
Guide for

Insulation co-ordination

Part 1. Terms, definitions, principles and rules

Guide sur la coordination de l'isolement

Partie 1. Termes, définitions, principes et règles

Hinweisblatt über Isolierungskoordination

Teil 1. Begriffe, Definitionen, Grundsätze und Regeln

National foreword

This Part of this British Standard is identical with IEC Publication 71-1 'Insulation co-ordination' Part 1 : 1976 'Terms, definitions, principles and rules'. It is published under the direction of the General Electrotechnical Engineering Standards Committee.

Other Parts of this British Standard are to be:

Part 2 : 1979 Application guide (identical with IEC Publication 71-2 : 1976)

Part 3 Insulation co-ordination for Ranges A and B (still under development within the IEC).

This British Standard gives guidance to those concerned with the design and testing of electrical apparatus.

When designing for the UK market, insulation levels of Series I are required (see clause 41).

Terminology. The text of the international standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology is not identical with that used in British Standards; attention is especially drawn to the following.

Wherever the words 'this publication' or 'this standard' appear, referring to this standard, they should be interpreted as 'this British Standard' or 'this Part of this British Standard' as appropriate. The words 'the appropriate IEC publications', appearing in clause 39(b), should be interpreted as 'the appropriate British Standards'.

The words 'Apparatus Committee' or 'Apparatus Committees', appearing throughout, should be interpreted as meaning technical committee(s) concerned with the requirements for apparatus. Similarly, the references in note 1 to clause 28 and in the note to table II to 'apparatus standards' should be interpreted as meaning British Standards relating to apparatus. The references in clause 50 and in clause 54(d) to 'IEC Technical Committee' should be interpreted as 'BSI Technical Committee(s)'.

Where, as in 38.1, the words '50 % disruptive discharge voltage' appear, they should be interpreted as having the same sense as '50 % dielectric breakdown voltage' used in BS 923. Terms such as 'disruptive discharge voltage' may be interpreted by analogy.

Where, as in clause 40, the words 'surge arresters' appear, they should be interpreted as having the same sense as 'surge diverters' used in BS 2914.

The printing convention used in the titles of tables I, II, III and IV is not followed in British Standards. In these titles therefore, the italic arabic numerals, the italic symbols and the italic inferior should all be read as upright; the upright symbol should be read as italic.

Cross-references

International standard*	Corresponding British Standard
IEC 60 : 1962	BS 923 : 1972
revised in Parts thus:	Guide on high-voltage testing techniques (related, see note 1)
60-1 : 1973	
60-2 : 1973	
60-3 : 1976	
60-4 : 1977	
IEC 71-2 : 1976 (see note 2)	BS 5622 Guide for insulation co-ordination Part 2 : 1979 Application guide (identical)
IEC 76 : 1967	BS 171 : 1970
revised in Parts thus:	Power transformers (related), revised in identical dual-numbered Parts of BS 171 thus:
76-1 : 1976	Part 1 : 1978 General
76-2 : 1976	Part 2 : 1978 Specification for temperature rise requirements
76-4 : 1976	Part 4 : 1978 Specification for tappings and connections
76-5 : 1976	Part 5 : 1978 Specification for ability to withstand short circuit
(see note 3)	(generic title of the revised BS 171 is unaltered) (see note 3)
IEC 99-1A : 1975	BS 2914 : 1972 Surge diverters for alternating current power circuits (appendix C is technically equivalent, see note 4)
IEC 186 : 1969	BS 3941 : 1975
*Undated in the text.	Voltage transformers (related, see note 5)

NOTE 1. As stated in its foreword, BS 923 : 1972 is based on IEC 60 : 1962 but 'also incorporates some information which will appear in the next revision of that publication'.

For the purposes of this standard and taking account of differing terminology as noted under 'Terminology' in this national foreword, BS 923 is technically equivalent to IEC 60.

NOTE 2. The 1976 edition of IEC 71-2 is referred to throughout as 'the second edition'.

In the last paragraph of clause 2 of this standard, the words 'will be supplemented' and '(in preparation) which will constitute', relating to IEC 71-2, should be read as 'is supplemented' and 'which constitutes', respectively.

NOTE 3. IEC 76-3 has not yet been published; until it has, IEC 76 : 1967 will continue to apply as appropriate. Similarly, BS 171 : 1970 has not been withdrawn.

