# IEC 62271-214

Edition 2.0 2024-04
COMMENTED VERSION

# INTERNATIONAL STANDARD



colour inside

**High-voltage switchgear and controlgear –**
**Part 214: Internal arc classification for AC metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV**

IEC 62271-214:2024-04 CMV(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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## High-voltage switchgear and controlgear – Part 214: Internal arc classification for AC metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

# Part 214: Internal arc classification for AC metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

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**This commented version (CMV) of the official standard IEC 62271-214:2024 edition 2.0 allows the user to identify the changes made to the previous IEC 62271-214:2019 edition 1.0. Furthermore, comments from IEC TC SC 17C experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.**

**A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.**

**This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.**

IEC 62271-214 has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High voltage switchgear and controlgear. It is an International Standard.

This second edition cancels and replaces the first edition published in 2019. This edition constitutes a technical revision.

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

a) indicators positioning update;
b) neutral earthing connection of the test circuit for three-phase tests;
c) general review for consistency with IEC 62271-200, Ed.3.0:2021.

The text of this International Standard is based on the following documents:

| Draft | Report on voting |
|---|---|
| 17C/924/FDIS | 17C/931/RVD |

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This standard shall be read in conjunction with IEC 62271-1, second edition, published in 2017, to which it refers, and which is applicable unless otherwise specified in this standard. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1. Amendments to these clauses and subclauses are given under the same references whilst additional subclauses are numbered from 101. Any clause with the term "Not applicable" relates to the clause not being relevant to IEC 62271-214, and does not infer the clause is or is not relevant for its applicable switchgear standard.

A list of all parts of the IEC 62271 series, published under the general title *High-voltage switchgear and controlgear*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

**IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

# INTRODUCTION

IEC 62271-214 has been developed due to the requirement to remove IAC Type C designated pole-mounted switchgear from IEC 62271-200. ~~Only enclosed terminal equipment is to be considered within IEC 62271-200. For this reason,~~ IEC 62271-214 is to be considered independent of IEC 62271-200, however it is still related to other product standards of the IEC 62271 series.

Only open terminal pole-mounted switchgear and controlgear has been considered within this document.

This equipment relates to operation in three-phase, two-phase and single-phase systems.

# HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

# Part 214: Internal arc classification for AC 1 metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

## 1 Scope

This part of IEC 62271 specifies requirements for internal arc classification of AC metal-enclosed pole-mounted switchgear ~~installations used for alternating current~~ and controlgear with rated voltages above 1 kV and up to and including 52 kV with service frequencies up to and including 60 Hz.

This document is applicable to three-phase, two-phase and single-phase open terminal equipment for which an internal arc classification is assigned 2. Enclosures may include fixed and removable components and may be filled with fluid (liquid or gas) to provide insulation.

NOTE 1 The IAC classification takes into account the installation disposition of the high-voltage switchgear and controlgear and worker's operating area. 3

NOTE 2 For the use of this document, high-voltage (IEC 60050-601:1985, 601-01-27) is the rated voltage above 1 000 V. However, medium voltage (IEC 60050-601:1985, 601-01-28) is commonly used for distribution systems with voltages above 1 kV and generally applied up to and including 52 kV; refer to [1][1].

This document does not preclude that other equipment may be included in the same enclosure. In such a case, any possible influence of that equipment on the switchgear and controlgear is to be taken into account.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-151:2001, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*
IEC 60050-151:2001/AMD1:2013
IEC 60050-151:2001/AMD2:2014
IEC 60050-151:2001/AMD3:2019
IEC 60050-151:2001/AMD4:2020
IEC 60050-151:2001/AMD5:2021

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses*
IEC 60050-441:1984/AMD1:2000

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*
IEC 62271-1:2017/AMD1:2021



[1] Numbers in square brackets refer to the Bibliography.

IEC 62271-200:2021, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1, IEC 60050-151 and IEC 60050-441, as well as the following apply.

NOTE 1 The classification system for definitions of IEC 62271-1:2017 is not followed. Terms and definitions are referenced and prioritized in the following order:

– Clause 3 of this document;

– IEC 62271-1:2017;

– IEC 60050-441;

– IEC 60050-151.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

NOTE 2 Additional definitions are classified so as to be aligned with the classification system used in IEC 60050-441.

