INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDE 111

Second edition
2004-07

Electrical high-voltage equipment in high-voltage substations – Common recommendations for product standards

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Electrical high-voltage equipment in high-voltage substations – Common recommendations for product standards

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL HIGH-VOLTAGE EQUIPMENT IN HIGH-VOLTAGE SUBSTATIONS – COMMON RECOMMENDATIONS FOR PRODUCT STANDARDS

FOREWORD

This second edition of IEC Guide 111 has been prepared in accordance with Annex A of Part 1 of the ISO/IEC Directives by an *ad hoc* group of the Standardization Management Board set up to harmonize characteristics for substation standards.

It constitutes a technical revision of the first edition, published in 1998. This edition has been amended to express more clearly the guidance being provided to product committees and contains corrected and completed technical material and references.

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

Approval document	Report on voting
C/1325/DV	C/1334/RV

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

INTRODUCTION

This Guide is for use by technical committees (TCs) involved in high-voltage (HV) substation systems, such as:

TC 13, TC 14, TC 17, TC 20, TC 22, TC 28, TC 32, TC 33, TC 36, TC 37, TC 38, TC 57, TC 95, TC 99.

It is of paramount importance that the IEC, through this Guide, finds a way to overcome the lack of consistency and unnecessary discrepancies between standards within one system, even though a few discrepancies might be justified in certain cases according to the specificity of a given product or situation.

Furthermore, the cost of over-standardization of one component when the nearest linked component is under-standardized should be considered. The supplementary cost does not in any way increase the reliability of the system as a whole.

Since the same external stresses (climatic, electrical, mechanical) apply to all the components of the substations, the consistency of their technical features is vital.

Hence, standards will deal more and more with the same essential requirements for safety, environmental impact, end of life, availability and integration of systems. All product standards for a single system have to fulfil these requirements with the same degree of responsibility.

The aim of this Guide is to provide common rules for HV substation equipment.

ELECTRICAL HIGH-VOLTAGE EQUIPMENT IN HIGH-VOLTAGE SUBSTATIONS – COMMON RECOMMENDATIONS FOR PRODUCT STANDARDS

1 Scope

IEC Guide 111 is a horizontal publication which gives guidance for the harmonization of product and system standards within substations where the highest voltage for equipment is higher than 1 kV. It primarily addresses conventional a.c. equipment which is found in high-voltage (HV) substations in most cases.

This Guide contains recommendations for common specifications for all HV substation product standards, each of which is augmented by the technical background specific to each TC, which naturally retains freedom in its technical choices.

Where HV power electronic equipment is part of an HV substation, for example, HVDC or SVC, economics and technology dictate a deviation from common clauses as standardized for a.c. equipment. However, when developing product standards for HV power electronic equipment for use in HV substations, the common recommendations of this Guide should be adopted as far as possible.

Clearly, any specification in this guide which is inapplicable to a certain type of product, because of that product's inherent characteristics, for example, should not be taken into account when writing standards for that type of product.

2 Reference documents

IEC 60027-1, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60038, *IEC standard voltages*

IEC 60059, *IEC standard current ratings*

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

IEC 60068 (all parts), *Environmental testing*

IEC 60068-2-18, *Environmental testing – Part 2-18: Tests – Test R and guidance: Water*

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

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

IEC 60071-2, *Insulation co-ordination – Part 2: Application guide*

IEC 60216 (all parts), *Electric insulating materials – Properties of thermal endurance*

IEC 60296, *Specification for unused mineral insulating oils for transformers and switchgear*

IEC 60376, *Specification and acceptance of new sulphur hexafluoride*

IEC 60417 (all parts), *Graphical symbols for use on equipment*

IEC 60480, *Guide to the checking of sulphur hexafluoride (SF_6) taken from electrical equipment*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60694, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 60695, *Fire hazard testing*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 60721-2-2, *Classification of environmental conditions – Part 2-2: Environmental conditions appearing in nature – Precipitation and wind*

IEC 60721-2-4, *Classification of environmental conditions – Part 2-4: Environmental conditions appearing in nature -- Solar radiation and temperature*

IEC 60721-2-6, *Classification of environmental conditions – Part 2-6: Environmental conditions appearing in nature – Earthquake vibration and shock*

IEC 60826, *Loading and strength of overhead transmission lines*

IEC 60867, *Insulating liquids – Specifications for unused liquids based on synthetic aromatic hydrocarbons*

