller quantities of *n*-heptane suitable for IP oxidation tests can be obtained from B.D.H.

² For equipment and method see *Research Paper No. 2079, Journal of Research*, National Bureau of Standards, 1950, 44, 309–310.

PETROLEUM SPIRIT – 100/120

Property	Value	Method
Relative density 60/60°F (15.5/15.5°C)	0.735 to 0.755	IP 160, 189, or 190
Distillation range:		ASTM D86–IP 123
I.B.P.	95°C min	
90% min	Between 100° and 120°C	
F.B.P.	125°C max	
Existent gum	2 mg/100 ml max	ASTM D381–IP 131
Bromine number	1 max	IP 129
Doctor test	Negative	IP 30
Colour	Water white (1.0)	IP 17

NOTE to reagent specifications.
Corresponding BS methods are listed below.

BS 4714 = ISO 3675
BS 2000 : Part 123

BS 4348 = EN 5
BS 2000 : Part 129

BENZENE

Conforming to BS135 for Benzene (Nitration Grade).

BENZOLE

Conforming to BS135/3 for 90's Benzene.

TOLUENE

Conforming to BS805 for Toluene (Nitration Grade).

TOLUOLE

Conforming to BS805/4 for 90's Toluene.

ACETONE³

Property	Value	Method
Relative density 60/60°F (15.5/15.5°C)	0.796 to 0.798	IP 160, 189 or 190
Distillation range	95% between 55.5° and 56.5°C	ASTM D86–IP 123
Existent gum	5 mg/100 ml max	ASTM D384–IP 131
Acidity	0.02 mg KOH/g max	IP 1
Alkalinity	None	IP 95
Miscibility with water (15°C)	Complete	—
Miscibility with carbon disulphide (15°C)	Complete	—
Colour	Water white (1.0)	IP 17

NOTE re benzene and toluene. In the current (1977) edition of BS 135, 458, 805 only one grade of benzene is specified which is suitable for use where nitration grade was specified; BS 805/2 is equivalent to nitration grade toluene; the 90's grades previously specified are omitted owing to lack of demand.

BS 4714 = ISO 3675
BS 2000 : Part 123
BS 4348 = EN 5
BS 2000 : Part 1

SPECIFICATIONS – IP STANDARD THERMOMETERS**1. INTRODUCTION**

These specifications cover glass thermometers required in IP Standards and graduated in Celsius or Fahrenheit degrees. The thermometers shall conform to the following general requirements and to the detailed specifications listed.

Purchasers should not accept thermometers as complying with these specifications because they are marked with IP markings, as these inscriptions are identification marks and do not necessarily constitute a guarantee. Thermometers with other identification marks may be used provided they conform to all the other requirements of the specification.

Purchasers should satisfy themselves that the permissible scale errors, given in the table of special requirements, have not been exceeded.

It is essential that thermometers be marked with a material resistant to the action of hot petroleum products.

Specifications for both Celsius and Fahrenheit thermometers have been included for many of the tests. However, in accordance with the general policy of the Institute of Petroleum it is the intention that Fahrenheit thermometers will be withdrawn as soon as practicable.

The format of the specification details has been changed to conform with that agreed with ASTM in order to facilitate the harmonization of thermometers used in IP and ASTM methods. Thermometers numbered in the form ASTM *x*/IP *y* are those where the details have been agreed and are identical in the IP and ASTM handbooks. Such thermometers continue to be placed in the table according to their IP number. A list of these thermometers appears in Annex C together with thermometers that are comparable but still differ in certain details.

All temperature measurements should be traceable to the International Practical Temperature Scale of 1968 (see Annex A).

³ This specification conforms essentially to the requirements of BS 509:1957.

NOTE to footnote 1: BS 509:1957 has been superseded by BS 509:1971.

2. GENERAL REQUIREMENTS

2.1. *Type* – Mercury-in-glass, solid stem except where otherwise stated. Gas (not air) filled. Top finished plain except in the case of Kin Visc thermometers which shall have a ring or button and Tank thermometers (IP 48C to IP 53C inclusive) when used in conjunction with the armoured case shall be finished with a flattened button top.

2.2. *Stem* – The enamel back stems of thermometers for temperatures up to but not including 300°C shall be made of an approved normal thermometric glass and of borosilicate glass for temperatures of 300°C and above except tank thermometers and those listed below which may be made of lead glass. In the case of the Kin Visc thermometers the enamel back stem and the bulb shall be made of the same or similar types of approved thermometric glass.