### 3.1 General terms and definitions

**3.1.101**
**metal-enclosed switchgear and controlgear**
switchgear and controlgear assemblies with an external metal enclosure intended to be earthed, and completely assembled except for external connections

[SOURCE: IEC 60050-441:1984, 441-12-04, modified – "complete" has been replaced by "completely assembled"; NOTE has been deleted.]

~~**3.1.102**~~
~~**functional unit**~~
~~part of pole-mounted switchgear and controlgear comprising all the components of the main circuits and auxiliary circuits that contribute to the fulfilment of a single function~~

~~Note to entry: Functional units are distinguished according to the function for which they are intended, e.g. incoming unit, outgoing unit, etc.~~

~~[SOURCE: IEC 60050-441:1984, 441-13-04, modified – references to the supply and feed sides in the note has been deleted]~~

**3.1.102**
**enclosure**
part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts and against contact with moving parts

[SOURCE: IEC 60050-441:1984, 441-13-01, modified – <of an assembly> has been deleted.]

**3.1.103**
**high-voltage compartment**
compartment of switchgear and controlgear, containing high-voltage conducting parts, enclosed except for openings necessary for interconnection, control or ventilation, where one segment of the compartment can be part of the outer earthed metallic enclosure

**3.1.104**
**component**
essential part of the high-voltage or earthing circuits of pole-mounted switchgear and controlgear which serves a specific function (e.g. circuit-breaker, disconnector, switch, fuse, instrument transformer, bushing, busbar)

**3.1.105**
**main circuit**
all the high-voltage conductive parts of pole-mounted switchgear and controlgear included in a circuit which is intended to carry the rated continuous current

[SOURCE: IEC 60050-441:1984, 441-13-02, modified – "high voltage" has been added, "assembly" has been substituted by "pole-mounted switchgear and controlgear" and "transmit electrical energy" has been substituted by "carry the rated continuous current".]

**3.1.106**
**earthing circuit**
conductors, connections, and the conducting parts of earthing devices intended to connect the high-voltage conductive parts to the earthing system of the installation

Note 1 to entry: Parts of metallic enclosures connected to the earthing system can be part of the earthing circuit.

**3.1.107**
**normal operating condition**
in service condition with all covers properly closed and secured

Note 1 to entry: The term "in service" implies "under live conditions".

[SOURCE: IEC 62271-200:2021[2], 3.1.106, modified – "<of an assembly>" and "doors and" have been removed and Note 1 to entry has been added.]

**3.1.108**
**pressure relief device**
device incorporated as part of an enclosure or compartment intended to operate to prevent excessive pressure in the enclosure or compartment

**3.1.109**
**fluid-filled compartment**
high-voltage compartment of pole-mounted switchgear and controlgear filled with a fluid, either gas, other than ambient air, or liquid, for insulation purposes

**3.1.110**
**pole**
vertical single member support in wood, concrete, steel or other material, with one end buried in the ground, either directly or by means of a foundation

Note 1 to entry: The term pole as defined here is not to be mixed up with the use of the same term as synonymous for phase as used in other standards.

[SOURCE: IEC 60050-466:1990, 466-07-01[8], modified – Note 1 to entry has been added.]

**3.1.111**
**pole-mounted switchgear and controlgear**
metal-enclosed switchgear and controlgear, typically connected to overhead lines, installed on one or more poles or equivalent structures at a defined height, with restricted accessibility by installation out of reach

**3.1.112**
**internal arc ~~classified switchgear and controlgear~~ classification**
**IAC**
metal-enclosed switchgear and controlgear for which prescribed criteria, for protection of authorized persons and the general public beneath the apparatus **4**, are met in the event of internal arc for specified installation conditions, as demonstrated by type tests

Note 1 to entry: The internal arc classification is described by the characteristics given from 3.1.~~1013~~114 to 3.1.~~1016~~116.

