

Specification for

Cathode ray tubes of assessed quality: Generic data and methods of test

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Foreword

This British Standard, which has been prepared under the authority of the Telecommunication Industry Standards Committee is the generic specification for cathode ray tubes in the system of standards for electronic components of assessed quality.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 115 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 General matters

1.1 Scope

This British Standard forms part of the system of common standard specifications for electronic components of assessed quality and should be read in conjunction with the standards in the series BS 9000 to BS 9009.

It applies to cathode ray tubes as defined in BS 204. It gives the terms, definitions, symbols, test methods, and other material necessary to implement fully the detail specifications for these tubes. The material herein shall be applicable only when called up by the detail specification, except for **1.6** to **1.14** which are mandatory requirements.

1.2 Related documents

BS 204, *Glossary of terms used in telecommunication (including radio) and electronics*.

BS 233, *Glossary of terms used in illumination and photometry*.

BS 448, *Dimensions of electronic tubes and valves*.

BS 1991, *Letter symbols, signs and abbreviations*.

BS 2011, *Methods for the environmental testing of electronic components and electronic equipment*.

BS 3939, *Graphical symbols for electrical power, telecommunications and electronic diagrams*. (IEC Publication 177).

BS 4727, *Glossary of electrotechnical, power, telecommunications, electronics, lighting and colour terms*.

BS 6001, *Sampling procedures and tables for inspection by attributes*. (BS 9001 has the same technical content.)

BS 9000, *General requirements for electronic components of assessed quality*.

IEC 100, *Methods for the measurement of direct interelectrode capacitances of electronic tubes and valves*.

IEC 139, *Preparation of outline drawings of oscilloscope and picture tubes*.

IEC 151-24, *Methods of measurement of cathode-ray charge-storage tubes*.

IEC 236, *Methods for the designation of electrostatic deflecting electrodes for cathode ray tubes*.

1.3 Terminology

For the purposes of this British Standard the following terms and definitions apply, in addition to those from BS 204.

1.3.1

display cathode ray tube

a cathode ray tube in which the target surface is integral with the tube and is coated with a material which becomes luminescent where it is bombarded by electrons in order to produce a visible display

1.3.2

estimated line width (or spot size)

the line width (or spot size) as estimated by the eye when viewed through a calibrated microscope (approximately $\times 10$) shall be assumed to be that bounded by the region of approximately 20 % peak luminance

1.3.3

spot displacement

displacement of the undeflected spot from the geometric centre of the screen face

1.3.4

flashover

internal or external arcing or discharge between two or more electrodes, elements or lead-outs

1.3.5

stray emission

emission, from a source other than the cathode surface, causing unwanted or uncontrollable excitation of the screen

1.3.6**modulator cut-off voltage**

the electrode voltage required to reduce the cathode ray tube screen light output to the point of visual extinction

1.3.7**effective blanking voltage**

the voltage difference between the blanking electrode and that electrode against which it acts to extinguish the spot

1.3.8**to flood**

to direct towards a storage assembly and/or display a screen an electron flux with a wide cross section containing no information

1.3.9**to write**

to introduce information, corresponding to the input signal, into the visible display or into some form of storage

1.3.10**to read**

to generate output information corresponding to the stored information

1.3.11**to erase**

to remove, by a controlled operation, all or part of the stored information

1.3.12**to hold**

to maintain storage elements at an equilibrium voltage by electron bombardment

1.3.13**to prime**

to charge storage elements to a potential suitable for writing

1.3.14**charge storage display cathode ray tube**

a storage tube in which information is written by means of a modulated electron beam and retained on a storage surface in the form of a pattern of electric charges for reproduction later in the form of a visible image

1.3.15**collimating lens**

an electronic lens used to cause the paths of electrons in a beam to become more nearly parallel and to approach a given plane normally; in a charge storage tube, this plane is the storage surface

1.3.16**CIE standard observer**

see BS 4727-4:Group 02:1971

1.4 Letter symbols, signs and abbreviations

For the purposes of this British Standard, the following letter symbols apply;

$\left. \begin{matrix} b_x \\ b_y \end{matrix} \right\}$ or be blanking electrode(s)

$\left. \begin{matrix} a_x \\ a_y \end{matrix} \right\}$ beam steering electrodes (alignment)

mod modulator electrode (usual symbol g_0 or g_1)

Other letter symbols shall be in accordance with BS 1991.

1.5 Graphical symbols

For the purposes of this British Standard graphical symbols shall be in accordance with BS 3939 (IEC Publication 117).

1.6 Marking of the tube and packing

The following symbols or codes shall be clearly and durably marked on the tube in the following order of preference as space permits. All symbols and codes except terminal marking and operating conditions shall also appear on the primary pack, e.g. carton, box, plastics envelope, etc., used as initial protection or wrapping for delivery:

- 1) Manufacturer's part designation number and special marking relating to hazard and special operating conditions.
- 2) Manufacturer's factory identification code.
- 3) Date code.
- 4) BS number of the detail specification.

1.7 Eligibility for qualification approval

The first stage of processing in accordance with 2.3.2 3) of BS 9000 is: Deposition of the screen and assembly of the gun(s) structure

The use of 2.3.2 3) ii) of BS 9000 is excluded.

1.8 Structurally similar tubes

Tubes from the same production unit(s) having similar construction and mechanical interchangeability, and differing only in their electrical ratings, characteristics, or light emitting materials may be grouped together for the purpose of obtaining samples for testing.

Tubes which use envelopes of similar dimensions, although they may differ electrically, may be grouped together for the purpose of obtaining samples for the following:

- Visual examination.
- Dimensions
- Base fixing.
- Lead fatigue (or fixed lug torque).
- Terminal inspection.
- Temperature cycling and moisture resistance.
- Solderability.
- Glass blemishes (faceplate)

1.9 Delayed delivery

Tubes held by the manufacturer for a period exceeding one year following acceptance inspection shall be re-examined for all Group A, subgroup A1 requirements prior to release.

1.10 Supplementary procedure for qualification approval

For production lot sizes of 280 specimens or less, 2.3.1 of BS 9000-1 is modified by the deletion of the second paragraph and the substitution of the following:

The manufacturer shall provide test evidence of conformity to the specification requirements on one lot for Groups A and B inspection and one sample for Groups C and D inspection. Samples shall be drawn from the lot for the Groups A, B, C and D inspection in accordance with the table given below, Where the number of defectives found exceeds the acceptance quantity but is less than the rejection quantity, a second sample, as shown in the table, shall be drawn and the acceptance or rejection of the lot determined from the results on the total sample.

Group or subgroup	Lot size	Sample size	Accept	Reject	Second sample	Total sample	Accept	Reject
A	1 to 5	100 % (see note)	0	1				
	6 to 280	5	0	2	3	8	1	2
B	1 to 5	100 % (see note)	0	1				
	6 to 280	5	0	2	3	8	1	2
C1 and C2	1 to 5	100 % (see note)	0	1				
	6 to 280	5	1	2				
C3	1 to 280	2	0	2	2	4	1	2
C4	1 to 280	2	0	1				
C5	1 to 3	100 % (see note)	0	1				
	4 to 280	3	0	2	2	5	1	2
D	1 to 280	2	0	2	2	4	1	2
NOTE Qualification approval depends upon a total of at least two tubes being tested.								

1.11 Certified test records

See 2.8 and Appendix C of BS 9000-1:1972.

1.12 Standard ratings and characteristics

Not applicable.

1.13 Unchecked parameters

Not applicable.