IP 1C and F	IP 44C and F
IP 2C and F	IP 45C
IP 3C and F	IP 46C and F
IP 8C	IP 60C
IP 14C	IP 61C
IP 15C and F	IP 63C
IP 18C and F	IP 64C and F
IP 20C	IP 72C and F
IP 21C	IP 74C and F
Abel Oil Cup C and F	IP 75C and F
Abel Water bath C and F	IP 76C
IP 39C and F	IP 77C
IP 40C	IP 78C
IP 42C	IP 89C and F
IP 43C and F	IP101C

2.3. *Bulb* – of a suitable thermometric glass approved by the National Physical Laboratory. At present these glasses include those shown in the Table on page AP-A5*.

The glass of the bulb and stem shall preferably be identified by a coloured stripe or stripes. If this identification is not provided, the glass should be identified by an inscription on the thermometer.

2.4. *Expansion and Contraction Chamber* – The following shall be the minimum distances between scale lines and the bulb and between scale lines and enlargements in the bore:

A 13 mm length of unchanged capillary between the bulb and the lowest scale line, if this is not above 100°C (212°F); a 30 mm length if the scale line is above 100°C (212°F).

A 5 mm length of unchanged capillary between an enlargement and the scale line immediately below, except at the top of the thermometer.

A 10 mm length of unchanged capillary between an enlargement other than the bulb, and the scale line immediately above if this is not above 100°C (212°F); a 30 mm length if the scale line is above 100°C (212°F).

No contraction chamber shall be above the immersion line or within 10 mm of the immersion line; it shall be of the long narrow type and where no auxiliary scale is present must be so located that the mercury stands in the contraction chamber at 0°C (32°F).

A 10 mm length of unchanged capillary above the highest scale line, if there is an expansion chamber at the top of the thermometer; a 30 mm length if there is no expansion chamber. For the purposes of this requirement, 'an expansion chamber' is interpreted as an enlargement at the top end of the capillary bore which shall have a capacity equivalent to not less than 20 mm of unchanged capillary.

2.5. *Scale Marks and Figuring* – The scale lines shall be clearly etched, and of uniform thickness, not exceeding the width given in the table for each thermometer. The lines shall be at right angles to the axis of the thermometer. When the thermometer is viewed from the front and in a vertical position the lines shall all finish on a line parallel to the axis on the left-hand side. The graduation lines shall be so positioned that the enamel backing in the stem provides a background for the mercury column when it is seen just beyond the left- or right-hand end of the short lines.

*Page 6 in this British Standard.

Thermometric glasses approved by the National Physical Laboratory (1974)

Glass	Identification stripe(s) or approved abbreviation	Normal maximum working temperature
Normal glass, made by Whitefriars Glass Ltd.	Single blue stripe	350°C
Normal glass, Dial, made by Plowden and Thompson Ltd.	Double blue stripe	350°C
Normal glass, Schott-N16, made by Jenaer Glaswerk Schott and Genossen, Mainz.	Single red stripe	350°C
Normal glass, 7560, made by Corning Glass Co.	CN	350°C
Corning borosilicate glass, made by Corning Glass Co.	CB	450°C
Thermometric glass, Schott-2954, made by Jenaer Glaswerk Schott and Genossen, Mainz.	Single black stripe	460°C
Borosilicate glass, made by Whitefriars Glass Ltd.	Single white stripe	460°C
Corning glass, 1720, made by Corning Glass Co.	C 1720	600°C
Schott-Supremax R8409, made by Jenaer Glaswerk Schott and Genossen, Mainz.	SPX 8409	600°C

NOTE: The maximum temperatures given in the last column of the table are a guide to normal practice. The performance of a thermometer depends greatly on the stabilizing heat treatment which it has been given during manufacture, and a well-made thermometer of 'Normal glass' may be quite satisfactory for many purposes at temperatures as high as 400°C. On the other hand, for the best accuracy it may be preferred to use one of the borosilicate glasses for temperatures lower than 350°C. In general the lower the maximum temperature of use in relation to the approved temperature of the glass the better will be the 'stability of zero' of the thermometer.

2.6. Marking – Each thermometer shall be marked with the IP or ASTM/IP thermometer type number where applicable, an identification number, and the maker's or vendor's name or trade mark. Some thermometers require special markings which are given in the footnotes to the thermometer specifications. Each thermometer shall also be marked with the immersion at which it is to be used – e.g. 'Total immersion,' '11 cm immersion.' Thermometers intended to be used at partial immersion should have a line etched round the stem to indicate the depth of immersion.

Thermometers intended to be used at 'Total immersion' should be immersed to the reading so that the bulb and liquid index column are at the temperature being measured.