[SOURCE: IEC 62271-200:~~2011~~2021, 3.~~132~~6.117, modified – "authorized" and "and general public beneath the apparatus" have been added, "assembly" has been changed by "metal-enclosed switchgear and controlgear".]

**3.1.113**
**arc fault current**
three-phase and where applicable the single-phase-to-earth RMS value of the internal arc fault current for which the switchgear and controlgear is designed to protect persons in the event of an internal arc

[SOURCE: IEC 62271-200:~~2011~~2021, 3.~~132.3~~7.101]

**3.1.114**
**arc fault duration**
duration of the internal arc fault current for which the switchgear and controlgear is designed to protect persons in the event of an internal arc

[SOURCE: IEC 62271-200:~~2011~~2021, 3.~~132.4~~7.102]

**3.1.115**
**approach distance**
distance between the test object and indicators arranged in an IAC test

**3.1.116**
**arc mitigation device**
device dedicated to reacting to internal arc fault conditions to decrease the arc energy

[SOURCE: CIGRE TECHNICAL BROCHURE 686:2017][5]

## 3.8 Index of definitions

**A – C**



**E – F**

**H – I**



**M – N**



**P**



## 4 Normal and special service conditions

~~**4.1 General**~~

~~Unless otherwise specified in this document, operation under normal and special service conditions is considered to be covered by the relevant IEC standard.~~

Clause 4 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable.

## 5 Ratings

Subclauses of Clause 5 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 5.1 General

Subclause 5.1 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable and replaced by following text:

The relevant ratings ~~with respect to the arc fault classification of pole-mounted switchgear and controlgear~~ for the internal arc classification are the following:

a) rated voltage ($U_r$);

b) rated frequency ($f_r$);

c) ratings of the internal arc classification (IAC).

### 5.2 Rated voltage ($U_r$)

Subclause 5.2 of IEC 62271-1:2017 is applicable with following addition to 5.2.1.

#### 5.2.1 General

The rated voltage is equal to the maximum system voltage for which the equipment is designed. It indicates the maximum value of the "highest system voltage" of networks for which the equipment may be used (refer to Clause 9 of IEC 60038:2009 [6]).

NOTE It is possible that components forming part of pole-mounted switchgear and controlgear have differing values of rated voltage in accordance with their relevant standards.

### 5.3 Rated insulation level ($U_d$, $U_p$, $U_s$)

Not applicable.

### 5.4 Rated frequency ($f_r$)

~~The standard values of the rated frequency are 16,7 Hz, 25 Hz, 50 Hz and 60 Hz.~~

Subclause 5.4 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is applicable.

### 5.101 Ratings of the internal arc classification (IAC)

#### 5.101.1 General

An IAC classified pole-mounted switchgear and controlgear shall have the following ratings: rated approach distance, arc fault currents and arc fault durations.

#### 5.101.2 Rated approach distance ($D_{AP}$)

The rated approach distance shall be stated by the manufacturer (refer to Figure 2).

#### 5.101.3 Rated arc fault currents ($I_A$, $I_{Ae}$)

The ~~standard~~ value of rated arc fault currents should be selected from the R 10 series specified in IEC 60059 [7].

Two ratings of the arc fault currents are recognised:

a) three-phase and phase-to-phase arc fault current ($I_A$), when applicable;

b) single-phase-to-earth arc fault current ($I_{Ae}$), when applicable.

When only a three-phase rating is specified, the single-phase rating is by default 87 % of the three-phase rating, and need not be specified.

NOTE 1 The rationale for this 87 % is the arc fault test with 2-phase ignition; refer to 7.101.7.2.

The manufacturer shall specify the compartments to which the single-phase-to-earth arc fault current rating applies. Such value is assigned to switchgear and controlgear where its construction will prevent the arc from becoming multiphase, as demonstrated during the internal arc test.

~~When IAC testing on single-phase switchgear and controlgear or single-phase high-voltage compartments where only a singlephase supply circuit has been applied only an $I_{Ae}$ rating shall be assigned.~~ In the case where all high-voltage compartments are only designed for single-phase-to-earth arc faults, instead of $I_A$ rating, the $I_{Ae}$ rating shall be assigned (refer to 7.101.7.2).