IEC 60943, *Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals*

IEC 61000-6-5, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation environments*

IEC 61180-1, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

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

CISPR 11, *Industrial scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

CISPR 18-2, *Radio interference characteristics of overhead power lines on high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits*

IEC Guide 109, *Environmental aspects – Inclusion in electrotechnical standards*

ISO 1996-1, *Acoustics – Description and measurement of environmental noise – Part 1: Basic quantities and procedures*

3 Guidance for the “Normative references” clause in product standards

The use of horizontal publications is of the utmost importance for the harmonization process. Strong reasons are needed to depart from the recommendations of horizontal publications, and, in all cases, it is necessary to explain the reason for any discrepancy.

Within the fields concerned, the essential horizontal documents to be taken into account and to be mentioned in the normative references clause of each standard are the following:

- field of definitions: International Electrotechnical Vocabulary (IEC 60050);
- field of voltage: IEC 60038;
- field of current: IEC 60059;
- field of insulation: IEC 60060, IEC 60071, IEC 60815 and IEC 61180;
- field of temperature rise: IEC 60216 and IEC 60943;
- field of degrees of protection: IEC 60529;
- field of environment: IEC 60664, IEC 60721, IEC 61166, IEC 60376, IEC 60296, IEC 60867 and IEC Guide 109;
- field of electromagnetic compatibility (EMC): IEC Guide 107; horizontal publications in the IEC 61000 series; CISPR 11, 18, 22 and 24;
- field of safety: IEC Guide 104; ISO/IEC Guide 51; ISO 60695 series
- field of mechanical stresses: IEC 60865 and IEC 62155.

4 Guidance for the “Definitions” clause in product standards

Definitions already in the IEV should always be used. If a definition already in the IEV is not satisfactory or not clear enough, the difficulty should be referred to TC 1 and solved in cooperation. New definitions should be discouraged unless absolutely necessary, i.e. no similar definition exists in publications on a similar subject. A similar definition may be modified with a reference to the original.

5 Environmental conditions

5.1 General

This clause should be the same for all TCs active in the area of substations. Installations, including all devices and auxiliary equipment which form an integral part of them, should be designed for operation under the climatic and environmental conditions listed below. Equipment product standards should be taken into account.

It is recommended that TCs should use the phrase “environmental conditions” in preference to “service conditions”.

5.2 Normal environmental conditions

Table 1 – Normal environmental conditions

			Indoor equipment	Outdoor equipment
a)	Ambient air temperature[1]	Upper limit	≤ 40 ºC	2 ≤ 40 ºC
		and 24 h average	≤ 35 ºC	≤ 35 ºC
		and one category: or or	"-5 indoor": ≥ –5 °C "-15 indoor": ≥ –15 °C "-25 indoor": ≥ –25 °C	"-10 outdoor": ≥ –10 °C "-25 outdoor": ≥ –25 °C "-40 outdoor": ≥ –40 °C
b)	Solar radiation (clear day, noon)		Negligible	≤ 1 000 W/m^2 [3]
c)	Altitude		≤ 1 000 m	≤ 1 000 m
d)	Air pollution by dust, salt, smoke, corrosive/flammable gas, vapours		No significant air pollution	≤ Level II – Medium (Table 1 of IEC 60071-2)
e)	Ice coating[4]		-	class 1: ≤ 1 mm or class 10: ≤ 10 mm or class 20: ≤ 20 mm
f)	Wind speed		-	≤ 34 m/s (correspond to 700 Pa on cylindrical surfaces) [5]
g)	Relative humidity: 24 h average		≤ 95 % [6]	
	Condensation, precipitation			7
h)	Vibration (external to equipment), earth tremors		Negligible	Negligible
i)	Electromagnetic disturbances		According to IEC Guide 107	According to IEC Guide 107

1 On auxiliary equipment, such as relays and control switches, intended to be used in ambient air temperature below –5 °C, an agreement between supplier and user is necessary.

2 Rapid temperature changes should be taken into account.

3 NOTE 1 Under certain conditions of solar radiation, appropriate measures, for example, roofing, forced ventilation, etc., may be necessary or derating may be used in order not to exceed the specified temperature rises.

NOTE 2 Details of global solar radiation are given in IEC 60721-2-4.

NOTE 3 Ultraviolet (UV) radiation can damage some synthetic materials. For more details see IEC 60068.

4 In regions where icing can occur the resulting load on flexible conductors and on rigid busbars and conductors should be taken into account.