1.14 Procedure to be followed in the event of failures in Group C or D inspection

The procedures in 2.6.4.1 and 2.6.4.2 of BS 9000-1:1972 shall apply, but see also 2.7.3 of this standard.

1.15 Ordering information

This will be found in the appropriate detail specification.

1.16 Release prior to completion of Group B tests

Not applicable.

2 Test procedures

2.1 Test and measurement conditions

All tests shall be carried out under the standard atmospheric conditions for testing as specified in 5.3 of BS 2011-1:1967.

The limits quoted in detail specifications are absolute. Tolerances of measurements shall be taken into account when determining the actual limits.

2.2 Visual inspection

Unless otherwise specified, visual inspection shall be performed under normal factory lighting conditions and without visual aids.

Visual inspection shall be carried out for good appearance and workmanship, and shall include the following items where applicable:

- 1) Correctness of marking.
- 2) Correct terminal identification, including colour of flying leads and lead terminations.
- 3) External coatings.
- 4) Attachment of tube base connector and anode cap(s).

5) Materials. (The materials and finish for external parts shall be seen to conform with the requirements of the detail specification and/or the quality of the qualification approval samples.)

6) Loose particles. (The procedure to be followed is that shown in 2.2.1.)

2.2.1 Loose particles

2.2.1.1 Purpose. The purpose of the inspection is to establish that the loose particles in a cathode ray tube are unlikely to have an adverse effect on performance.

2.2.1.2 Procedure. The tube shall be held with the neck axis at approximately 45° to the vertical with the screen downwards, and shall be lightly tapped with the fingers on the maximum diameter. Any loose particles shall be caused to traverse the screen a few times.

The particles shall then be examined, and if not clearly visible when the tube is held as described above, then the tube shall be held so that the particles appear in the next area.

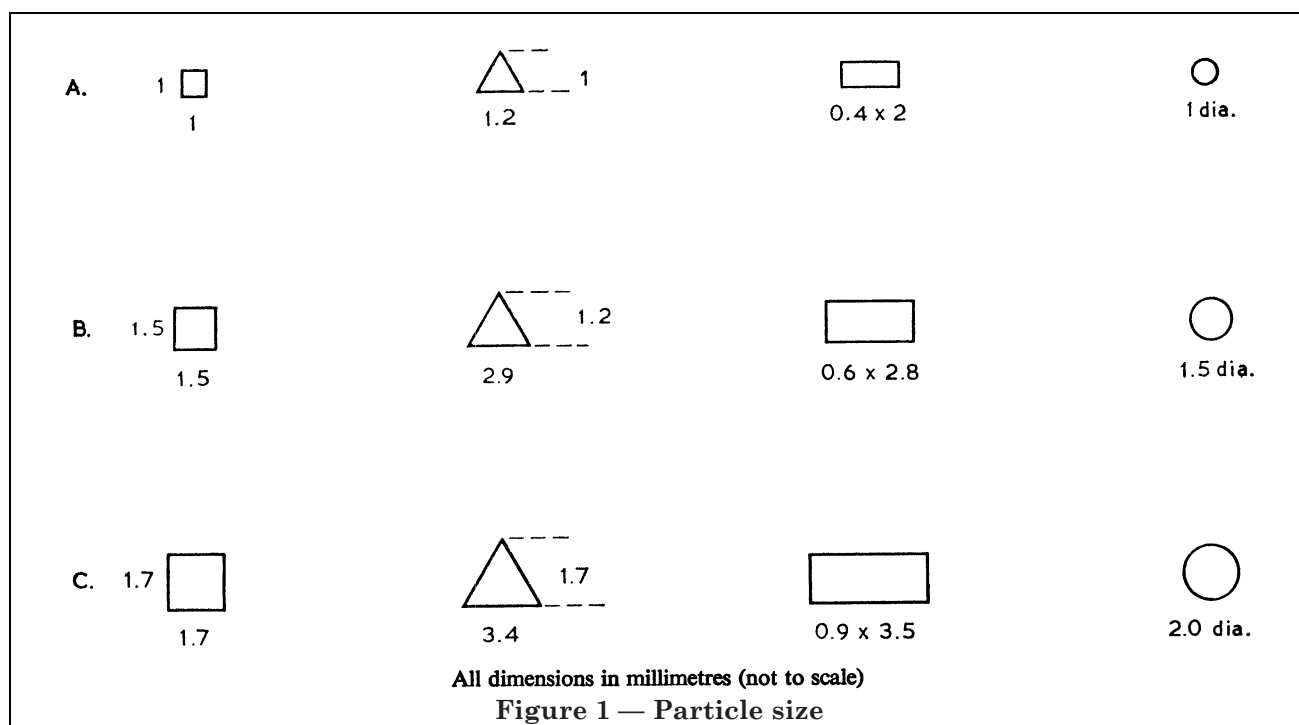
The tube shall be deemed not to comply with the requirements if any free phosphor is found after the tapping described above.

Other particles shall be classified in accordance with Table 1.

Table 1 — Classification of particles

Group	Material	Limit	Size ^a
1	Glass	1	A
2	Ceramic	1	A
3	Metal (assessed on linear dimensions, not on area)	1	A
4	Graphite, mica	one of each	C
5	Dust (aggregate of any particles each of size not greater than 20 % of size A)	Total area = 26 mm ² max.	

^a See Figure 1.



2.3 Dimensioning and gauging procedure

Dimensional and gauging tests shall be made in accordance with the detail specification and selected from Table 2.

Table 2 — Dimensions for outlines of cathode ray tubes

For the purpose of this table nom.± means nominal value with tolerances.

Required dimensions	Round tubes		Rectangular tubes	
	Electrostatic deflection and focusing	Magnetic deflection and magnetic or electrostatic focusing	Electrostatic deflection and focusing	Magnetic deflection and magnetic or electrostatic focusing
1) Views required	side	side (see Note 1)	(4) (see Note 2)	(4) (see Note 2)
2) Overall length	nom.±	nom.±	nom.±	nom.±
3) Length from centre of face to junction of body and straight portion of neck	max.	—	max.	—
4) Length from reference line to centre of face (see Note 3)	—	nom.±	—	nom.±
5) Outside diameter of neck	nom.±	nom.±	—	nom.±
6) Essential radii or dimensions to define shape of side walls	nom.	nom.	nom.	nom.
7) Outside radius of face, or two or more radii when shape requires	nom.±	nom.±	nom.±	nom.±
8) Greatest diameter of face	nom.±	nom.±	—	—
9) Greatest diagonal of face	—	—	nom.±	nom.±
10) Greatest width of face	—	—	nom.±	nom.±
11) Greatest height of face	—	—	nom.±	nom.±
12) Essential radii to define shape of sides and corners of face end (top-view)	—	—	nom.	nom.
13) Diameter or diagonal of screen	min.	min.	min.	min.
14) Greatest width of screen	—	—	min.	min.
15) Greatest height of screen	—	—	min.	min.
16) Radii of curved sides and corners of screen	—	—	nom.	nom.
17) Diameter or diagonal deflection angle (see Note 6)	—	nom.	—	nom.
18) Horizontal deflection angle (see Note 6)	—	—	—	nom.
19) Vertical deflection angle (see Note 6)	—	—	—	nom.
20) Location of side contact(s)	(see Note 4)	(see Note 4)	(see Note 4)	(see Note 4)
21) Location of contact area of external conductive bulb coating with respect to reference line (see Note 5)	nom.±	nom.±	nom.±	nom.±
22) Place reserved for deflection coils and focusing device with respect to reference line	—	nom.	—	nom.
23) Place reserved for the ion trap magnet and/or correcting or alignment magnets with respect to the reference line	—	nom.	—	nom.
24) Centre of deflection with respect to the reference line (see Note 6)	—	—	—	—
25) Base identification (see Note 7)			BS 448 reference	
26) Side contact identification (see Note 7)			BS 448 reference	
27) Reference line gauge identification (see Note 7)			BS 448 reference	
28) Position of neck axis (see Note 8) with respect to the centre of face	max.	—	max.	—
29) Projecting length of side contact pins	nom.±	—	nom.±	—
30) Diameter of side contact pins	nom.±	—	nom.±	—
31) Dimensions of graticule or external markings	nom.±	nom.±	nom.±	nom.±
32) Position of centre of graticule with respect to centre of face	max.	max.	max.	max.
33) Orientation of axes of graticule with respect to axes of the face	(see Note 9)	(see Note 9)	max.	max.
34) Dimensions and location of protective coatings with respect to the protected item	nom.±	nom.±	nom.±	nom.±
35) Essential radii or dimensions to define shape of implosion protection or mounting frame	nom.±	nom.±	nom.±	nom.±
36) Dimensions of fixing holes in the frame	nom.±	nom.±	nom.±	nom.±
37) Radial position of fixing holes with respect to reference points on face	nom.±	nom.±	nom.±	nom.±