NOTE 2 Information about the relationship between type of neutral earthing and the single-phase-to-earth arc fault current is provided in 9.101.6.

#### 5.101.4 Rated arc fault duration ($t_A$, $t_{Ae}$)

~~Standard~~ Recommended values for the arc fault duration ($t_A$, $t_{Ae}$) are 0,1 s, 0,5 s and 1 s.

NOTE It is in general not possible to calculate the permissible arc duration for a current which differs from that used in the test.

## 6 Design and construction

Subclauses of Clause 6 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 6.11 Nameplate

~~6.11.1 General~~

### 6.11.2 Application

Subclause 6.11.2 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is applicable, except for Table 9, with the following additions:

Pole-mounted switchgear and controlgear, with a rated internal arc classification shall include in the nameplate the additional IAC information in accordance with Table 1.

**Table 1 – Nameplate information**

| | Abbreviation | Unit | ** | Condition: Marking only required if |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Internal arc classification | IAC | | X | |
| Rated approach distance | $D_{AP}$ | m | X | |
| Arc fault current and duration | $I_A$, $t_A$ | kA, s | Y | Three-phase test or phase-to-phase test are applicable |
| Single-phase-to-earth arc fault current and duration | $I_{Ae}$, $t_{Ae}$ | kA, s | Y | A single-phase test is applicable or $I_{Ae}$ differs from 87 % of $I_A$ |
| Fitted with arc mitigation device | | | Y | Arc mitigation device fitted and not disabled during testing |
| (**) X : the marking of these values is mandatory ~~where internal arc classification is assigned;~~ Y : conditions for marking of these values are given in column (5) | | | | |
| NOTE ~~1~~ If there is an abbreviation in column (2) it can be used instead of the terms in column (1). | | | | |

### 6.101 Internal arc fault

Pole-mounted switchgear and controlgear, in principle, are designed and manufactured, to prevent the occurrence of internal arc faults.

However~~, where internal arc classification is assigned~~, the switchgear and controlgear shall be designed to give a defined level of protection of persons in the event of an internal arc, when the switchgear and controlgear is in normal ~~service~~ operating condition.

~~If an internal arc classification is assigned by the manufacturer and verified by type tests according to , the pole-mounted switchgear and controlgear shall be designated as follows:~~

~~– Designation: IAC (Internal Arc Classified)~~

~~– Rated three-phase arc fault values (where applicable): current [kA] and duration [s] and/or~~

~~– Rated single-phase arc fault values (where applicable): current [kA] and duration [s]~~

~~— If the unit is fitted with a device limiting the duration of the arc that cannot be disabled, then the IAC designation shall indicate that the switchgear and controlgear is: "Fitted with arc mitigation device"~~

