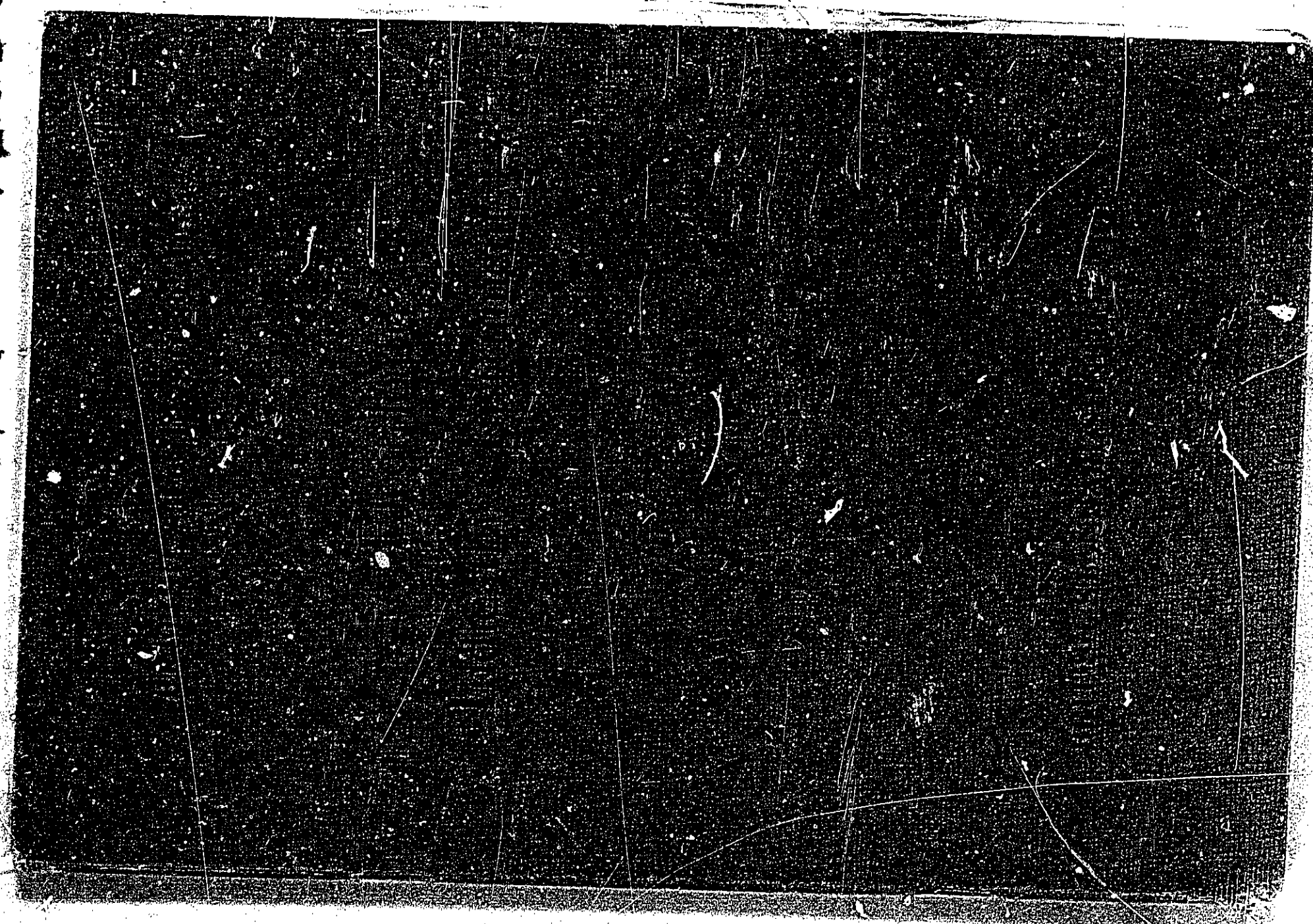




BRITISH STANDARD SPECIFICATION

ELECTRICAL
INDICATING INSTRUMENTS

B.S. 89 : 1954

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Price 4/6 net

BRITISH STANDARDS INSTITUTION

INCORPORATED BY ROYAL CHARTER

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THIS BRITISH STANDARD, having been approved by the Electrical Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 24th February, 1954.

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 2000, indexed and cross-indexed for reference, together with an abstract of each standard, will be found in the Institution's Yearbook, price 12s. 6d.

This standard makes reference to the following British Standards :—

B.S. 81. Instrument transformers.

B.S. 158. Marking and arrangement for switchgear bus-bars, main connections and auxiliary wiring.