2.7. Annealing – Stress in the glass shall be reduced to a level sufficient to minimize the possibility of fracture due to mechanical or thermal shock.

2.8. Bulb Stability:

2.8.1. For all thermometers except kinematic viscosity thermometers and thermometers of similar accuracy: During manufacture, thermometers must be subjected to a suitable heat treatment in order to secure bulb stability as shown by the reproducibility of reading at some reference point such as the ice point (0°C).

This treatment shall be such that if the finished thermometer is subjected to the bulb stability test described in 2.9.1 the accuracy shall be within the limits specified and the rise in reading at the reference point shall not be greater than the maximum error specified.

This Bulb Stability Test is normally restricted to the following types of thermometers:

IP 4C	IP 37 C
IP 5 C	IP 47 C
IP 6 C	IP 62 C and F
IP 16 C and F	IP 73 C and F
IP 22 C	IP 88 C
IP 28 C and F	

2.8.2. For kinematic viscosity thermometers and thermometers of similar accuracy: The changes in calibration of kinematic viscosity thermometers, and other thermometers of similar accuracy may become significant within a short period of time after initial calibration requiring a different procedure and criteria for the Bulb Stability Test of these thermometers.

During manufacture, thermometers must be subjected to a suitable heat treatment in order to secure bulb stability as shown by the reproducibility of reading at a reference point on the main scale, and at the ice point (if scale lines at 0°C are available on the thermometer). This treatment shall be such that, if the thermometer is subjected to the stability test described in 2.9.2, there shall be no change in the reading at the selected reference point on the main scale and at the ice point, and hence no change in difference between the corrections obtained at the two calibration temperatures.

In practice, however, measurements are subject to experimental error and, in deciding whether a thermometer complies with the requirement, allowance must be made for possible errors in the test (variously known as 'uncertainty of measurement' or 'limits of accuracy').

Thus, in practice, the maximum permitted observed difference between corrections at each calibration temperature, determined before and after the bulb stability test, is twice the stated uncertainty of measurement during calibration.

This Bulb Stability Test is normally restricted to IP kinematic viscosity thermometers used for measuring temperatures at and above 50°C and is especially applicable to the following:

IP 17 C and F	IP 36 C and F	
IP 32 C and F	IP 66 C and F	
IP 34 C and F	IP 90 C and F	
IP 35 C and F	IP 93 C	IP 100C

Experience shows that a thermometer which has been calibrated to an uncertainty of $\pm 0.01^\circ\text{C}$ or $\pm 0.02^\circ\text{C}$ can reliably measure temperatures to the same accuracy only if due regard is given to all the conditions of use described in Annex D: Notes on Care and Use of Liquid-in-glass Thermometers.

2.9 Bulb Stability Test:

2.9.1. For all thermometers except kinematic viscosity thermometers and thermometers of similar accuracy: Heat the thermometer to a temperature equal to its highest reading and keep it at this temperature for 5 min. Allow the thermometer to cool with the test in the test bath or naturally in still air to 20°C above ambient or to 50°C whichever is the lower, and then determine the correction at the selected reference point. If natural cooling is used the correction should be determined within 1 h. Heat the thermometer again to a temperature equal to its highest reading, keep it at this temperature for 24 h, allow the thermometer to cool to one of the two temperatures referred to above at the same rate as at the start of the test, and re-determine the correction at the same reference point under the same condition as before. The most commonly used reference point is 0°C (or 32°F) and the recommended procedure for standardization at this point is described in 2.10.

2.9.2. For kinematic viscosity thermometers and thermometers of similar accuracy:

- (a) Heat the thermometer to the selected reference point on the main scale, maintain the temperature for at least 15 min and determine the scale correction at this point.
- (b) Allow the thermometer to cool slowly in the test bath (or naturally in still air) to at least 20°C above ambient or to 50°C whichever is the lower, and then determine the correction after at least 15 min at the ice point. If natural cooling is used the correction should be determined within 1 h. If there are no scale lines at 0°C then the correction at the ice point cannot be determined but otherwise the procedure must be adhered to.
- (c) Heat the thermometer again to the selected reference point on the main scale, and keep it at this temperature for 168 h. Allow the thermometer to cool as in (b) and then repeat the procedures described in (a) and (b). It must be emphasized that to obtain meaningful results, the procedure adopted after the 168 h period of heating must be identical to that used in the original calibration.