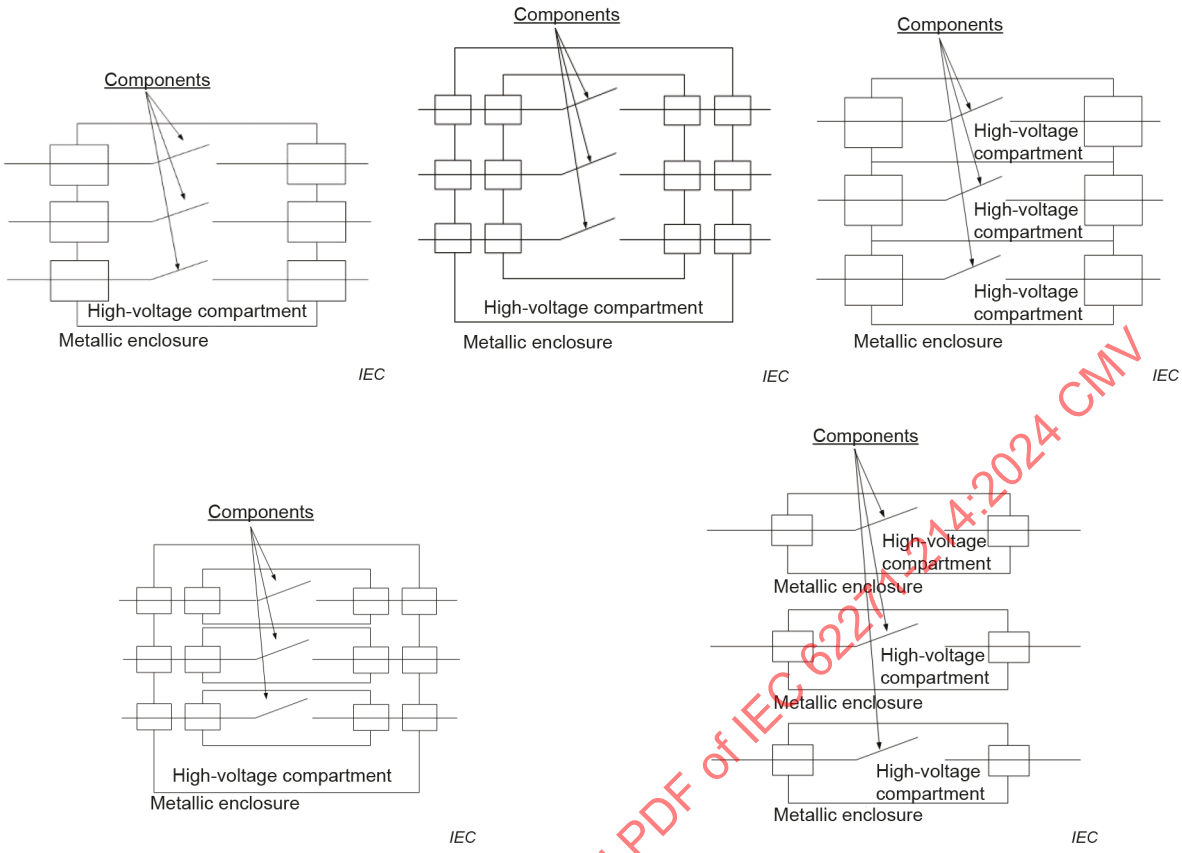
The designation shall be included in the nameplate (refer to 6.11).

Some examples for internal arc classification are given in 7.101.7.2.5.

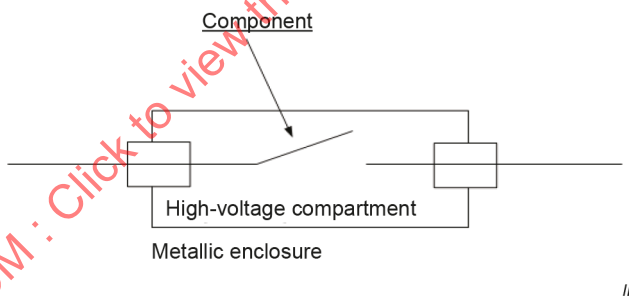
### 6.102 Enclosure

The ~~complete~~ enclosure ~~should be capable of~~ is designed for withstanding the mechanical, electrical, thermal and environmental stresses likely to be encountered in normal ~~service~~ operating condition and under conditions of internal arc fault.

Figure 1 shows examples of different arrangements of components in high voltage compartment(s) within an enclosure.




**a) three-phase**




**b) single-phase**

**Figure 1 – Examples of enclosures and compartment(s) in different arrangements**



## 7 Type tests

Subclauses of Clause 7 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 7.1 General

#### 7.1.1 Basics

The type test is performed to verify the internal arc ratings and characteristics of pole-mounted switchgear and controlgear.

### 7.1.2 Information for identification of test object

Subclause 7.1.2 of IEC 62271-1:2017 does not apply for this document and is replaced by following text.

The manufacturer shall submit to the testing laboratory, drawings and other data containing sufficient information to unambiguously identify by type the essential details and parts of the switchgear and controlgear presented for test. A summary list of the drawings and data schedules shall be supplied by the manufacturer and shall be uniquely referenced and shall contain a statement to the effect that the manufacturer guarantees that the drawings or data schedules listed are the correct version and truly represent the switchgear and controlgear to be tested.

The testing laboratory shall check that drawings and data sheets adequately represent the essential details and parts of the test object, but is not responsible for the accuracy of the detailed information.