Table 2 — Dimensions for outlines of cathode ray tubes

Required dimensions	Round tubes		Rectangular tubes	
	Electrostatic deflection and focusing	Magnetic deflection and magnetic or electrostatic focusing	Electrostatic deflection and focusing	Magnetic deflection and magnetic or electrostatic focusing
38) Longitudinal position of fixing holes with respect to reference points on face	nom.±	nom.±	nom.±	nom.±
39) Centre of grid plane from reference line	—	min.	—	min.
40) Length of flexible lead from side wall	nom.±	nom.±	nom.±	nom.±
41) Diameter of flexible lead	nom.	nom.	nom.	nom.
42) Axial alignment of base to neck axis	max.	max.	max.	max.
NOTE 1 In general, only the side-view of the tube is required, but the top-view may also be required for some types such as projection picture types. NOTE 2 Four views of the tube are required, i.e. top-view, side-view of long side, side-view of short side and diagonal view. (The diagonal view may not be necessary if all the information required can be given by other means.) NOTE 3 The reference line is defined by the appropriate reference line gauge. NOTE 4 Specified for each side contact by: 1) showing distance from either i) centre of face for electrostatic deflection tubes or ii) reference line for magnetic deflection tubes; 2) indicating angular tolerance, etc.; 3) indicating on which side, etc. NOTE 5 Specified by showing orientation with respect to side contact and minimum dimensions of contact area. NOTE 6 Not required for acceptance tests in detail specifications, but the information may be required for inclusion in application data. NOTE 7 Where information is not given in BS 448^a corresponding details of the features should be shown. NOTE 8 The neck axis is defined as a line passing centrally through two defined planes along the neck. NOTE 9 The orientation of graticule axis with axis of deflection is required here. ^a BS 448, "Dimensions of electronic tubes and valves".				

