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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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.

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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.

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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 GUIDE 111:2004](https://standards.iteh.ai/catalog/standards/sist/4e8a1939-60e7-4d4e-9b87-64192cd20532/iec-guide-111-2004)

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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 (SF₆) 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	2 ≤ 40 °C
		and 24 h average	≤ 35 °C
		and one category:	“-5 indoor”: ≥ –5 °C
		or	“-15 indoor”: ≥ –15 °C
	or	“-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/m³ 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.