B.S. 229. Flameproof enclosure of electrical apparatus.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

ELE. 13.

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CO-OPERATING ORGANIZATIONS

The Electrical Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations :—

- * Admiralty
- Air Ministry
- Association of Consulting Engineers (Incorporated)
- * Association of Supervising Electrical Engineers
- British Electrical and Allied Industries Research Association
- * British Electrical and Allied Manufacturers' Association
- British Electrical Development Association
- * British Electricity Authority and Area Boards
- British Railways, The British Transport Commission
- Cable Makers' Association
- Crown Agents for the Colonies
- Electric Lamp Manufacturers' Association
- Electric Light Fittings Association
- Electrical Contractors' Association (Incorporated)
- Electrical Contractors' Association of Scotland
- * Engineering Equipment Users' Association
- * General Post Office
- * Institution of Electrical Engineers
- * Ministry of Fuel and Power
- Ministry of Labour and National Service (Factory Dept.)
- * Ministry of Supply
- Ministry of Works
- * National Physical Laboratory
- * North of Scotland Hydro-Electric Board
- Oil Companies Materials Committee
- Public Transport Association (Incorporated)
- Radio Industry Council
- * War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard :—

Inter-Service Radio Components Standardization Committee

BRITISH STANDARD SPECIFICATION FOR ELECTRICAL INDICATING INSTRUMENTS

FOREWORD

In this revision of B.S. 89 : 1937, authorized by the Electrical Industry Standards Committee, the types of instruments and accessories dealt with have been divided into two classes, Precision and Industrial, the former being capable of a higher degree of accuracy than the latter.

Opportunity has been taken to simplify the method of defining the limits of error in both classes and to associate these limits, to a greater extent than in previous editions, with the type of movement employed.

The accuracy prescribed in the specification is not to be understood as in any way representing the highest degree of precision that can be attained with British instruments. There is no difficulty in arranging with manufacturers for the supply of instruments having higher degrees of accuracy than those laid down by the specification.

Some guidance on the choice of instruments is given in the appendices.

This specification does not relate to varmeters, but they are referred to in an appendix and will be considered for inclusion within the specification when it is next revised.

SPECIFICATION

SECTION ONE : GENERAL

SCOPE

1. This specification relates only to indicating ammeters, voltmeters, wattmeters, frequency indicators and power-factor indicators, grouped in two grades according to their degree of accuracy and known, respectively, as Precision and Industrial. It includes multi-purpose multi-range instruments only in so far as they relate to the meters and indicators named.

DEFINITIONS

2. For the purposes of this British Standard the following definitions shall apply :—

a. Instrument. An appliance for measuring amperes, volts, watts, frequency or power-factor, including any accessory (with the exception of external shunts or instrument transformers) necessary for the performance of such measurement.

b. Self-contained instrument. An instrument in which all accessory apparatus necessary to cause the indication to correspond with the value of the quantity measured, is permanently connected, and either enclosed in or permanently attached to the instrument case. (See Appendix K).

c. External shunt or resistor. A shunt or resistor that is neither enclosed in, nor is permanently attached to, the instrument case.

d. Scale range. The number of units indicated on the scale between the two scale-end marks, with the exception that in suppressed-zero instruments, the scale range is the highest value indicated.

e. Full-scale value. The higher of the values associated with the scale-end marks.

f. Effective range. That portion of the scale over which the instrument purports to comply with the accuracy requirements of the specification.

g. Scale-length. The distance traversed by the tip of the pointer in passing from one end of the scale to the other.

h. Scale-marks. Marks on the scale for the purpose of dividing the scale into suitable intervals.

j. Scale-division. The interval between the centres of successive scale-marks.

k. Pointer. The visual means by which the value of the measured quantity is indicated on the instrument scale.

l. Error in indication (indication error). The difference obtained by subtracting the true value of the quantity measured from the indicated value.

m. Variation in indication. A change in the indication caused by a change in conditions other than of the quantity purporting to be measured.

n. Rated current. A value of current through the instrument terminals assigned by the manufacturer as that at and below which the instrument purports to comply with the specification.

o. Rated voltage. The value of voltage assigned by the manufacturer as that at and below which the instrument purports to comply with the specification.

p. Rated-voltage and rated current of a wattmeter. The voltage and current respectively assigned by the manufacturer as those at and below which the wattmeter purports to comply with the specification.

q. Maximum current and maximum voltage. Values of current and voltage assigned by the manufacturer as those which the instrument will withstand indefinitely without damage.

SECTION TWO : RATINGS

STANDARD FREQUENCY

3. The standard frequency for the purposes of this British Standard shall be 50 c/s unless otherwise marked on the instrument.

