INTERNATIONAL STANDARD

IEC 60137

Fifth edition
2003-08

Insulated bushings for alternating voltages above 1 000 V

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 60137:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE X

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSULATED BUSHINGS FOR ALTERNATING VOLTAGES ABOVE 1 000 V

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60137 has been prepared by sub-committee 36A: Insulated bushings, of IEC technical committee 36: Insulators.

This fifth edition cancels and replaces the fourth edition, published in 1995, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- standard values of highest voltage for equipment of 550 kV and 800 kV to replace 525 kV and 765 kV;
- consideration of the development in the use of non-ceramic insulating envelopes and to special requirements for bushings used in air-insulated ducting;
- special requirements for bushings fitted to transformers.

The text of this standard is based on the following documents:

FDIS	Report on voting
36A/111/FDIS	36A/114/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2003. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

To reflect the current usage of the term “composite bushing”, the definition has been changed to mean a bushing with an insulating envelope consisting of a resin impregnated fibre tube with rubber compound covering. The previous definition of a multi-dielectric bushing is given the term “combined insulation bushing”.

For bushings operating in air-insulated ducting, locally high ambient air temperatures have a significant effect on their current rating. This edition defines a limit to this temperature and specifies corresponding test conditions.

The term “highest voltage for equipment” is introduced into this standard in preference to “rated voltage”. This change is in line with other equipment standards.

Gas-insulated and gas-impregnated bushings have become a mature technology, for use in gas insulated switchgear. Limiting values for temperature rise and dielectric dissipation factor have therefore been introduced.

The special requirements addressed for bushings fitted to transformer have not been considered necessary for bushings fitted to switchgear or used for other applications. A high level of integrity is needed to ensure that the bushing will not fail, or be the initiator of internal flashover in the transformer under test. Dry power-frequency withstand test voltage levels for transformers bushings should be increased according to 9.3. Extension of the range of application of lightning impulse and switching impulse tests, included in IEC 60076-3, is not considered technically or commercially justified for bushing routine or type tests.

The dynamic current withstand test is not mentioned in the text, because insufficient experience has so far been collected to design a realistic test.

INSULATED BUSHINGS FOR ALTERNATING VOLTAGES ABOVE 1 000 V

1 Scope

This International Standard specifies the characteristics and tests for insulated bushings.

This standard is applicable to bushings, as defined in Clause 3, intended for use in electrical apparatus, machinery, transformers, switchgear and installations for three-phase alternating current systems, having highest voltage for equipment above 1 000 V and power frequencies of 15 Hz up to and including 60 Hz.

Subject to special agreement between purchaser and supplier, this standard may be applied, in part or as a whole, to the following:

- bushings used in other than three-phase systems;
- bushings for high-voltage, direct current systems;
- bushings for testing transformers;
- terminals for power cables (potheads);
- bushings for capacitors.

Special requirements and tests for transformer bushings in this standard apply also to reactor bushings.

This standard is applicable to bushings made and sold separately. Bushings which are a part of an apparatus and which cannot be tested according to this standard, should be tested with the apparatus of which they form part.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038:1983, *IEC standard voltages*
Amendment 2 (1997)

IEC 60050(212):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 212: Insulating solids, liquids and gases*

IEC 60059:1999, *IEC standard current ratings*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-17:1994, *Basic environmental testing procedures – Part 2: Tests – Test Q: Sealing*

IEC 60071-1:1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60076-5:2000, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60216-2:1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 2: Choice of test criteria*

IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements*

IEC 60354:1991, *Loading guide for oil-immersed power transformers*

IEC 60505:1999, *Evaluation and qualification of electrical insulation systems*

IEC 60507:1991, *Artificial pollution tests on high-voltage insulators to be used on a.c. systems*

IEC 60815:1986, *Guide for the selection of insulators in respect of polluted conditions*

IEC 61462:1998, *Composite insulators – Hollow insulators for use in outdoor and indoor electrical equipment – Definitions, test methods, acceptance criteria and design recommendations*

IEC 61463:1996, *Bushings – Seismic qualification*

IEC 62155:2003, *Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V*

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
bushing
device that enables one or several conductors to pass through a partition such as a wall or a tank, and insulates the conductors from it. The means of attachment (flange or fixing device) to the partition forms part of the bushing

[IEV 471-02-01, modified]

NOTE 1 The conductor may form an integral part of the bushing or be drawn into the central tube of the bushing.

NOTE 2 The bushing may be of the types as prescribed in 3.2 to 3.21.

3.2
liquid-filled bushing
bushing in which the space between the inside surface of the insulating envelope and the solid major insulation is filled with oil

3.3
compound-filled bushing
bushing in which the space between the inside surface of the insulating envelope and the solid major insulation is filled with an insulating compound

3.4
liquid-insulated bushing
bushing in which the major insulation consists of oil or another insulating liquid

3.5
gas-filled bushing
bushing in which the space between the inside surface of the insulating envelope and the solid major insulation is filled with gas (other than ambient air) at atmospheric pressure or higher

NOTE This definition includes bushings which are intended to form an integral part of gas-insulated equipment, the gas of the equipment being in communication with that of the bushing.