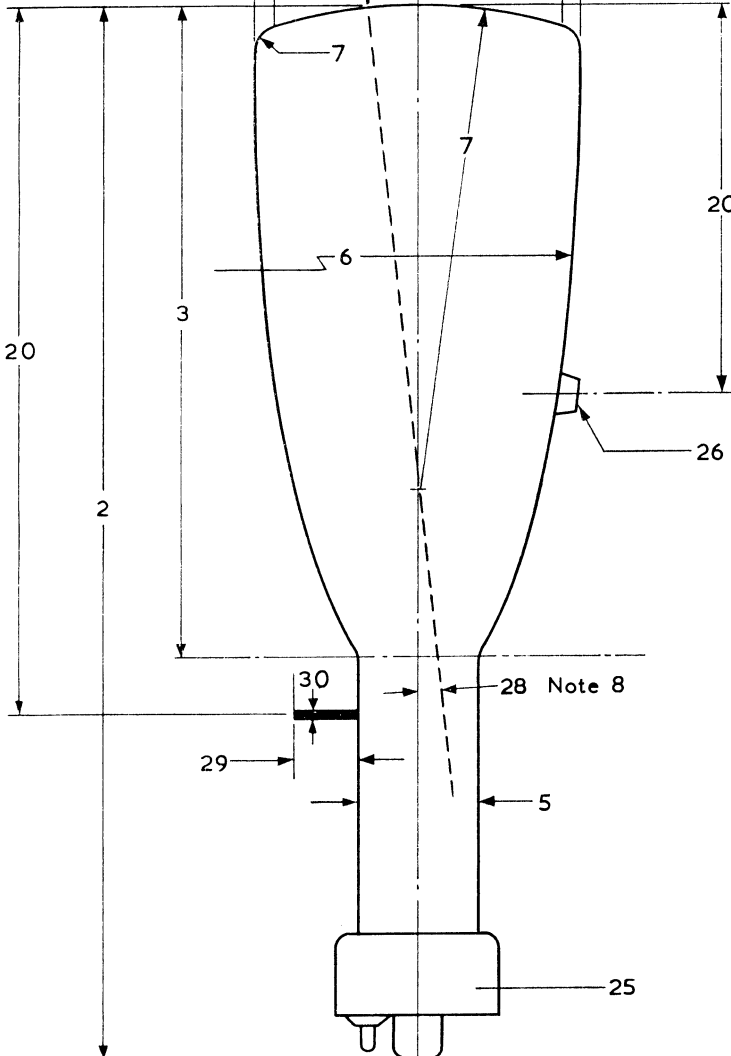
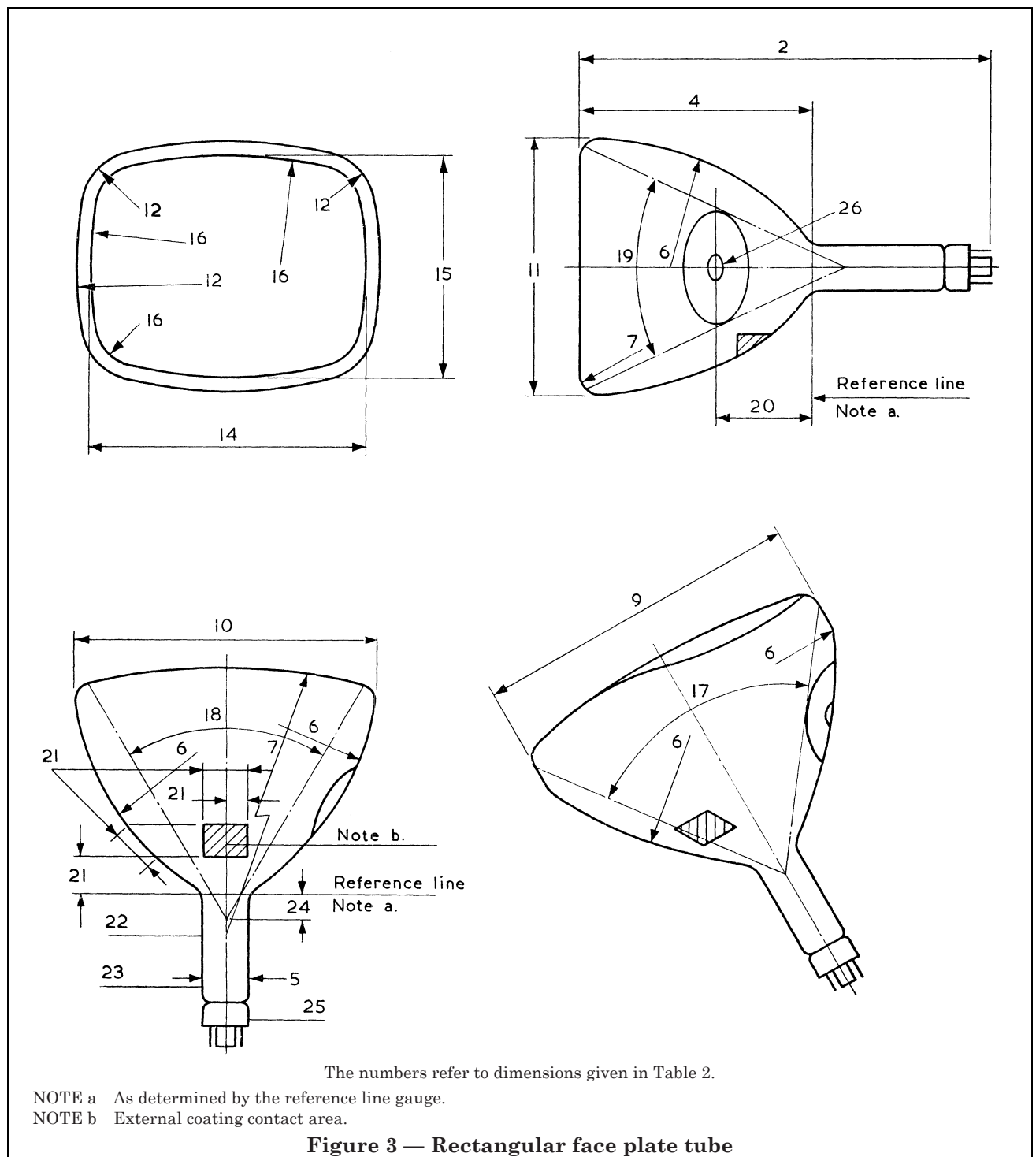
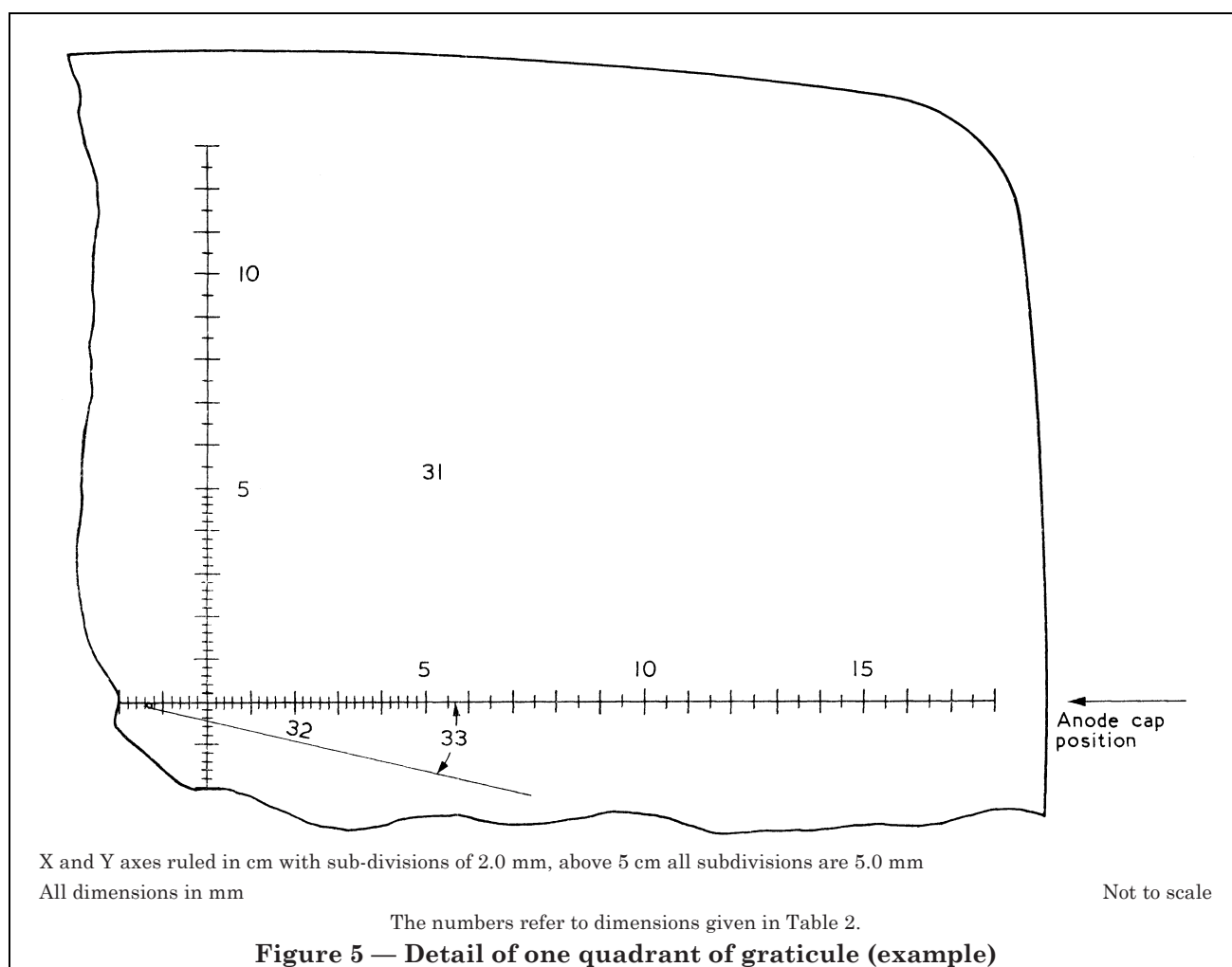


Figure 2 — Circular cone and face plate







2.4 Electrical test procedures

2.4.1 Alternative methods of test. See 2.4.2 of BS 9000:1967¹⁾.

2.4.2 General precautions. Before measurements are made, tubes shall be stored at the measuring temperature for a time sufficient to allow the entire tube to reach this temperature. Where the recovery period called for after conditioning is not sufficient for stabilization of temperature, the period shall be stated in the relevant specification.

Where the measurements are made at a temperature other than the specified temperature, the results shall, where necessary, be corrected to the specified temperature and the ambient temperature during the measurements stated in the test report.

NOTE During measurements the tubes shall not be exposed to draughts, direct sun-rays, or other influences likely to cause error.

2.4.3 Voltage reference point. The detail specification will state:

- 1) The electrode against which the electrode voltages are referred.
- 2) The polarity of the voltage with respect to the reference electrode or terminal.
- 3) The value of the reference point potential if other than "earth".

¹⁾ BS 9000, "General requirements for electronic parts of assessed quality".

2.4.4 Pulse modulation. Where the requirement is for the intensity modulating electrode (control grid) to be pulse modulated, the detail specification will state:

- 1) Pulse shape (rise time, droop and fall time).
- 2) Pulse duration.
- 3) Pulse repetition frequency.
- 4) Pulse amplitude.

2.4.5 Raster scan. Where a raster display is required, the following parameters are prescribed in the detail specification:

- 1) Number of lines per field and whether interlaced or non-interlaced.
- 2) Field repetition frequency.
- 3) Horizontal and vertical dimensions of the display.
- 4) Linearity of scan if applicable.
- 5) Flyback time if applicable.