The reference to IEC 76 (in the note to clause 55 of this standard) constitutes informative matter only.

NOTE 4. Appendix C of BS 2914 : 1972 is a reproduction of IEC 99-1A : 1965 except as noted under 'Terminology' in this national foreword; there are also some minor editorial and numbering changes.

Clause C.3 of BS 2914 : 1972 corresponds to clause 3 of IEC 99-1A : 1965.

NOTE 5. The reference (in the note to clause 55 of this standard) to IEC 186, for which there is no technically equivalent British Standard, constitutes informative matter only and, since no mandatory requirements are involved, the validity of this British Standard is not affected.

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British Standard Guide for

Insulation co-ordination

Part 1. Terms, definitions, principles and rules

CHAPTER 1: GENERAL CONSIDERATIONS

SECTION ONE — SCOPE AND OBJECT

1. Scope

This standard applies to equipment for three-phase a.c. systems, having a highest voltage for equipment above 1 kV.

This standard covers only phase-to-earth insulation, except in respect of some definitions. Standards for insulation other than phase-to-earth insulation are under study.

2. Object

The object of this standard is to specify the insulation of the various items of equipment used in a given installation. Each Apparatus Committee is responsible for specifying the insulation level and test procedure suitable for its equipment, taking into consideration the recommendations given in the following sections; in particular, for the tests prescribed in this standard, the values of the rated withstand voltages shall be chosen from the standardized insulation levels of this publication.

This standard will be supplemented by Publication 71-2 (in preparation) which will constitute the Application Guide.

SECTION TWO — DEFINITIONS

The following definitions have been adopted for the purpose of this standard.

3. Nominal voltage of a three-phase system

The r.m.s. phase-to-phase voltage by which the system is designated and to which certain operating characteristics of the system are related.

4. Highest voltage of a three-phase system

The highest r.m.s. phase-to-phase voltage which occurs under normal operating conditions at any time and at any point of the system. It excludes voltage transients (such as those due to system switching) and temporary voltage variations due to abnormal system conditions (such as those due to fault conditions or the sudden disconnection of large loads).

5. Highest voltage for equipment

The highest r.m.s. phase-to-phase voltage for which the equipment is designed in respect of its insulation as well as other characteristics which relate to this voltage in the relevant equipment standards.

This voltage is the maximum value of the highest voltage of the system for which the equipment may be used.

In this standard, the highest voltage for equipment will be represented by U_m .

Note. — In systems with highest voltage for equipment equal to or greater than 123 kV, this voltage U_m in general does not materially differ from the highest value of the system operating voltage. Below 123 kV, the voltage U_m may be higher than the highest system voltage, since each standard value of U_m applies to different systems the nominal voltage of which may differ by as much as 20% (for instance: $U_m = 24$ kV covers 20 kV and 22 kV), and having therefore different values of the highest system voltage.

6. External insulation

The distances in air and the surfaces in contact with open air of solid insulation of the equipment which are subject to dielectric stresses and to the effects of atmospheric and other external conditions such as pollution, humidity, vermin, etc.

7. Internal insulation

The internal solid, liquid or gaseous parts of the insulation of equipment which are protected from the effects of atmospheric and other external conditions such as pollution, humidity, vermin, etc.

8. Indoor external insulation

External insulation which is designed to operate inside buildings and consequently not exposed to the weather.

9. Outdoor external insulation

External insulation which is designed to operate outside buildings and consequently exposed to the weather.

10. Self-restoring insulation

Insulation which completely recovers its insulating properties after a disruptive discharge caused by the application of a test voltage; insulation of this kind is generally, but not necessarily, external insulation.

11. Non-self-restoring insulation

Insulation which loses its insulating properties or does not recover them completely, after a disruptive discharge caused by the application of a test voltage; insulation of this kind is generally, but not necessarily, internal insulation.

12. Type test

A test made on one piece of equipment or on several similar pieces intended to show that all pieces of equipment made to the same specification and having the same essential details would pass an identical test; it is usually not repeated on different deliveries.

25. Temporary overvoltage

An oscillatory phase-to-earth or phase-to-phase overvoltage at a given location of relatively long duration and which is undamped or only weakly damped.