If local experience or statistics are not available, ice coatings of 1 mm, 10 mm or 20 mm based on criteria given in IEC 60694 may be assumed. The density of the ice is assumed to be 900 kg/m^3 in accordance with IEC 60826.

5 Characteristics of wind are described in IEC 60721-2-2.

6 For these conditions, condensation may occasionally occur.

NOTE 1 Condensation can be expected where sudden temperature changes occur in periods of high humidity.

NOTE 2 To avoid breakdown of insulation or corrosion of metallic parts due to high humidity and condensation, equipment designed for such conditions and tested accordingly should be used.

NOTE 3 Condensation may be prevented by special design of the building or housing, by suitable ventilation and heating of the station or by the use of dehumidifying equipment.

7 Precipitation in the form of dew, condensation, fog, rain, snow, ice or hoar frost should be taken into account.

NOTE Precipitation characteristics for insulation are described in IEC 60060-1 and IEC 60071-1. For other properties, precipitation characteristics are described in IEC 60721-2-2.

5.3 Special environmental conditions

When high-voltage equipment is used under conditions different from the normal environmental conditions given in 5.2, the user's requirements should refer to the standardized steps given in Table 2.

Table 2 – Special environmental conditions

		Special environmental conditions	Notes
a)	Ambient air temperature	Very cold climates: –50 °C to +40 °C Very hot climates: –5 °C to +50 °C	
b)	Altitude	> 1 000 m	For installation at an altitude higher than 1 000 m above sea level, the insulation level of external insulation under the standardized reference atmospheric conditions should be determined by multiplying the insulation withstand voltages required at the service location by a factor K_a in accordance with IEC 60071-2. NOTE 1 For internal pressurized insulation, the dielectric characteristics are identical at any altitude and no special precautions need to be taken. NOTE 2 For low-voltage auxiliary and control equipment, no special precautions need be taken if the altitude is lower than 2 000 m above sea-level. For higher altitudes, see IEC 60664-1. NOTE 3 The pressure variation due to altitude is given in IEC 60721. Regarding this phenomenon, particular attention should be devoted to the following points: – thermal exchanges by convection, conduction or radiation; – efficiency of heating or air-conditioning; – operating level of pressure devices; – efficiency of diesel generating set or compressed air station; – increase of corona effect.
c)	Air pollution by dust, salt, smoke, corrosive/ flammable gas, vapours	Level III: heavy, or Level IV: very heavy (Table 1 of IEC 60071-2)	
d)	Relative humidity		In certain regions with frequent occurrence of warm, humid winds, sudden changes of temperature may occur resulting in condensation, even indoors. In tropical indoor conditions, the average value of relative humidity measured during a period of 24 h can be 98 %.
e)	Vibration (external to equipment)	According to IEC 60721-2-6	

		Special environmental conditions	Notes
f)	Seismic conditions		Installations situated in a seismic environment should be designed to take this into account. This should be achieved by applying the following measures. a) Any individual equipment should be designed to withstand the dynamic forces resulting from the vertical and horizontal motions of the soil. These effects may be modified by the response of the foundation and/or the supporting frame and/or the floor in which this equipment is installed. The spectrum of the impulse earthquake should be considered for the design of the equipment. b) The layout should be chosen in order to limit the following loads to acceptable values: - loads due to interconnections between adjoining devices needing to accommodate large relatively axial, lateral, torsional or other movements, bearing in mind that other stresses may develop during an earthquake; - the service stresses of equipment, which may be transmitted through a common monolithic foundation or floor (for example opening/reclosing of circuit-breakers). Where load specifications apply to the installation of civil work or equipment to meet seismic conditions then these specifications should be observed.

When special environmental conditions prevail at the location where equipment is to be put in service, they should be specified by the user by reference to IEC 60721-1.

6 Ratings

6.1 General

The common ratings of equipment, including their operating devices and auxiliary equipment, if any, are the rated values and operating conditions selected from the following, if applicable:

a) highest voltage for equipment (U_m);

b) rated insulation level;

c) rated frequency (f_r);

d) rated current (I_r);

e) rated short-time withstand short-circuit current (I_k);

f) rated peak withstand current (I_p);

g) rated duration of short circuit (t_k);

h) rated supply voltage of auxiliary circuits (U_a);

i) rated supply frequency of auxiliary circuits.

NOTE Other rated characteristics may be necessary and will be specified in the relevant IEC standards.