2.4.6 Pre-heating. A minimum tube operating warm-up time before measurements are made is prescribed in the detail specification. For a particular tube type it may be required that certain tests are carried out during the warm-up period, and these tests will be prescribed separately in the detail specification.

2.4.7 Index of test methods. Unless otherwise specified, all electrical measurements shall be made under normal factory lighting conditions and without visual aids.

For convenience of identification in detail specifications the following numbering system for methods has been used. These methods follow **2.7.3** in this standard.

Index of test methods

Title	Method
Cold insulation	1002
Gas test	1003
Intensity modulator electrode cut-off voltage	1004
Cathode quality	1005
Specific luminous intensity of CRT screen and modulating voltage	1006
Undelected spot position	1007
Maximum voltage tests	1008
Heater current or voltage	1009
Heater to cathode leakage	1010
Quality of fluorescent screen and faceplate and useful screen area	1011
External conductive coating resistance	1012
Electrode leakage currents	1013
Heater modulation	1014
Intensity modulator electrode total negative current	1015
Persistence	1016
Persistence	1017
Resolution	1018
Resolution	1019
Resolution	1020
Resolution	1021
<i>Electrostatic deflection tube</i>	
Beam steering or alignment (electrostatic)	1101
Pattern distortion	1102
Pattern distortion	1103
Pattern distortion (multi-beam tubes)	1104
Scan dimensions (electrostatic deflection, post-deflection accelerator tubes)	1105

Title	Method
Deflection coefficient	1106
Beam blanking	1107
Post deflection accelerator resistance	1108
Post deflection accelerator total current	1109
Trace intermodulation (interaction factor)	1110
Deflection linearity (uniformity factor)	1111
Deflection linearity (uniformity factor)	1112
Spot displacement — leakage and beam current effect	1113
<i>Charge storage tubes</i>	
Flood gun electrode voltages for uniformity of pulse erasure	1201
Flood gun electrode voltage for minimum variation of backing electrode cut-off	1202
Flood gun modulator electrode cut-off voltage	1203
Storage surface cut-off voltage	1204
Target leakage, spurious emission and gas check	1205
Write gun modulator electrode cut-off voltage	1206
Write gun cathode quality	1207
Measurement of resolution of half-tone tubes	1208
Saturated luminance	1209
Writing speed	1210
Quality of display	1211

2.4.8 Clearance procedure. Where the clearance procedure is required the following procedure shall be used:

- 1) Remove the screen voltage, unless it is specified otherwise.
- 2) Raise the voltage on the backing electrode to the same value as the collector voltage, or as specified.
- 3) Hold for approximately half a second. Restore to former value.
- 4) Restore the screen voltage. The screen will now be at maximum luminance.
- 5) Allow five seconds for the store surface potential to stabilize.

2.4.9 Manual erase procedure. Where the manual erase procedure is required, the following procedure shall be used:

- 1) Remove the screen voltage, unless it is specified otherwise.
- 2) Raise the voltage on the backing electrode to the value found in TM 1204.
- 3) Hold for one second. Restore to former value.
- 4) Restore the screen voltage. The screen will now be dark.

2.5 Mechanical test procedures

2.5.1 Adhesion of base, base inserts, and cap

2.5.1.1 Purpose. The purpose of the test is to determine the adhesion of bases, base inserts and caps which are not integral parts of the tube envelope, but which are permanently attached to the envelope to constitute a complete tube. (These tests are not intended for purposes of testing glass to metal or ceramic to metal seals.)

2.5.1.2 Procedure. Gradually apply torque to the various items to the value specified in the following table:

Diameter of base or cap size	Torque
mm	N m
Bases less than 16.5	1.3
Bases between 16.5 and 40	2.3
Bases larger than 40	4.6
Medium, small or miniature caps	0.2
Caps larger than 12	0.4

When a base or cap is affixed to the tube envelope by cement the tube shall be subjected to one of the following immersion tests as appropriate:

- 1) *Bases less than 40 mm diameter.* Immerse in boiling water for a minimum period of 6 h.
- 2) *Bases exceeding 40 mm diameter.* Immerse in water at a minimum temperature of 50 °C for a minimum period of 18 h.

After immersion the tubes shall be allowed to cool to room temperature for a maximum period of 1 h, after which there shall be no movement of the cemented joints when torque specified in the table above is applied.

2.5.2 Base strain — glass to pin seals

2.5.2.1 Test equipment. The following test equipment is required:

- 1) A water container having minimum dimensions such that no part of the tube or tubes under test is closer than 20 mm to the sides of the container. During the test the container shall be sufficiently full to ensure a uniform temperature gradient for each tube under test.
- 2) Pin straightening tool.
- 3) Deflection cone conforming to Figure 6.

2.5.2.2 Precaution. If several tubes are tested simultaneously, it is recommended that a holder be used to prevent the tube envelopes making contact with each other.

2.5.2.3 Procedure. The test shall be done at least 1 h after the exhaust operation.

Use the pin straightener.

The axis of the tube shall be aligned with the axis of the deflection cone, which shall then be pushed into the circle formed by the pins until firm contact is made against the tube header. Completely submerge the base with the cone attached into water at a temperature of 97 °C to 100 °C for a period of not less than 10 s. Remove from the water and allow to cool to room temperature.

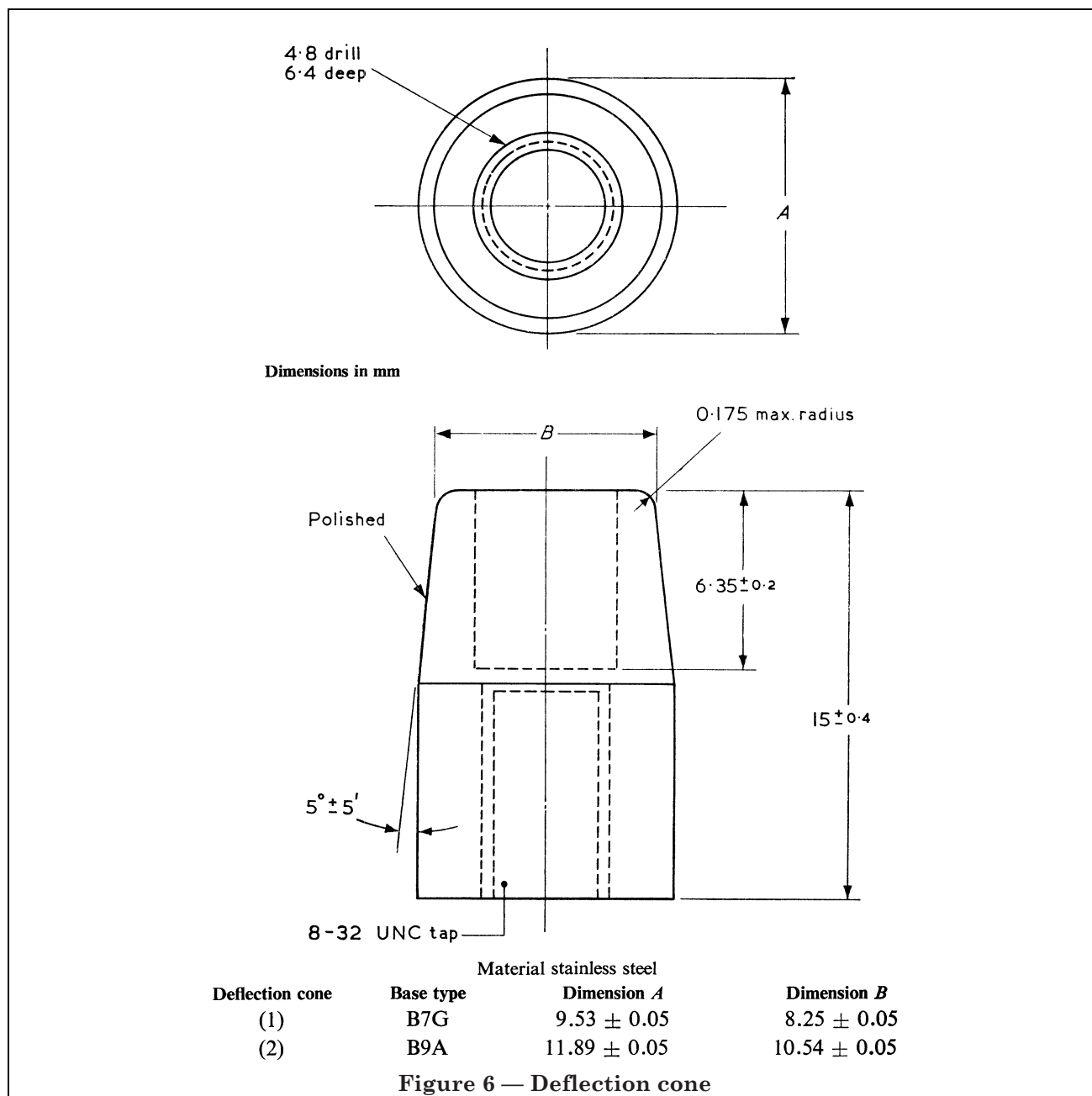
The tube or base shall not be allowed to be in contact with a metallic or other heat conducting surface.