STANDARD AMBIENT TEMPERATURE

4. The standard ambient temperature for the purposes of this British Standard shall be 20°C (68°F), except that for instruments intended for use in the tropics the standard ambient temperature shall be 35°C (95°F).

CONTINUOUS SERVICE

5. An instrument intended for continuous service shall be capable of being used continuously at its rated current and/or rated voltage, without failing to comply with all the relevant clauses of this specification.

RELATIONSHIP OF FULL-SCALE VALUE TO THE RATED CURRENT OF AN AMMETER

6. a. *Self contained ammeters.* Except as provided for in Sub-clause 6c, the full-scale value of a self-contained ammeter shall correspond with the rated current of the instrument.

b. *Ammeters operated from external shunt or transformer.*

(i) Except as provided for in Sub-clause 6c, the full-scale value of an instrument intended for connection to a shunt shall be equal to the rated current of the shunt.

(ii) Except as provided for in Sub-clause 6c, the full-scale value of an instrument intended for connection to the secondary of a current transformer shall not exceed 1.5 times the rated primary current of the current transformer or of one of the rated primary currents if more than one. The rated current of the ammeter shall correspond with the current through the primary of the current transformer necessary to produce deflection of the instrument pointer to full-scale value divided by the nominal ratio of the current transformer. The preferred full-scale values should be one of the two alternatives shown in Table 1.

TABLE 1. PREFERRED FULL-SCALE VALUES OF AMMETERS FOR USE WITH CURRENT TRANSFORMERS (see Sub-clause 6b (ii))

Rated primary current of current transformer	Full-scale value of ammeter
amperes	amperes
5	5 or 7.5
10	10 or 15
15	15 or 20
20	20 or 30
30	30 or 40
40	40 or 60
50	50 or 75
60	60 or 80
75	75 or 100
100	100 or 150
150	150 or 200
200	200 or 300
300	300 or 400
400	400 or 600
500	500 or 750
600	600 or 800
800	800 or 1200
1000	1000 or 1500
1200	1200 or 1600
1500	1500 or 2000
2000	2000 or 3000
3000	3000 or 4000
4000	4000 or 6000
5000	5000 or 7500
6000	6000 or 8000

c. An ammeter intended for the indication of momentary overloads may have a full-scale value exceeding the value given in Sub-clauses 6a and 6b provided that the portion of its scale exceeding the rated current value shall be ignored in determining the limits of error, shall not be required to comply with the limits of error laid down in this specification, and shall be distinctively marked.

RATED VOLTAGE AND FULL-SCALE VALUE OF A VOLTMETER

7. *a.* The rated voltage of a voltmeter unless otherwise marked on the instrument, shall correspond with the full-scale value.

b. The full-scale value of a voltmeter intended for use on a circuit of declared or other steady voltage shall preferably be in accordance with Table 2 so as to bring the scale-mark corresponding thereto into the open part of the scale.

TABLE 2. PREFERRED RANGES AND FULL-SCALE VALUES FOR VOLTMETERS

Nominal circuit voltage	Full-scale value (side-zero or centre-zero)	Scale range (suppressed-zero)
volts	volts	volts
6	8	4-8
24	35*	15-30
50	70*	30-60
100-120	150	70-140
200-250	300	150-300
380-400	500	250-500
415-460	600	300-600
550-660	800	400-800
kilovolts	kilovolts	kilovolts
2.2	3	1.5-3
3.3	4	2-4
6.6	8	4-8
11	15	7-14
22	30	15-30
33	40	20-40
44	60	30-60
66	80	40-80
88	120	60-120
110	150	70-140
132	160	80-160
165	200	100-200
220	300	160/320
275	350	200/400

* Normally for battery circuits.

FULL-SCALE VALUE OF AN INDUSTRIAL WATTMETER

8. An industrial wattmeter shall have a full-scale value not less than 50 per cent and not more than 100 per cent of the product of its rated current, or the rated primary current of a current transformer used with it, and its rated voltage, or the rated primary voltage of a voltage transformer used with it. The upper limit of 100 per cent may be raised to 150 per cent for industrial wattmeters intended for the indication of momentary overloads.

EFFECTIVE RANGE

9. *a.* Except as provided for in Sub-clauses 9*b* and 9*c* the effective range of an instrument shall be from full-scale value down to that fraction of the scale range given in Table 3.