6.2 Highest voltage for equipment

Highest voltage for equipment should always be used. In some product standards, “rated voltage” assuming normal environmental conditions currently appears, and “highest voltage for equipment” is not used; it is recommended to replace it with “highest voltage for equipment”.

Standard values should be selected from IEC 60038.

6.3 Rated insulation levels

The rated insulation level of equipment, that is, the set of standard withstand voltages which characterize the dielectric strength of the insulation, should be selected from the standardized values given in IEC 60071-1.

For most instances of the highest voltage for equipment, several rated insulation levels exist to allow for the application of different performance criteria or overvoltage patterns. The choice should be made by considering the degree of exposure to fast-front and slow-front over-voltages, the type of neutral earthing of the system and the type of overvoltage limiting devices (see IEC 60071-2).

6.4 Rated frequency

The standard values of the rated frequency are 50 Hz and 60 Hz.

6.5 Rated current

The values of rated current, which is the r.m.s. value of the current which equipment should be able to carry continuously under specified conditions of use and behaviour, should be selected from the R 10 series, specified in IEC 60059.

NOTE 1 The R 10 series comprises the numbers 1; 1,25; 1,6; 2; 2,5; 3,15; 4; 5; 6,3; 8; and their products multiplied by 10^n.

This term is equivalent to “rated normal current”, as used in some committees currently. It is preferable to use only the expression “rated current”.

NOTE 2 In the area of transformers, rated power is used and not rated current.

6.6 Rated short-time withstand current

This is the r.m.s. value of the current which the equipment can carry during a specified short time under prescribed conditions of use and behaviour.

The standard values of rated short-time current should be selected from the R 10 series specified in IEC 60059.

6.7 Rated peak withstand current

This is the peak current associated with the first major loop of the rated short-time withstand current which equipment can carry under prescribed conditions of use and behaviour.

The rated peak withstand current should correspond to the rated frequency and the time constant of the d.c. component of the system.

The time constant of the d.c. component of the system depends strongly on the network characteristics, namely type of lines, type of transformers, nominal voltage etc., and is the same for every piece of equipment in a single substation.

The preferred time constant of the d.c. component should be 45 ms, which corresponds to more than 80 % of the market need. For this value, the rated peak withstand current is 2,5 times the rated short-time current for 50 Hz and 2,6 times the rated short-time current for 60 Hz.

For other cases and for standardization purposes, the other recommended time constants of the d.c. components are 60 ms, 80 ms and 120 ms.

6.8 Rated duration of short circuit

This is the interval of time for which equipment can carry a current equal to its rated short-time withstand current.

The preferred value of rated duration of short circuit is 1 s.

If necessary, a value lower or higher than 1 s may be chosen. The recommended values are 0,5 s, 2 s and 3 s.

6.9 Rated supply voltage of auxiliary and control circuits

The supply voltage of auxiliary and control circuits should be understood to mean the voltage measured at the circuit terminals of the apparatus itself during its operation, including, if necessary, the auxiliary resistors or accessories supplied or required by the manufacturer to be installed in series with it, but not including the conductors for the connection to the electricity supply.

The rated supply voltage should be selected from the standard values given in Table 3 for d.c. (tolerance –15 %, +10 %) and in IEC 60038 for a.c., except for equipment with a self-contained auxiliary voltage supply.

Table 3 – DC supply voltage

DC supply voltage V
24
48
60
110
125
220
250

6.10 Rated supply frequency of auxiliary and control circuits

The standard values of rated supply frequency of auxiliary and control circuits are, for a.c. frequency supply, the rated frequency of the main circuit. This supply may be d.c.

7 Design and construction

7.1 Requirements for liquids and gases in equipment

Product standards using liquid or gas for insulation should refer to the relevant horizontal standards:

- IEC 60376 for new SF_6 or IEC 60480 for used SF_6, or
- IEC 60296 for oil, or
- IEC 60867 for synthetic fluid.

7.2 Earthing of equipment

The frame of each equipment should be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions. The connecting point should be marked with the “earth” symbol, as indicated by symbol 5019 of IEC 60417. The earthing connection should be designed in such a way that catalytic corrosion is minimized.

7.3 Low-voltage part of equipment

a) The main characteristics of auxiliary contacts should be taken from the rated values given in Table 4.