Strain test defects shall be classified in accordance with the following tabulation:

Defects

- Envelope or tip cracks (or both)
- Button (wafer header) cracks
- Seal cracks

It shall be permitted to use tubes which are rejects for electrical or mechanical reasons.



2.5.3 Base pin solder depth

2.5.3.1 Purpose. The purpose of the test is to determine the depth of solder contact between the tube leads and base pins on those tubes which have rigid leads soldered into base joints.

2.5.3.2 Procedure. The depth of solder contact within the base pins shall be determined either by sectioning soldered joints or by the use of X-ray techniques.

The minimum depth of soldered contacts within the base pins shall be as follows:

Pin diameter	Minimum penetration
mm	mm
2.3	0.8
3.2	0.8
4	1.5
4.8	1.5
larger than 4.8	2.3

It shall be permitted to use tubes which are rejects for electrical or mechanical reasons.

2.5.4 Axial neck alignment — magnetic deflection tubes

2.5.4.1 Purpose. The purpose of the test is to measure the axial alignment of the tube neck, in the region of the deflector coil position, with respect to the mounting planes of the tube.

2.5.4.2 Procedure. Rotate the tube about the centre line passing through two mounting planes on the bulb or neck.

Measure the maximum excursion of the neck between the specified limits of the deflector coil position, with respect to the centre line in the above paragraph.

Measure the maximum excursion at the specified pitch circle diameter on the screen face in a direction parallel to the centre line.

NOTE A gauge or fixture may be used as an alternative to rotating the bulb providing that it accurately establishes the centre line, and the maximum mechanical deviation, without being influenced by variations in the dimensions of the tube under test.

The two tube mounting planes are prescribed in the detail specification.

2.6 Environmental test procedures

The following tests shall be performed as required by the detail specification which will state whether or not they are destructive. Tests in 2.6.1 to 2.6.7 refer to Part 2 of BS 2011²⁾.

2.6.1 Test A — Cold. Preferred severity: — 10 °C.

2.6.2 Test B — Dry heat. Preferred severity: 70 °C.

2.6.3 Test Ca — Damp heat. Preferred duration: 4 days.

The marking shall remain legible at the end of the test.

2.6.4 Test D — Accelerated damp heat. Preferred duration: 2 cycles.

2.6.5 Test Ea — Shock. Preferred severities: As shown in BS 2011-2Ea²⁾, plus the following:

Peak acceleration 147 m/s², duration of pulse 3 ms.

Wave shape: Half sine unless otherwise specified.

2.6.6 Test Fc — Vibration — swept frequency. Procedure B4.

Preferred severities:

Frequency	Acceleration or amplitude
10–55 Hz	0.21 mm, 0.35 mm, 0.75 mm.
55–500 Hz	24.5 m/s ² , 49 m/s ² , 98 m/s ² .

Rate of change of frequency:

Not exceeding one octave per minute 55–200 Hz.

Not exceeding 100 Hz per minute 200–500 Hz.

2.6.7 Test Fc — Vibration — fixed frequency. Preferred severities:

Acceleration: 24.5 m/s², 49 m/s², 98 m/s².

Frequency: Within the range 100 Hz to 200 Hz, tolerance ± 5 Hz.

The tube shall be vibrated in three mutually perpendicular planes, one of which shall be axial with the gun assembly.

The preferred periods of duration in each plane are:

30 min, 90 min, 6 h, 30 h.

2.6.8 Increased air pressure. The tube shall be subjected to an increase of air pressure to the value stated in the detail specification, and maintained for a period of not less than one minute.

Preferred severities: 200 kN/m², 300 kN/m² absolute.

²⁾ BS 2011, “Methods for the environmental testing of electronic components and electronic equipment”, Part 2A, “Cold”, Part 2B, “Dry heat” Part 2C, “Damp heat long term exposure”, Part 2Da, “Damp heat cyclic”, Part 2Ea, “Shock”, Part 2F, “Vibration”.

2.7 Endurance test procedures

2.7.1 Non-operating endurance (holding test). Where the holding period is not specified in the detail specification it shall be assumed that none is necessary.

The test shall commence at the completion of all cathode activating processes and the tubes shall not be operated during the holding period.

Those tests to be performed before and after completion of the holding period are specified in the detail specification. Other tests may be performed before, during or after the holding period at the discretion of the manufacturer.

2.7.2 Non-operating endurance (storage test). Not applicable.

2.7.3 Operating endurance. The tube shall be set up and operated in accordance with the requirements of the detail specification.

For each tube type (account being taken of structural similarity) the following shall apply:

A minimum of three tubes per period of 12 months, each tube to achieve a minimum of 200 h, 500 h, 1 000 h or 2 000 h (as specified in the detail specification). A total of at least 6 000 h of operation (unless otherwise prescribed in the detail specification) shall be achieved on tubes meeting the minimum requirement during the year (12 months).

Unless otherwise specified tubes undergoing test shall be subject to the post endurance tests of the detail specification at the following time intervals:

0 h, 160 h, 500 h (also 1 000 h and 2 000 h according to the duration specified) to within + 48 h and – 24 h.

The manufacturer may perform measurements at additional time intervals at his own discretion.

In the event of two consecutive tubes failing to achieve the specified minimum endurance the procedure, detailed in 2.6.4.2 of BS 9000³⁾, for failure of a second sample shall apply. The requirement for a second sample of double the original sample size shall not apply for endurance tests.

Tubes rejected for those characteristics which are not the subject of post endurance tests may be used.

³⁾ BS 9000, "General requirements for electronic parts of assessed quality".

COLD INSULATION

Purpose. To ensure adequate cold insulation between electrodes and to protect test equipment by prior elimination of inter-electrode shorts.

Procedure. Connect modulator, cathode, and heater together and count as one electrode.