2.10. *Standardization at the Ice Point* – Select pieces of ice prepared from distilled or de-ionized water. Discard any cloudy or unsound portions. Rinse the ice with distilled or de-ionized water and shave or crush the ice into small pieces, avoiding direct contact with the hands or any chemically unclean objects. Fill a Dewar vessel (or an insulated porcelain container provided with means of draining away excess water) with the prepared ice. Add, while mixing with a chemically clean rod, sufficient distilled or de-ionized, preferably pre-cooled, water to form a slush, but not enough to float the ice. Make a cavity in the ice for

the insertion of the thermometer under test by inserting vertically an open-ended glass tube of appropriate diameter. Withdraw a column of the ice-water mixture by closing the top of the tube before lifting it out. To show that the mixture is of the required consistency the column of ice may be released from the glass tube to stand on a flat surface as an unsupported column. Insert the thermometer into the cavity as far as the immersion line at the 0°C (32°F) graduation, packing the ice gently about the stem to ensure good thermal contact with the bulb. As the ice melts, drain off excess water and gently repack ice around the bulb and stem. Relieve excess ice pressure on the bulb by rotating the thermometer in the cavity. Read the thermometer by means of a low-powered optical aid, taking care to avoid parallax errors. Leave the thermometer in the ice for at least 10 min before taking the observation.

Except when following the procedure for the Bulb Stability Test described in 2.9.1 or 2.9.2, observations at the ice point should be made after the thermometer has been registering normal ambient room temperature for at least 24 h in order to reduce any error caused by the depression of zero.

2.11. *Verification* – For referee purposes, only thermometers which have been tested at the National Physical Laboratory or other approved testing laboratory shall be used, and the appropriate corrections shall be applied. Satisfactory thermometers should be marked by the testing centre with the year of test and a certificate of corrections issued. The recommended limits of accuracy of test are given in Annex B.

It is desirable that thermometers be re-tested at intervals not exceeding five years. In the case of high-accuracy, finely divided thermometers such as the Kin Visc thermometers, it is desirable to have the zero or a point on the main stem rechecked at more frequent intervals.

Additional information on the care and use of liquid-in-glass thermometers is given in Annex D.

2.12. *Emergent Column Temperatures* – The scale error of IP partial immersion thermometers shall not exceed the specified amount when the temperatures of the emergent column are as stated in the table below. The emergent column temperatures for intermediate temperatures shall be obtained by interpolation from a smooth curve using the points in the table. Since it may not be possible during manufacture and testing to control these emergent column temperatures to the required values, the corrections resulting from the difference between the actual and specified temperatures must be calculated as described below, and allowed for in determining whether or not the thermometer complies with the specification.

The correction to a thermometer reading for an exposed column temperature differing from that obtained during calibration (or, for example, as given on an NPL Certificate) may be calculated by applying to the observed thermometer correction an additional correction obtained by evaluating the expression $KN(t-T)$.

where K = the differential expansion of the liquid in the particular type of glass used and an average value of 0.00016 or 0.00009 may be assumed for mercury-in-glass Celsius or Fahrenheit thermometers respectively;

N = the length of the exposed column expressed in degrees;

t = the mean temperature of the exposed column during calibration or as given on the NPL Certificate;

T = the mean temperature of the exposed column under conditions of use or as required by the specification.

Table. Emergent column temperatures

Temperature	Average temperature of emergent column	Temperature	Average temperature of emergent column
IP 1C –38 to +50°C 21°C over entire range		IP 1F –36 to +120°F 70°F over entire range	
IP 2C –80 to +20°C 21°C over entire range		IP 2F –112 to +70°F 70°F over entire range	
IP 8C 0 to 45°C 15°C over entire range			
IP 9C 40 to 85°C 30°C over entire range			