TABLE 3. LOWER LIMIT OF EFFECTIVE RANGE

Form of movement	Lower limit of effective range expressed as a fraction of the scale range
Permanent-magnet moving-coil	$\frac{1}{10}$
Electro-dynamic wattmeter	$\frac{1}{10}$
Induction wattmeter	$\frac{1}{10}$
Induction ammeter and voltmeter	$\frac{1}{6}$
Moving iron	$\frac{1}{6}$
Rectifier	$\frac{1}{4}$
Electrostatic voltmeter*	$\frac{1}{6}$
Electro-dynamic ammeter and voltmeter	$\frac{1}{3}$
Thermal ammeter and voltmeter	$\frac{1}{6}$

b. In an ammeter intended for the indication of momentary overloads as described in Sub-clause 6*c* the upper limit of the effective range shall correspond to the rated current of the instrument and the lower limit shall be one-quarter of the upper limit.

c. In a voltmeter having a suppressed zero, the effective range shall be the whole range of the instrument provided that the lowest limit of the effective range is not less than that given in Table 3.

d. The effective range of instruments having special scale characteristics may differ from that laid down in Sub-clause 9*a* provided that the portion of the scale outside the effective range is distinctively marked, or the effective range is stated on the dial.

* Except that in an instrument having a scale-length less than $3\frac{1}{4}$ inches, the effective range shall be from one-quarter to three-quarters of the scale-range.

SECTION THREE : CONSTRUCTION

GENERAL

10. *a.* The construction of the instrument shall be mechanically sound, suitable for its purpose, and such as to give reasonable assurance of permanence in all mechanical, electrical and magnetic adjustments.

b. Case or other protection.

(i) The instrument shall be contained in a suitable case to afford adequate protection when reasonably used; and any accessory apparatus shall, if necessary, be protected to ensure permanence of the accuracy of the indications.

(ii) A metal-cased instrument shall be so constructed that, unless marked to the contrary, its case may be earthed.

(iii) An instrument or accessory required for use under particularly adverse conditions such as arise, for example, in tropical or industrial areas shall be the subject of agreement between the purchaser and the manufacturer.

(iv) A *flameproof* case shall comply with the relevant requirements of B.S. 229*.

(v) A *water-tight* case shall withstand complete immersion for one hour, under a three-foot head of water, without penetration of water into the interior.

(vi) A *weather-proof* case shall be so constructed or protected that exposure to the weather or splashings of water will not impair the operation of the instrument.

(vii) *Fogging.* The manufacturer shall take all reasonable precaution in manufacture and design of instruments to prevent undue fogging of the instrument glass taking place.

SCALE†

11. *a. Value of divisions.* The value of each scale-division except as provided in Sub-clause 11g, Notes 1 and 2, shall be either 1, 2 or 5 of the units measured, or any decimal multiple or sub-multiple of these numbers.

b. Width of divisions.

(i) For all Precision instruments, and for portable Industrial instruments the width of a scale-division within the effective range shall be not less than 0.03 inch (0.76 mm.).

* B.S. 229, 'Flameproof enclosure of electrical apparatus'.

† In view of the investigations now taking place on the readability of instruments, the clauses on scales have purposely been left open so as to permit the use of improved scales as they are developed.

(ii) For Industrial instruments, other than of the portable-type, the width of a scale-division within the effective range, shall be not less than 0.05 inch (1.25 mm.), except that:

(A) for instruments for special testing purposes the width of the scale-division may be less than 0.05 inch (1.25 mm.).

(B) for instruments having a scale-length of 2.5 inches (63.5 mm.) or less, the width of a scale-division within the effective range shall be not less than 0.04 inch (1 mm.).

(iii) Where the scale is not evenly divided as in moving-iron instruments, or when complete sub-division would render the marking too congested, some of the scale-marks may be omitted.

c. Construction of scales.

(i) The scale-divisions shall be consistent with the requirements of Sub-clause 11b. The medium scale-mark shall preferably be not less than 1.3 times, or more than 1.5 times, the length of the short scale-mark. The long scale-mark shall preferably be not less than 1.7 times, or more than 2.0 times, the length of the short scale-mark.

(ii) The thickness of scale-marks on Precision or portable Industrial instruments shall not differ noticeably from the thickness of the pointer knife-edge (see Clause 12c). Numbered and other salient marks may be thickened in switchboard instruments, but not in Precision or portable Industrial instruments.

d. Figuring.

(i) Long scale-marks shall preferably be numbered in increments 1, 2 or 5 or any decimal multiple or sub-multiple of these units, using the lowest possible number of digits.

(ii) The digits shall be of such shape as to minimise the risk of confusion with one another. To render individual numbers* clearly distinguishable from adjacent numbers, the minimum distance between them should preferably be not less than the height of a digit. Where necessary for this purpose the noughts may be reduced in size.