Apply a d.c. voltage of 250 V (– 0, + 5 %) between each electrode in turn and all other electrodes connected together, measuring the current drawn by the electrode under test.

Each measurement shall indicate a resistance of not less than $200/n$ M Ω or 50 M Ω , whichever is the greater, where n is the number of electrodes connected together for the test.

GAS TEST

Purpose. To measure residual gas after completion of tube processing. It is mainly applicable to tubes using guns other than triode configuration.

Procedure. Apply voltages to the tube electrodes as stated in the detail specification.

Adjust modulator control voltage for cathode or first anode current as specified.

Measure current at specified electrode.

The value of the gas ratio shall be computed from the following equation:

$$\text{Gas ratio} = \frac{\text{current in specified electrode}}{\text{current in the cathode or first anode}}$$

Precautions. Before starting the test all coils (focus, deflection, alignment, etc.), shall be disconnected or removed, and ion trap magnets shall not be fitted.

Leakage currents shall be subtracted from readings.

Conditions prescribed in the detail specification

- 1) All electrode voltages, e.g. heaters, anode(s), etc., as appropriate, and cathode or first anode current.
- 2) The electrode at which the current is to be measured.

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INTENSITY MODULATOR ELECTRODE CUT-OFF VOLTAGE

Purpose. To measure the modulator electrode voltage to reduce the cathode ray tube screen light output to the point of visual extinction under specified conditions.

Procedure. The test shall be carried out in a darkened room.

Apply voltages to the tube electrodes as stated in the detail specification and display the required pattern on the screen. Unless otherwise stated in the detail specification this shall be an undeflected focused spot. Adjust the modulation electrode voltage for visual extinction of the spot (or pattern) and record the voltage.

Conditions prescribed in the detail specification

- 1) All electrode voltages, e.g. heaters, anode(s), etc., as appropriate.
- 2) Deflection requirements, if any.

CATHODE QUALITY

Purpose. To ensure that the cathode emission meets the required limits.

Procedure. Apply the specified electrode voltages and, if specified, scan deflection, then measure the following parameters:

- 1) Negative modulator voltage, or positive cathode voltage for visual cut-off of spot or raster.
- 2) Cathode current, at zero volts, between modulator electrode and cathode.

The cathode current must be equal to or greater than the value arrived at by the following calculation:

$$\text{Cathode current } I_k = K (\text{cut-off voltage})^{3/2}$$

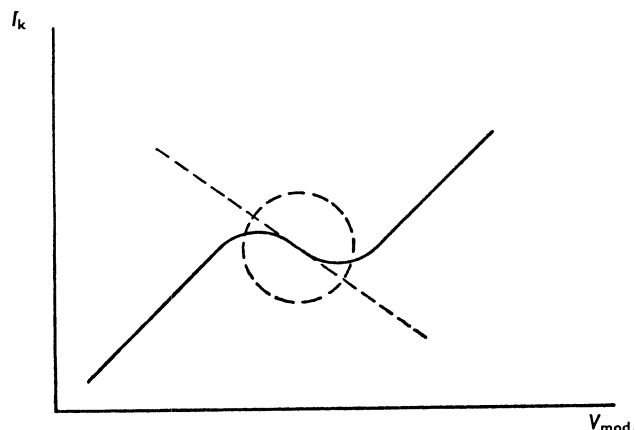
where K is the cathode factor specified.

Where the operation at zero bias would harm the tube due to excessive cathode loading, the specification may call for the cathode current to be measured at a modulator voltage or cathode voltage equal to half the visual cut-off voltage.

The minimum cathode current permissible will be:

$$I_k = \frac{K (\text{cut-off voltage})^{3/2}}{\sqrt{128}}$$

There shall be no evidence of restriction of emission current, as shown by a negative slope in the cathode current/modulator voltage characteristic (see figure).



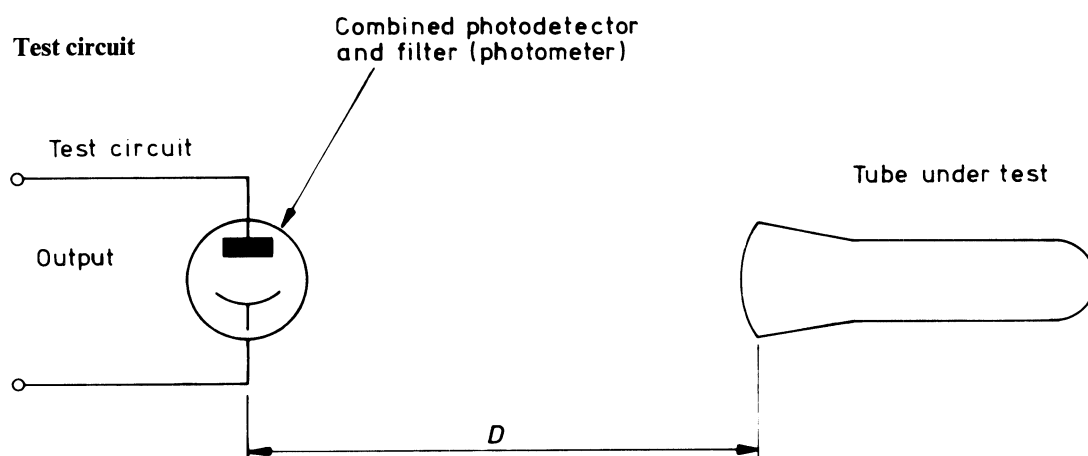
Conditions prescribed in the detail specification

- 1) All electrode voltages, e.g. heater, anode(s), etc., as appropriate.
- 2) Deflection requirements, if any.

LUMINANCE CHARACTERISTICS

Purpose. To measure:

- 1) the voltage applied to the intensity modulating electrode and/or the current in a specified electrode to give a specified luminous intensity/luminance under specified operating conditions, or
- 2) the luminous intensity/luminance of the screen under specified operating conditions, specified modulating voltage or specified electrode current.



Description. The tube under test, and photometer (which shall be calibrated to measure luminous intensity), shall be located in a dark room or shall be housed together in a lightproof container. D is the distance between the cathode ray tube screen and the light sensitive surface of the photometer. The value of D is such that the photometer obeys the inverse square law with change of D . This will normally be of the order of 5 times the diagonal of the raster for 1 % accuracy.

Alternatively, a photometer of known aperture, calibrated against a Lambertian source, may be placed in close proximity to the screen to measure luminance.

Unless otherwise stated in the detail specification, the spectral response of the photometer shall be that of the CIE Standard Observer 1931.

Procedure 1. Apply voltages to the tube electrodes as stated in the detail specification. Measure the intensity modulator electrode cut-off voltage in accordance with the procedure of Test method 1004.

With the specified display, adjust the, modulation electrode voltage to give the specified luminous intensity/ luminance.

Measure the modulator electrode voltage and/or the current in the specified electrode.

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Procedure 2. Apply voltages to the tube electrodes as stated in the detail specification. With the specified display, adjust the modulator electrode voltage or the current in the specified electrode to the value stated in the detail specification. Measure the luminous intensity/luminance of the screen.

Notes to procedures 1 and 2

NOTE 1 The current measured in the specified electrode may be corrected to eliminate the effect of electrode leakage currents.

NOTE 2 The modulation (drive) voltage may be specified and is calculated by subtracting the measured voltage from the modulator cut-off voltage.