Temperature	Average temperature of emergent column	Temperature	Average temperature of emergent column
IP 15C -5 to + 110°C		IP 15F 20 to 230°F	
0°C	19°C	32°F	66°F
20°C	20°C	70°F	70°F
40°C	31°C	100°F	86°F
70°C	40°C	150°F	104°F
100°C	48°C	212°F	118°F
IP 16C 90 to 370°C		IP 16F 200 to 700°F	
100°C	61°C	200°F	140°F
150°C	65°C	300°F	149°F
200°C	71°C	400°F	160°F
250°C	78°C	500°F	175°F
300°C	87°C	600°F	195°F
350°C	99°C	700°F	220°F
IP 17C 32 to 82°C		IP 17F 100 to 180°F	
25°C over entire range		77°F over entire range	
IP 20C -38 to + 42°C			
-35°C	5°C		
-20°C	15°C		
0°C	20°C		
20°C	25°C		
40°C	30°C		
IP 21C 25 to 105°C			
25°C	25°C		
50°C	40°C		
75°C	45°C		
100°C	45°C		
IP 22C 195 to 205°C			
40°C over entire range			
IP 28C -6 to + 400°C		IP 28F 20 to 760°F	
0°C	18°C	32°F	64°F
50°C	34°C	122°F	93°F
100°C	44°C	200°F	110°F
150°C	54°C	300°F	129°F
200°C	64°C	400°F	150°F
250°C	77°C	500°F	175°F
300°C	91°C	600°F	205°F
350°C	108°C	700°F	240°F
IP 37C 144 to 156°C			
40°C over entire range			
IP 40C 20 to 120°C			
30°C over entire range			
IP 41C 100 to 230°C			
40°C over entire range			
IP 42C -38 to + 30°C			
15°C over entire range			
IP 43C 10 to 110°C		IP 43F 50 to 230°F	
25°C over entire range		77°F over entire range	
IP 44C 15 to 121°C		IP 44F 60 to 250°F	
30°C over entire range		85°F over entire range	

Temperature	Average temperature of emergent column	Temperature	Average temperature of emergent column
IP 45C 15 to 30°C 20°C over entire range			
IP 59C 90 to 170°C 100°C 70°C 130°C 60°C 160°C 50°C			
IP 62C -5 to +300°C 0°C 19°C 50°C 35°C 100°C 49°C 150°C 61°C 200°C 70°C 250°C 76°C 300°C 80°C		IP 62F 20 to 580°F 32°F 66°F 122°F 95°F 212°F 120°F 302°F 142°F 392°F 158°F 482°F 169°F 572°F 176°F	
IP 63C 32 to 127°C 25°C over entire range			
IP 72C -37 to +21°C 21°C over the entire range		IP 72F -35 to +70°F 70°F over the entire range	
IP 73C -5 to +400°C 0°C 19°C 100°C 50°C 200°C 75°C 300°C 89°C 400°C 94°C		IP 73F 20 to 760°F 32°F 66°F 212°F 122°F 392°F 167°F 572°F 192°F 752°F 201°F	
IP 74C -35 to +70°C 21°C over entire range		IP 74F -35 to +160°F 70°F over entire range	
IP 75C -30 to +80°C 21°C over entire range		IP 75F -25 to +180°F 70°F over entire range	
IP 76C 10 to 55°C 25°C over entire range			
IP 77C -2 to +52°C 25°C over entire range			
IP 78C 24 to 78°C 25°C over entire range			
IP 79C 48 to 102°C 30°C over entire range			
IP 80C 72 to 126°C 30°C over entire range			
IP 81C 98 to 152°C 100°C 30°C 115°C 33°C 130°C 35°C 150°C 35°C			
IP 82C 95 to 255°C 100°C 30°C 150°C 35°C 200°C 40°C 250°C 45°C			

Temperature	Average temperature of emergent column	Temperature	Average temperature of emergent column
IP 83C 123 to 177°C 35°C over entire range			
IP 84C 148 to 202°C 35°C over entire range			
IP 85C 173 to 227°C 175°C 34°C 190°C 38°C 205°C 40°C 225°C 40°C			
IP 86C 198 to 252°C 40°C over entire range			
IP 87C 223 to 277°C 225°C 40°C 240°C 40°C 255°C 41°C 275°C 46°C			
IP 88C 248 to 302°C 45°C over entire range			
IP 91C 0 to 110°C 30°C over entire range			
IP 98C 100 to 300°C 100°C 60°C 150°C 65°C 200°C 70°C 250°C 75°C 300°C 80°C			
IP 101C 20 to 150°C 40°C 30°C 70°C 40°C 100°C 50°C 130°C 60°C 150°C 65°C			

The emergent column temperature may be estimated preferably by a Faden or thread thermometer of suitable bulb length placed alongside the emergent column or alternatively by taking the mean of a series of auxiliary thermometers placed with the bottom of the bulb of the first of these thermometers at a distance of 1 cm from the point of emergence and the others evenly spaced along the length of the exposed column at intervals not exceeding 10 cm.

Up to a bulb temperature of about 100°C the two methods give results that are in agreement for most practical purposes but above this temperature, the Faden thermometer method is recommended as giving the more reliable and reproducible results. Where possible the same method for estimating the emergent column temperature should be adopted for the thermometer in use as when it was standardized.

SPECIAL NOTE

Existing stocks of thermometers conforming to previous specifications may be used, when appropriate. New thermometers shall conform to the current requirements.