

Method for the

Measurement of voltage with sphere-gaps —

(One sphere earthed)

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Foreword

This standard makes reference to the following British Standard:

BS 923, *Impulse-voltage testing*.

This British Standard, prepared under the authority of the Electrical Industry Standards Committee, revises and supersedes the 1939 edition.

This edition has been drafted concurrently with the Recommendations for voltage measurement with sphere-gaps prepared by the International Electrotechnical Commission and is in technical agreement with the IEC Recommendations.

The revision gives a method of checking the spheres for surface irregularities and also more detailed information regarding the irradiation of the sphere-gaps.

Appendix A gives a bibliography of experimental calibrations, and Appendix B indicates the procedure by which the flashover voltage values have been derived.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16 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 Scope

This publication contains rules and recommendations for the construction and use of sphere-gaps for voltage measurement where one sphere is earthed. The rules apply to the measurement of the peak value of:

- a) alternating voltages,
- b) full standard impulses (as defined in BS 923¹⁾) and impulses with longer tails,
- c) direct voltages.

The peak flashover voltages in air for various spacings between the spheres are given in Table 3 and Table 4.

Appendix A gives the limits of voltage and frequency over which the tables have been derived from experiment and can be presumed to be accurate within the limits specified in Clause 11.

Appendix B gives the procedure by which the values in the tables have been derived from previous National Standards and other sources.

2 Standard sphere-gap

The standard sphere-gap is a peak voltage measuring device constructed and arranged in accordance with the rules in this document. It consists of two metal spheres of the same nominal diameter (D) and their shanks, operating gear, insulating supports, supporting frame and leads for connection to the points between which the voltage is to be measured. Standard values of D , in centimetres, are 2, 5, 6.25, 10, 12.5, 15, 25, 50, 75, 100, 150 and 200. The spacing between the spheres is designated S . The points on the two spheres which are closest to each other are called the sparking points.

Figure 1 and Figure 2 show two arrangements, one of which is typical of sphere-gaps with a vertical axis and the other of sphere-gaps with a horizontal axis.

3 Requirements for the spheres

The spheres shall be carefully made so that their surfaces are smooth and their curvature is as uniform as possible.

They shall meet the following requirements:

- a) *General shape*. The diameter of each sphere shall nowhere differ from the nominal value by more than two per cent.
- b) *Freedom from surface irregularities*. The spheres shall be reasonably free from surface irregularities in the region of the sparking point. This region is defined by a circle such as would be drawn on the spheres by a pair of dividers set to an opening of $0.3 D$ and centred on the sparking point.

The freedom from surface irregularities shall be checked by a spherometer of which the feet are between $0.125 D$ and $0.25 D$ apart.

A spherometer measures the distance h of its central point from the plane passing through the three feet of the instrument, which form an equilateral triangle of side a .

When the three feet and the central point are in contact with a perfectly spherical surface of radius $D/2$, a value for h is obtained as follows:

$$h = \frac{D}{2} - \frac{1}{2} \sqrt{D^2 - \frac{4a^2}{3}}$$

$$= \frac{D}{3} \left[\left(\frac{a}{D} \right)^2 + \frac{1}{3} \left(\frac{a}{D} \right)^4 \right] \text{ with adequate accuracy.}$$

¹⁾ BS 923, "Impulse-voltage testing".

When the feet of the spherometer are placed on the spheres in various positions in the region defined above, the difference between the measured values of h and the value given in the formula shall nowhere exceed:

0.1 per cent of the nominal diameter (D) if this is less than or equal to 100 cm.

0.2 per cent of the nominal diameter (D) if this is greater than 100 cm.

If a spherometer is not available, a flat circular gauge may be used for an approximate evaluation of surface irregularities.

NOTE The tolerances on size and shape need usually only be checked in the manner described above when the spheres are first supplied. It will normally be sufficient to make subsequent examinations by feeling the spheres or inspecting them visually.

c) *State of the surfaces.* In the neighbourhood of the sparking points the spheres shall be free from any trace of varnish, grease or other protective coating.

They shall be clean and dry but need not be polished.

If the spheres become excessively roughened or pitted in use they shall be reburnished or replaced.

NOTE If the relative humidity of the air exceeds about 90 per cent, moisture may condense on to the surface and the measurements will then cease to be accurate.

4 Construction and mounting of the spheres

a) *Vertical gap.* When the spheres are mounted vertically, the shank of the high-voltage sphere shall be free from sharp edges or corners and its diameter shall not exceed $0.2 D$ over a length D . This requirement is made in order to reduce the influence of the high-voltage shank on the flashover voltage. If a stress distributor is used at the end of the shank, its greatest dimensions, perpendicular to the axis of the spheres, shall not exceed $0.5 D$. Such stress distributors shall be at least $2 D$ from the sparking point of the high-voltage sphere.

The earthed shank and the operating gear have a smaller effect and their dimensions are therefore less important.

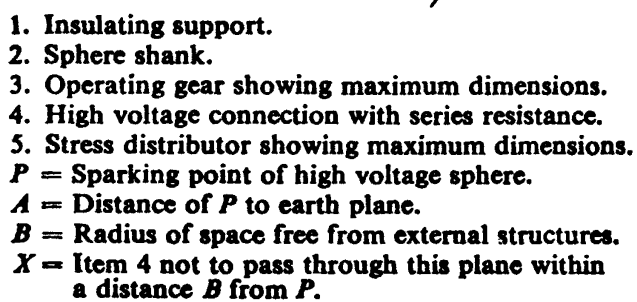
Figure 1 gives the limits of size of the components of a typical vertical sphere-gap.

b) *Horizontal gap.* The limiting dimensions of a typical sphere-gap for horizontally mounted spheres are given in Figure 2. They are the same for both sides of the gap.

NOTE The sphere shanks shall be reasonably in line, whichever form of gap is used.

5 Height of the spheres above the horizontal earth plane

The sphere-gap should be used with the sparking point at a distance A from an earthed plane, such as a conducting network in or on the floor of the laboratory, or some other large conducting surface; the distance A shall be within the limits given in Table 1. This requirement applies whether the axis of the gap is parallel or normal to the earthed plane.



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