Temporary overvoltages usually originate from switching operations or faults (e.g. load rejection, single-phase faults) and/or from non-linearities (ferro-resonance effects, harmonics). They may be characterized by their amplitude, their oscillation frequencies, and by their total duration or their decrement.

26. Statistical switching (lightning) impulse withstand voltage

The peak value of a switching (lightning) impulse test voltage at which insulation exhibits under specified conditions a probability of withstand equal to a specified reference probability.

This reference probability is chosen as 90% in this standard.

The concept of statistical withstand is at present applicable only to self-restoring insulation.

27. Conventional switching (lightning) impulse withstand voltage

The peak value of a switching (lightning) impulse test voltage at which an insulation shall not show any disruptive discharge when subjected to a specified number of applications of this impulse, under specified conditions.

This concept applies particularly to non-self-restoring insulations.

28. Rated switching (lightning) impulse withstand voltage

The prescribed peak value of the switching (lightning) impulse withstand voltage which characterizes the insulation of an equipment as regards the withstand tests.

Notes 1. — Depending on the kind of insulation and complying to what is specified in the relevant apparatus standards, dielectric tests are made to verify that:

- the statistical switching (lightning) impulse withstand voltage is equal to or higher than the rated switching (lightning) impulse withstand voltage (see Sub-clause 40.2);
- the conventional switching (lightning) impulse withstand voltage is equal to or higher than the rated switching (lightning) impulse withstand voltage (see Sub-clause 40.3).

2. — The standard impulse shapes used for withstand tests on equipment as well as the test procedures are defined in Chapter V.

29. Rated short duration power-frequency withstand voltage

The prescribed r.m.s. value of sinusoidal power-frequency voltage that the equipment shall withstand during tests made under specified conditions and for a specified time usually not exceeding 1 min.

30. Rated insulation level

- a) For equipment with highest voltage for equipment equal to or greater than 300 kV: the rated switching and lightning impulse withstand voltages.
- b) For equipment with highest voltage for equipment lower than 300 kV: the rated lightning impulse and short duration power-frequency withstand voltages.

31. Statistical safety factor

For a given type of event, the ratio of the appropriate statistical switching (or lightning) impulse withstand voltage to the statistical overvoltage, established on the basis of a given risk of failure, taking into account the statistical distributions of withstand voltages and overvoltages.

Note. — Indications regarding the correlation between the minimum value of the statistical safety factor and the risk of failure not to be exceeded will be found in the second edition of the Application Guide (IEC Publication 71-2).

32. Conventional safety factor

The ratio of a conventional switching (or lightning) impulse withstand voltage to the corresponding conventional maximum overvoltage, established on the basis of experience and taking into account the possible deviations of the actual withstand voltage and overvoltages from their conventional values as well as any other factors.

33. Protection level of a protective device

The highest peak voltage values which should not be exceeded at the terminals of a protective device when respectively switching impulses and lightning impulses of standard shapes and rated values are applied under specified conditions.

Notes 1. — The value for lightning impulses is the highest value of any of the following:

- maximum sparkover voltage with 1.2/50 impulse;
- maximum residual voltage at the specified current;
- maximum front-of-wave sparkover voltage divided by 1.15.

2. — Either the statistical or the conventional impulse protective level can be considered, with the same meaning as in Clauses 23, 24, 26 and 27.

34. Protection factors of a protective device

The protection factors of a protective device are the ratios of the switching impulse and lightning impulse values respectively of the protection level of a protective device to the peak value of the rated voltage of the protective device.

Note. — In the case of spark gaps, the phase-to-earth voltage corresponding to the highest voltage for equipment is used conventionally as the rated voltage.

SECTION THREE — BASIC PRINCIPLES OF INSULATION CO-ORDINATION

35. Insulation co-ordination

Insulation co-ordination comprises the selection of the electric strength of equipment and its application, in relation to the voltages which can appear on the system for which the equipment is intended and taking into account the characteristics of available protective devices, so as to reduce to an economically and operationally acceptable level the probability that the resulting voltage stresses imposed on the equipment will cause damage to equipment insulation or affect continuity of service.

36. Voltage stresses and other factors affecting insulation

The following classes of dielectric stresses may be encountered during the operation of an equipment:

- power-frequency voltages, under normal operating conditions, i.e. not exceeding the highest voltage for equipment;
- temporary overvoltages;