(iii) It is recommended that no number shall comprise more than four digits. When values exceed those which can be expressed by four digits, prefixes, such as kilo- or mega-, should preferably be used or a suitable decimal factor, such as micro- or milli- marked on the dial.

e. Modified scales.

(i) Precision instruments shall not be supplied with suppressed zero scales.

* 'Numbers' as used in this sense mean groups of digits expressing a value, e.g. 1,000.

(ii) Industrial spring-controlled instruments may have if required, the lower-half, or any lesser portion of the scale, including the zero, totally suppressed.

f. Scales of edgewise instruments. The angular deflection of an edgewise instrument shall be not greater than 75° .

g. Scales of instrument having more than one range. When the indications of an instrument have to be multiplied or divided by a factor in order that the values of the quantity measured may be deduced from the indication, the factor used shall be 1, 2 or 5 or any decimal multiple or sub-multiple of those numbers.

NOTE 1. In portable instruments a factor of 3 or 4 may be employed.

NOTE 2. The requirements of this clause shall apply to wattmeters wherever it is reasonably possible.

POINTER

12. *a.* The pointer shall be so shaped as to promote accuracy of reading.
b. The pointer, pointer stops and scale-plate, if of metal, shall be substantially at the same potential.

c. In any instrument not provided with means for avoiding errors of reading due to parallax, the clearance between the scale and the portion of the pointer which traverses it shall be not more than 0.06 inch (1.5 mm.) or 1/100 part of the length of the scale whichever is the greater.

d. A knife-edge pointer shall extend over the whole length of the short scale-marks, but not appreciably beyond them.

For an instrument fitted with a mirror, the knife-edge of the pointer shall be coloured red on the top edge and black on the bottom edge.

e. The thickness of the pointer knife-edge shall not exceed 0.007 inch for a Precision instrument or 0.012 inch for a portable Industrial instrument. The thickness of the scale-mark shall not differ noticeably from the thickness of the pointer knife-edge.

DIRECTION OF DEFLECTION

13. *a.* Unless otherwise required by the user the direction of deflection of the pointer of an instrument other than a vertical edgewise instrument and a power-factor indicator, shall be from left to right with an increasing positive quantity, and when the angular deflection is more than 180° the direction of deflection of the pointer shall be clockwise, with the zero and maximum points below the horizontal centre-line.

b. Unless otherwise required by the purchaser the direction of deflection of the pointer of a vertical edgewise instrument shall be upwards with an increasing positive quantity.

c. In a power-factor indicator with a circular scale the top left-hand quadrant shall refer to 'current-lagging', and unity power-factor shall be on the vertical centre-line.

ZERO-ADJUSTMENT

14. *a.* Spring-controlled instruments other than those provided for in Sub-clauses 14*d* and 14*e* shall be fitted with a suitable device, accessible from the outside of the case preferably from the front for adjusting the pointer to zero or other setting mark, without risk of damage to the working parts of the instrument.

b. This device, which shall be deemed to be part of the instrument case, shall be subjected to the high-voltage tests specified in Clause 24.

c. When the foregoing conditions cannot be fulfilled for instruments intended for use at voltages exceeding 660 volts, a suitable caution shall be conspicuously and indelibly marked on the case or dial of the instrument.

d. In flameproof, or water-tight instruments a zero-adjuster accessible from the outside of the case need not be provided.

e. In instruments with a mechanically suppressed zero, an external zero-adjuster shall not be fitted unless provision is made to prevent accidental operation, and discourage unauthorized operation.

NORMAL POSITION OF USE

15. *a. Precision instruments.* The normal position of use for the purposes of this specification shall be with the dial horizontal.

b. Industrial instruments.

(i) For the purposes of this specification unless otherwise required by the purchaser, the normal position of use for switchboard instruments, other than of the edgewise types, shall be with the dial vertical, in an upright position.

(ii) For the purposes of this specification the normal position of use for edgewise instruments shall be as agreed between the purchaser and the manufacturer.

(iii) For the purposes of this specification the normal position of use for portable instruments shall be with the dial horizontal.

SHUNTS

16. *a.* The main terminals of the shunt shall be so constructed that slight variations in the method of connecting them to the main circuit shall not alter the indication of the associated instrument by more than 0.15 per cent of full-scale value for shunts of rated current up to and including 200 amperes, and by more than 0.25 per cent of full-scale value for shunts of rated current greater than 200 amperes.

b. The construction of the shunt and the connecting leads shall be such that the thermo-electric effect produced at the rated current does not alter the indication of an associated Precision instrument by more than