Conditions prescribed in the detail specification

- 1) All electrode voltages.
- 2) Deflection requirements, if any (if a raster scan, requirements in accordance with **2.4.5**).
- 3) Deflection requirements, if any, for measuring cut-off.
- 4) Ambient temperature near the screen, if applicable.
- 5) Screen luminous intensity/luminance or specified electrode and its current or intensity modulator electrode voltage.
- 6) Photometer spectral response, if other than CIE Standard Observer 1931.
- 7) Focus requirements.
- 8) Position(s) of photometer on the tube face for measurement of luminance.
- 9) Aperture area of photometer.

UNDEFLECTED SPOT POSITION

METHOD A. FOR TUBES HAVING ELECTROSTATIC DEFLECTION

Purpose. To ensure that the position of an undeflected focused spot is within specified limits on the cathode ray tube faceplate.

Procedure. Apply the voltages to the tube electrodes as stated in the detail specification.

Connect each deflecting plate to the specified anode and adjust the focus for optimum.

The spot shall be within a zone, the dimensions of which shall be specified. The centre of the zone shall coincide with the geometric centre of the tube face and the zone shall be aligned with either one axis of deflection or the centre line of a rectangular screen as specified.

Precautions. The tube shall be shielded against external magnetic influences.

The current in the beam shall be adjusted or pulsed, as specified in the detail specification, to a value which will not damage the screen.

METHOD B. FOR TUBES HAVING MAGNETIC DEFLECTION

Procedure. Apply the voltages to the tube electrodes as stated in the detail specification.

Electrostatically focused tubes shall be adjusted for optimum focus at centre of screen.

Magnetically focused tubes shall be operated with zero focus coil current. Permanent magnet focus assemblies shall be removed.

Adjust the voltage applied to modulator control electrode to give the smallest discernible spot.

The tube shall be rotated and the centre point of the spot marked at two positions 180° apart. The mid point between the two marks represents the true undeflected spot position, and shall be within the specified distance of the geometric centre of the screen.

Conditions prescribed in the detail specification

- 1) All electrode voltages, e.g. heaters, anode(s), etc., as appropriate.
- 2) Dimensions of the zone.

MAXIMUM VOLTAGE TESTS

Purpose. To ensure that when the tube is operated with maximum rated voltages there is no evidence of breakdown or stray emission.

Procedure. If prescribed by the detail specification the tube shall be held with the screen in the specified plane.

Apply voltages to the tube electrodes as stated in the detail specification.

Display the specified raster over the useful screen area and adjust the modulator electrode control voltage to give the specified screen luminance or to cut-off value as required.

There shall be no sign of breakdown over a period of 60 s minimum.

If prescribed in the detail specification the tube neck shall be tapped using a forked, rubber covered, wooden hammer for a specified duration. Unless otherwise specified the periodicity shall be four taps per second.

Adjust the modulator control electrode voltage to cut-off value and remove the deflecting fields.

The tube shall be deemed not to comply with the requirements if flashover or stray emission causes visible excitation of the screen after the first 5 s of tapping, and for 15 s after tapping has ceased.

NOTE 1 A suitable design for a hammer is given in Figure 1008/1 of this Test method.

NOTE 2 For tubes operating at very high anode voltages (from 20 kV) it may be specified that the e.h.t. supply is switched on and off during the period that the tube neck is being tapped.

Conditions prescribed in the detail specification

- 1) All electrode voltages, e.g. heaters, anode(s), etc., as appropriate.
- 2) Raster scan in accordance with 2.4.5.
- 3) Screen luminance.
- 4) Plane of screen, e.g. horizontal or vertical.
- 5) If required, duration of tapping and number of taps per second.

All dimensions are in millimetres. Not to scale.

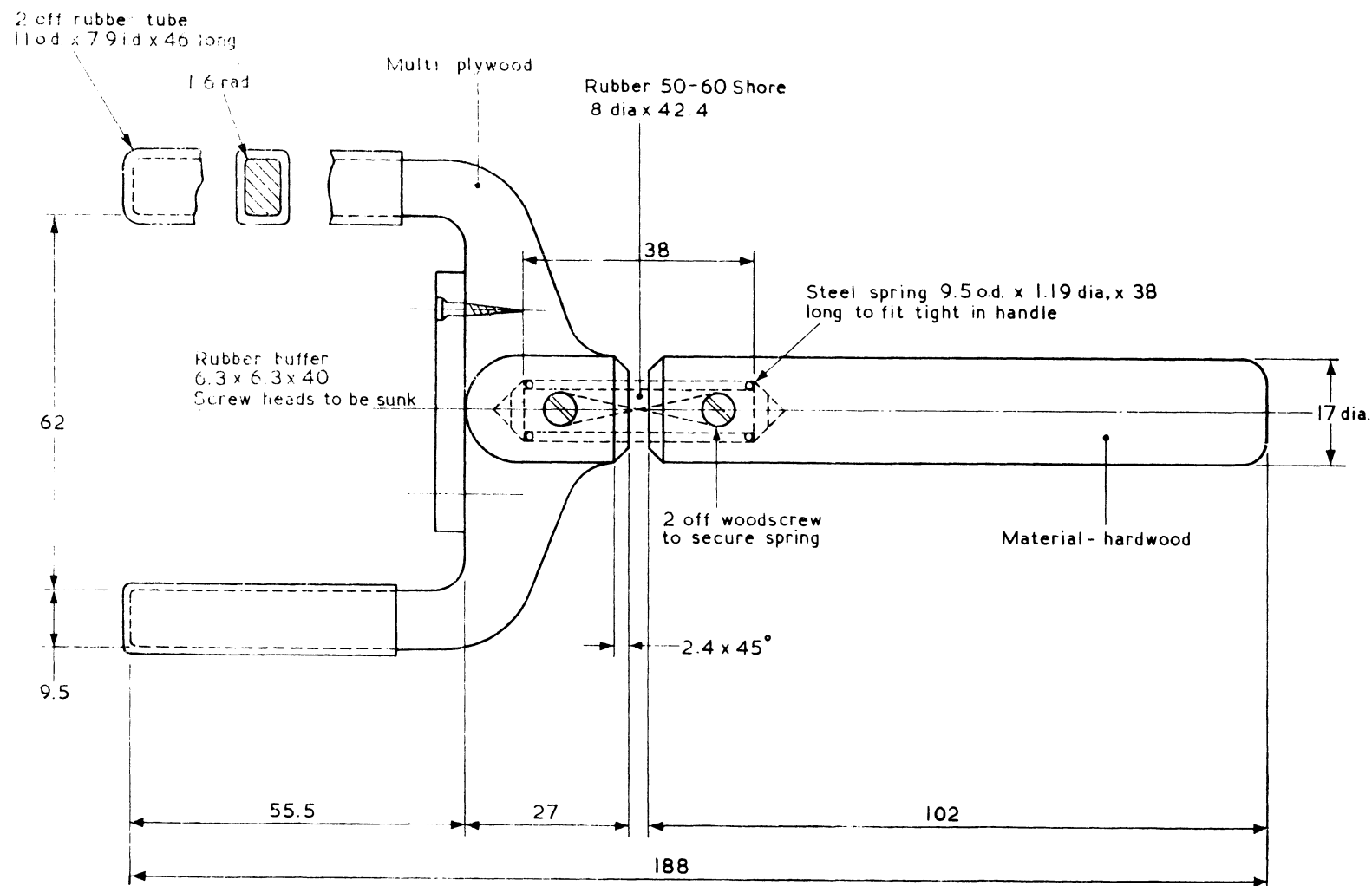


Figure 1008/1 — Hammer for cathode ray tube stray emission test