3.6
gas-insulated bushing
bushing in which the major insulation consists of gas (other than ambient air) at atmospheric pressure or higher

NOTE 1 This definition includes bushings which are intended to form an integral part of gas-insulated equipment, the gas of the equipment being in communication with that of the bushing.

NOTE 2 A bushing which contains solid insulating materials other than the envelope containing the gas (e.g. support for conducting layers or insulating cylinder), is a combined insulation bushing (see 3.13).

3.7
gas-impregnated bushing
bushing in which the major insulation consists of a core wound from paper or plastic film (GIF) and subsequently treated and impregnated with gas (other than ambient air) at atmospheric pressure or higher, the space between the core and the insulating envelope being filled with the same gas

3.8
oil-impregnated paper bushing
OIP
bushing in which the major insulation consists of a core wound from paper and subsequently treated and impregnated with an insulating liquid, generally transformer oil

NOTE The core is contained in an insulating envelope, the space between the core and the insulating envelope being filled with the same insulating liquid as that used for impregnation.

3.9
resin-bonded paper bushing
RBP
bushing in which the major insulation consists of a core wound from resin-coated paper

NOTE 1 During the winding process, each paper layer is bonded to the previous layer by its resin coating and the bonding achieved by curing the resin.

NOTE 2 A resin-bonded paper bushing can be provided with an insulating envelope, in which case the intervening space can be filled with an insulating liquid or another insulating medium.

3.10
resin-impregnated paper bushing
RIP
bushing in which the major insulation consists of a core wound from untreated paper and subsequently impregnated with a curable resin

NOTE A resin-impregnated paper bushing can be provided with an insulating envelope, in which case the intervening space can be filled with an insulating liquid or another insulating medium.

3.11
ceramic, glass or analogous inorganic material bushing
bushing in which the major insulation consists of a ceramic, glass or analogous inorganic material

3.12
cast or moulded resin-insulated bushing
bushing in which the major insulation consists of a cast or moulded organic material with or without an inorganic filler

3.13
combined insulation bushing
bushing in which the major insulation consists of a combination of at least two different insulating materials

3.14
capacitance graded bushing
bushing, in which a desired voltage grading is obtained by an arrangement of conducting or semiconducting layers incorporated into the insulating material

[IEV 471-02-02, modified]

3.15
indoor bushing
bushing, both ends of which are intended to be in ambient air at atmospheric pressure, but not exposed to outdoor atmospheric conditions

[IEV 471-02-03]

3.16
outdoor bushing
bushing, both ends of which are intended to be in ambient air at atmospheric pressure and exposed to outdoor atmospheric conditions

[IEV 471-02-04]

3.17
outdoor-indoor bushing
bushing, both ends of which are intended to be in ambient air at atmospheric pressure

NOTE One end is intended to be exposed to outdoor atmospheric conditions, and the other end not to be exposed to outdoor atmospheric conditions.

[IEV 471-02-05]

3.18
indoor-immersed bushing
bushing, one end of which is intended to be in ambient air but not exposed to outdoor atmospheric conditions and the other end to be immersed in an insulating medium other than ambient air (e.g. oil or gas)

[IEV 471-02-06]

NOTE This definition includes bushings operating in air at temperatures above ambient, such as occur with air-insulated ducting.

3.19
outdoor-immersed bushing
bushing, one end of which is intended to be in ambient air and exposed to outdoor atmospheric conditions and the other end to be immersed in an insulating medium other than ambient air (e.g. oil or gas)

[IEV 471-02-07]

3.20
completely immersed bushing
bushing, both ends of which are intended to be immersed in an insulating medium other than ambient air (e.g. oil or gas)

[IEV 471-02-08, modified]

3.21
bushing for separable connector
plug-in type bushing
bushing, one end of which is immersed in an insulating medium and the other end designed to receive a separable insulated cable connector, without which the bushing cannot function

3.22
highest voltage for equipment
U_m
highest r.m.s. value of 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 standard

[IEV 604-03-01]

3.23
rated phase-to-earth voltage
maximum r.m.s. value of the voltage which the bushing withstands continuously between the conductor and the earthed flange or other fixing device, under the operating conditions specified in Clause 5

3.24
rated current
I_r
maximum r.m.s. value of current which the bushing can carry continuously under the operating conditions specified in Clause 5, without exceeding the temperature rise limits of Table 2

3.25
rated thermal short-time current
I_{th}
r.m.s. value of a symmetrical current which the bushing withstands thermally for the rated duration (t_{th}) immediately following continuous operation at rated current with maximum temperatures of ambient air and immersion media in accordance with 5.3

3.26
rated dynamic current
I_d
peak value of a current which the bushing withstands mechanically

3.27
temperature rise
difference between the measured temperature of the hottest spot of the metal parts of the bushing which are in contact with insulating material and the ambient air temperature (see 4.8)

3.28
rated frequency
f_r
frequency at which the bushing is designed to operate

[IEV 421-04-03, modified]