Table 4 – Auxiliary contact classes

Class	DC current		
	Uninterrupted	Short time	Break capability
1	10 A	100 A/30 ms	2 A at 220 V
2	2 A	100 A/30 ms	100 mA at 220 V
3	200 mA	1 A/30 ms	50 mA at 48 V

b) Auxiliary contacts should be suitable for their intended duty in terms of environmental conditions and making and breaking capacity.

c) Auxiliary and control equipment and their circuits, with the exception of short lengths of wire at the terminals of instrument transformers, tripping coils, auxiliary contacts etc., should be segregated from the main circuit by either earthed metallic or insulating partitions.

d) Auxiliary equipment requiring attention during service should be accessible without risk of direct access to high-voltage parts.

e) Components of auxiliary and control circuits should comply with applicable IEC standards, if any.

For particular applications, different values may be specified to the manufacturer.

7.4 Marking

Equipment and its operating devices, if any, should have permanent marking containing the necessary information, such as the name or trade mark of the manufacturer, the year of manufacture, the manufacturer’s type designation, the serial number, the rated characteristics etc., as specified in the relevant IEC product standards.

For outdoor equipment, the markings and their fixings should be weather- and corrosion-proof.

If the equipment consists of independent poles, each pole should be provided with a mark (for example, on a nameplate).

Technical characteristics on marking and in documents which are common to high-voltage equipment should be represented by the same symbols. Such characteristics and their symbols should follow IEC 60027-1.

7.5 Degrees of protection by enclosures

7.5.1 Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects

Refer to IEC 60529 with a minimum degree of IP2X, subject to the product committee's decision.

7.5.2 Protection of equipment against ingress of water

No minimum degree of protection against harmful ingress of water according to the second characteristic numeral of the IP code is specified (second characteristic numeral X).

Equipment for outdoor installation provided with additional protection features against rain and other weather conditions should be specified by means of the supplementary letter W placed after the second characteristic numeral, or after the additional letter, if any.

7.5.3 Protection of equipment against mechanical impact under normal service conditions

The mechanical impact withstand level should be selected according to IEC 60721-1.

7.6 Creepage distances

IEC 60815 gives general rules that assist in choosing ceramic or glass insulators which should give satisfactory performance under polluted conditions.

7.7 Fire hazard

The materials should be chosen or the parts designed in such a way that they retard the propagation of fire in the equipment and reduce harmful effects on the environment. In cases where product performance requires the use of flammable materials, product design should take flame retardation into account.

7.8 Noise level

If noise-level limits are given (usually by administrative authorities), they should be achieved by appropriate measures such as

– using sound insulation techniques against sound transmitted through air or solids;
– using low-noise equipment.

Criteria for noise evaluation for different places and different periods of day are given in ISO 1996-1.

7.9 Electromagnetic compatibility (EMC)

7.9.1 Emissions

For HV parts of equipment in normal operation, without switching operations, the radiated emission level should be verified.

7.9.2 Immunity

The LV part of the equipment should be able to withstand electromagnetic disturbances without damage or malfunction.

This applies both under normal operation and under switching conditions, including interruption of fault currents in the HV part of the equipment.

The LV part of the equipment consists of

- control and auxiliary circuits, including circuits in central control cubicles, mounted at, or adjacent to, the equipment;
- equipment for monitoring, diagnostics, etc. that is part of the equipment.

NOTE In practice there is a wide variation in the complexity of equipment within the LV part of the equipment. In some cases, the system may consist of only some auxiliary all-or-nothing relays, signal cabling and terminal blocks. In other cases, complete equipment for protection, control and measurement is included.

7.10 Mechanical stresses on terminals

Product standards should define the values of static and dynamic mechanical stresses applicable to terminals, following IEC 60865 and IEC 62155, taking into account all the parameters involved, such as short-circuit current, wind, ice, type of connections, length of connections and size of insulators.

7.11 Interfaces

Product standards should contain or refer to specifications for standardized terminals, and, where relevant, interfaces, connecting equipment in substations. Terminals and interfaces which require most urgent standardization include

- electrical interface among equipment assemblies, and between equipment and substation systems;
- mechanical interface between equipment, and earthing/grounding as well as other construction elements; and
- low-voltage electrical interface between equipment and control/command devices.

8 Tests

8.1 General

8.1.1 General

This clause describes the structure and contents of testing clauses in product standards, and recommends product TCs to follow this model in order to ensure the coherence of standards for substations.

The following recommendations are to ensure the same level of confidence of tests for all the equipment of the system under consideration.

