

Guide for

Partial discharge measurements

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- Association of Short Circuit Testing Authorities
- British Industrial Ceramic Manufacturers' Association
- Electric Cable Makers Confederation
- Electrical and Electronic Insulation Association (BEAMA Ltd.)
- Electricity Supply Industry in England and Wales
- Transmission and Distribution Association (BEAMA Ltd.)

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National foreword

This revision of this British Standard has been prepared under the direction of the Power Electrical Engineering Standards Committee and supersedes BS 4828:1972 which is withdrawn. It is identical with IEC 270:1981 *“Partial discharge measurements”*, including the Corrigendum, published by the International Electrotechnical Commission (IEC).

Terminology and conventions. The text of the International Standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Cross-references

International Standard	Corresponding British Standard
IEC 60-2:1973	BS 923 <i>Guide on high-voltage testing techniques</i> Part 2:1980 <i>Test procedures</i> (Identical)

The Technical Committee has reviewed the provisions of C.I.S.P.R. Publication 16:1977, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard is BS 727:1983 *“Specification for radio-interference measuring apparatus”*.

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 to iv, pages 1 to 18, an inside back cover 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 standard applies to the measurement of partial discharges during tests with alternating voltage, but general terms, definitions and requirements are usually also applicable for measurement of partial discharges during tests with direct voltage. Some special characteristics of partial discharge measurements under direct voltage are given in a separate clause and necessary references are made throughout the text. This standard is intended principally as a general-guide to the drafting of specifications for specific apparatus.

Measurements of partial discharges are made for the following main purposes:

- to verify that the test object does not exhibit partial discharges greater than a specified magnitude, at a specified voltage;
- to determine the voltage amplitude at which partial discharges of a specified low magnitude commence with increasing voltage and cease with decreasing voltage;
- to determine the magnitude of the specified discharge quantity at a specified voltage.

The partial discharges which are considered in this standard are localized electrical discharges in insulating media, restricted to only a part of the dielectric under test and only partially bridging the insulation between conductors. Discharges mostly occur in the form of individual pulses, which can be detected as electrical pulses in the external circuit connected to the test object. However, a more continuous form may also occur, the so-called pulseless discharge. This form will normally not be detected by the measurement methods described in this standard.

Partial discharges may occur in cavities in solid insulation, in gas bubbles in liquid insulation or between layers of insulation with different dielectric characteristics. They may also occur at sharp edges or points of metallic surfaces.

Even though they involve only small amounts of energy, partial discharges may lead to progressive deterioration of the dielectric properties of insulating materials; the definition and evaluation of such deterioration, however, is beyond the scope of this standard.

Partial discharge measurements on cables and on apparatus having windings, such as transformers, generators and motors, are complicated by attenuation, resonance and travelling wave phenomena. Special requirements for tests on these objects are only briefly dealt with.

This standard deals mainly with electrical measurements of partial discharges, but some reference is also made to non-electrical methods.

2 Object

The objects of this standard are:

- to define the terms used;
- to define the relevant quantities to be measured;
- to describe test and measuring circuits which may be used;
- to recommend some types of measurement and instrumentation suitable for particular applications;
- to recommend methods for calibration;
- to describe test procedures;
- to give some assistance concerning the discrimination of partial discharges from external interference.

3 Definitions

3.1

partial discharge

a partial discharge, within the terms of this standard, is an electric discharge that only partially bridges the insulation between conductors. Such discharges may, or may not, occur adjacent to a conductor

NOTE Partial discharges in gases around a conductor are sometimes referred to as “corona”. This term should not be applied to other forms of partial discharges.

the general term “ionization” should not be used to denote the particular case of partial discharges

3.2 Quantities related to partial discharges

3.2.1

general

partial discharges occurring in any test object under given conditions may be characterized by different measurable quantities such as charge, repetition rate, etc. Quantitative results of measurements are expressed in terms of one or more of the specified quantities. For tests with direct voltage, see Clause 9

3.2.2

apparent charge q

the apparent charge q of a partial discharge is that charge which, if injected instantaneously between the terminals of the test object, would momentarily change the voltage between its terminals by the same amount as the partial discharge itself. The apparent charge is expressed in picocoulombs

NOTE 1 The apparent charge is not equal to the amount of charge locally involved at the site of the discharge and which cannot be directly measured.