8.1.2 Types of test

The tests specified in this guide are classified as follows.

- Type test: test made on equipment for the purpose of proving its characteristics.
- Routine test: test to which each individual piece of equipment is subjected. Routine tests are for the purpose of revealing faults in material or in construction. They do not impair the properties and reliability of the test object.
- Special test: test other than a type test or a routine test, which may be
  - a test agreed on by manufacturer and purchaser,
  - a pre-qualification or long-term (non-type) test, or
  - a design test.

- Sample test: selected type test, routine test or special test made on pieces of equipment taken from the production line.
- Commissioning or post-installation test: test of the final installation, in particular where components have been shipped separately.

8.1.3 Sequencing and grouping of tests

Product standards should specify the sequence of tests where required in order to discover product failures.

For convenience of testing, type tests should be grouped in order to use a minimum number of specimens.

8.1.4 Information for identification of specimens

Each test specimen should entirely conform to the drawing and be fully representative of its type (see Annex A).

The product standard should require the manufacturer to submit to the testing laboratory drawings and other data containing sufficient information to identify unambiguously by type the essential details and parts of the equipment presented for test.

8.1.5 Information to be included in type-test reports

The results of all type tests, when applicable, should be recorded in type-test reports containing sufficient data to prove compliance with the specification, and sufficient information so that the essential parts of the equipment can be identified.

8.2 Type tests

The minimum list of type tests is given below. It should be completed by TCs according to their products' specific characteristics.

8.2.1 Dielectric tests

Dielectric tests of the main circuit of equipment should be specified in accordance with IEC 60060-1.

Dielectric tests of the auxiliary circuit of equipment should be specified in accordance with IEC 61180-1.

8.2.2 Temperature-rise or cycling tests

Temperature-rise or cycling type tests should be specified; test procedures may be defined separately for each product standard.

IEC 60943 gives guidance on acceptable maximal temperature and temperature rise. It is strongly recommended to use this. See also IEC 60216 for the thermal properties of insulating materials.

8.2.3 Verification of protection

In accordance with the requirements specified in IEC 60529 and in IEC 60068-2-18, tests should be specified on the enclosures of equipment fully assembled as in service conditions.

An impact test for enclosures according to IEC 60068-2-75 should also be specified.

8.2.4 Electromagnetic compatibility (EMC) tests

8.2.4.1 Emission tests on HV parts of equipment

For HV parts of equipment in normal operation above 123 kV, without switching operations, the emission level is verified by means of the radio interference voltage test according to CISPR 18-2.The frequency and level of such emissions are considered to be part of the normal electromagnetic environment.

8.2.4.2 Immunity tests on LV parts of equipment

LV parts of equipment should be subjected to electromagnetic immunity tests if they include electronic equipment or components. In other cases, no tests are required.

The immunity tests should be as specified in IEC 61000-6-5 or in the relevant product standards.

8.2.4.3 Emission tests on LV parts of equipment

Electronic equipment which is part of the LV parts of equipment should fulfil the requirements with regard to emission defined in CISPR 11. No other tests are specified.

8.2.5 Mechanical stresses on terminals

The test should be specified according to IEC 62155.

Relevant TCs should calculate the appropriate values of mechanical stress on terminals for each type of equipment.

8.2.6 Impact of environmental stresses on products

Tests should be specified in accordance with the IEC 60068 series. At least, corrosion tests and humidity tests should be considered.

8.3 Routine tests

Routine tests should be specified whenever reasonably practicable at the manufacturer's premises on each piece of apparatus manufactured, to ensure that the product matches the equipment on which the type tests have been carried out.

When equipment is not completely assembled before transport, the product standard should specify separate tests on all units to be transported and require the manufacturer to demonstrate their validity.

8.4 Special tests

Product committees should investigate whether there is a requirement for special tests and whether to include detailed characteristics.

8.5 Sample tests

Product committees should investigate whether there is a requirement for sample tests and whether to include detailed characteristics.

8.6 Commissioning tests

Product committees should investigate whether there is a requirement to specify tests after installation and whether to include detailed characteristics.

9 Rules for transport, storage, erection, operation and maintenance

Product standards should specify that instructions for transport, storage, erection, operation and maintenance should be provided by the manufacturer, in good time for their intended use.

The following are the most important points to be considered in the instructions to be provided by the manufacturer:

- conditions during transport, storage and erection;
- unpacking and lifting;
- assembly;
- mounting;
- connections;
- final installation inspection;
- operation;
- maintenance;
- failure report.

10 Safety

10.1 General

Product committees should assume that high-voltage equipment is normally only accessible to skilled persons, and is only operated and maintained by such persons. When access to equipment is unrestricted, additional safety features may be required.

Subclauses on the following model are recommended to specify personal safety measures for equipment against various hazards.

10.2 Electrical aspects

- Earthing (indirect contact)
- Separation of HV and LV circuits
- Internal arc problems
- IP code (direct contact)

10.3 Mechanical aspects

- Pressurized components
- Manual actuating force
- IP code (moving parts)
- Mechanical impact protection (IK code)

10.4 Thermal aspects

- Maximum temperature of accessible parts
- Fire safety.

10.5 Operation aspects

11 Effects of product standards on the natural environment

All product standards should refer to IEC Guide 109 and actively reflect its recommendations in their normative text. Aspects include environmentally conscious design, life-cycle analysis and end-of-life recycling or disposal.

12 Guide for the selection of equipment according to use

Product committees are recommended to prepare guidance for selection of their products according to use and in relation to linked products.

13 Information to be given with enquiries, tenders and orders

Product committees are recommended to prepare guidance for the information to be given with enquiries, tenders and orders, in order to facilitate communication between users and suppliers. The following is a checklist of categories for consideration (the information is to be provided by the user or future user unless otherwise stated).

- Operating conditions:
  - normal conditions;
  - abnormal conditions;
  - service life;
  - reliability.
- Essential technical characteristics
- Terminals and interfaces
- Information to be provided by the manufacturer:
  - erection;
  - maintenance;
  - disassembly.

Annex A

Identification of test specimens

The text below provides an example of the manner in which a product standard may mandate or recommend the identification of test specimens, as an annex to the relevant test specifications.

The following, as applicable, should be submitted by the manufacturer to the testing laboratory in respect of each test sample (but not necessarily included in the test report):

- *manufacturer's name;*
- *type designation, ratings and serial number of apparatus;*
- *outline description of apparatus (including number of poles, interlocking system, busbar system, earthing system and the arc extinguishing process);*
- *make, type, serial numbers and ratings of essential parts, where applicable;*
- *rated characteristics of fuse-links and protective devices;*
- *whether the apparatus is intended for operation in the vertical or horizontal plane;*
- *list of drawings (see Table A.1).*

Table A.1 – List of drawings to be submitted by manufacturer

Drawings to be submitted	***Contents of drawings (as applicable)***
Defined by the relevant TC	*Defined by the relevant TC*

Standards Survey

The IEC would like to offer you the best quality standards possible. To make sure that we continue to meet your needs, your feedback is essential. Would you please take a minute to answer the questions overleaf and fax them to us at +41 22 919 03 00 or mail them to the address below. Thank you!

Customer Service Centre (CSC)

International Electrotechnical Commission
3, rue de Varembé
1211 Genève 20
Switzerland

or

Fax to: **IEC**/CSC at +41 22 919 03 00

Thank you for your contribution to the standards-making process.

Nicht frankieren
Ne pas affranchir

Non affrancare
No stamp required

A Prioritaire

RÉPONSE PAYÉE

SUISSE

Customer Service Centre (CSC)
International Electrotechnical Commission
3, rue de Varembé
1211 GENEVA 20
Switzerland

Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: *(e.g. 60601-1-1)*

.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ❑
librarian ❑
researcher ❑
design engineer ❑
safety engineer ❑
testing engineer ❑
marketing specialist ❑
other.....

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ❑
consultant ❑
government ❑
test/certification facility ❑
public utility ❑
education ❑
military ❑
other.....

Q4 This standard will be used for: *(tick all that apply)*

general reference ❑
product research ❑
product design/development ❑
specifications ❑
tenders ❑
quality assessment ❑
certification ❑
technical documentation ❑
thesis ❑
manufacturing ❑
other.....

Q5 This standard meets my needs: *(tick one)*

not at all ❑
nearly ❑
fairly well ❑
exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ❑
standard is incomplete ❑
standard is too academic ❑
standard is too superficial ❑
title is misleading ❑
I made the wrong choice ❑
other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness.....
quality of writing.....
technical contents.....
logic of arrangement of contents .....
tables, charts, graphs, figures.....
other .....

Q8 I read/use the: *(tick one)*

French text only ❑
English text only ❑
both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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