NOTE 2 In practice, the waveform of the voltage appearing across the terminals of the test object due to the partial discharge itself may be different from that produced by the calibrating pulse. The apparent charge is considered to be that charge which, if injected between the terminals of the test object, will give the same reading on the measuring instrument as the partial discharge itself. Special cases are those in which the test objects include travelling wave or attenuation phenomena, see Appendix C.

3.2.3

repetition rate n

the partial discharge pulse repetition rate n is the average number of partial discharge pulses per second measured over a selected time

NOTE In practice, only pulses above a specified magnitude or within a specified range of magnitudes, may be considered. The results are sometimes expressed as cumulative frequency distribution curves of partial discharge magnitudes.

3.2.4

integrated quantities

for particular purposes integrated quantities which are characterized by summations over a time interval T are in use. This time interval is often long compared with the duration of one cycle of an alternating voltage applied to the test object

examples of such quantities are:

- the average discharge current I ,
this is the sum of the absolute values of the apparent charges during a certain time interval divided by this time interval;
- the quadratic rate D ,
this is the sum of the squares of the apparent charges, during a certain time interval, divided by this time interval;
- the discharge power P ,
this is the average power fed into the terminals of the test object due to partial discharges.

for particulars, see Appendix B

3.3

specified partial discharge magnitude

the specified partial discharge magnitude is the value of the partial discharge quantity stated in standards or specifications for the given test object at a specified voltage

3.4 Voltages related to partial discharges

voltage values during partial discharge tests are given by their peak values divided by $\sqrt{2}$ in the case of alternating voltages. The following voltages are of particular interest. For tests with direct voltages, see Clause 9.

3.4.1

partial discharge inception voltage U_i

the partial discharge inception voltage U_i is the lowest voltage at which partial discharges are observed in the test arrangement, when the voltage applied to the object is gradually increased from a lower value at which no such discharges are observed

in practice, the inception voltage U_i is the lowest voltage at which the partial discharge magnitude becomes equal to or exceeds a specified low value

3.4.2

partial discharge extinction voltage U_e

the partial discharge extinction voltage U_e is the lowest voltage at which partial discharges are observed in the test arrangement when the voltage applied to the object is gradually decreased from a higher value at which such discharges are observed in practice, the extinction voltage U_e is the lowest voltage at which the partial discharge magnitude becomes equal to or less than a specified low value

3.4.3

partial discharge test voltage

the partial discharge test voltage is a specified voltage, applied in a specified test procedure, during which the test object should not exhibit partial discharges exceeding a specified magnitude

4 Test circuits and measuring instruments

4.1 General requirements

In this clause, various types of test circuits and instruments for the measurement of partial discharges are briefly described. Whatever type of test circuit and measuring instrument is used, they should be calibrated as specified in Clause 5 and should meet the requirements specified by the relevant Technical Committee (Clauses 6 and 7). The relevant Technical Committee shall specify the particular quantity or quantities to be measured. Any instrument measuring this quantity or quantities is in general considered acceptable. The Committee may also recommend a particular test circuit to be used. If not otherwise specified by the relevant Technical Committee, any of the test circuits mentioned in Sub-clause 4.2 and any of the instruments mentioned in Sub-clause 4.3 are acceptable.

For tests with direct voltages, see Clause 9.

Non-electrical methods of partial discharge detection are not recommended for quantitative measurements, but they are useful for special purposes, for example, discharge location. Some information is therefore given in Sub-clause 4.4.