Particular drawings or data required to be submitted by the manufacturer to the test laboratory for identification of essential parts of test object are specified in Annex A.

### 7.1.3 Information to be included in type-test reports

The results shall be recorded in type-test reports containing sufficient data to prove compliance with the test clauses of this document for the test(s) conducted. Sufficient information shall be included so that the essential parts of the test object can be identified. In particular, the following information shall be included:

– manufacturer;
– type designation and unique identifier for ~~switchgear~~ the test object;
– rated characteristics of ~~switchgear~~ the test object;
– photographs to illustrate the condition of ~~switchgear~~ the test object before and after test;
– sufficient outline drawings and data schedules to represent the ~~switchgear~~ test object;
– the reference numbers of all drawings including revision number submitted to identify the essential parts of the test object;
– details of the testing arrangement (including diagram of test circuit);
– statements of the behaviour of the ~~switchgear~~ test object during test and its condition after test;
– description of the test object with a drawing showing the main dimensions, details relevant to the mechanical strength, the arrangement of the pressure relief device(s) and the method of fixing the ~~switchgear and controlgear~~ test object to the pole(s), including the pole characteristics;
– point and method of initiation of the internal arc fault;
– drawings of test arrangement (test object, source side connection point, and mounting frame of indicators, pole dimensions) and any other relevant installation conditions; applied voltage and frequency;
  - IAC designation validated by test;
  - include use of fuse protection if used;
  - include the use of arc mitigation device if used;
– for the prospective and/or test current (refer to 7.101.6.3):
  a) RMS value of the AC component during:
     - the first three half-cycles;
     - the last three half-cycles;
  b) highest peak value (actual and/or prospective);

c) average RMS value of the AC component over the actual duration of the test;

d) ~~test~~ duration of arc fault current;

e) prospective RMS value and duration of the test current;

– oscillogram(s) showing currents and voltages;

– optionally, total arc energy, peak arc power;

– optionally, measurement of pressure in compartments;

– assessment of the test results, including a record of the observations in accordance with 7.101.8;

– other relevant remarks.

### 7.101 Internal arc type test

#### 7.101.1 General

The test is applicable to pole-mounted switchgear and controlgear for which internal arc classification is assigned, covering the event of an arc fault within the enclosure(s) or within components having housings which form part of the enclosure in normal operating condition. The internal arc test makes allowance for effects acting on all parts of the enclosure, such as internal overpressure, thermal effects of the arc or its roots, and for the effects of ejected hot gases and glowing particles on the persons situated beneath the apparatus under test. The tests are not intended to cover e.g.:

– the influences of an internal arc between compartments;

– the effect of an arc on the external connections outside the enclosure;

– the effects caused by an explosion of high-voltage components;

– the presence of gases with potential toxic characteristics, or the hazard of fire propagation to combustible materials or equipment placed in the proximity of the pole-mounted switchgear and controlgear.

#### 7.101.2 Test conditions

The test shall be carried out with the switchgear and controlgear in normal operating condition. This means the position of high-voltage switching devices~~, connecting and disconnecting withdrawable parts~~ is set according to 7.101.7.1.4. All other equipment, for example measuring instruments and monitoring equipment shall be in the position as it is in normal ~~service~~ operating condition.

Pole-mounted switchgear and controlgear which are protected by type-tested current-limiting fuses, integrated inside the switchgear and controlgear, shall be tested with the fuse type that causes the highest cut-off current (let-through current). The actual duration of the current flow will be controlled by the fuses. The tests shall be performed at the rated voltage of the equipment. The tested switchgear and controlgear will be designated as 'fuse-protected'. The specific fuse, including manufacturer, part number, and ratings, used for protection shall be specified in the instructions manual.

Application of suitable current-limiting fuses in combination with switching devices can limit the short-circuit current and minimize the fault duration. It is well documented that the arc energy transferred during such tests is not predictable by $I^2t$. In the case of current-limiting fuses, the maximum arc energy may occur at current levels below the maximum interrupting rating. Further, the effects of using current-limiting devices that employ pyrotechnic means to commutate current to a current-limiting fuse shall be considered when evaluating designs utilizing such devices.

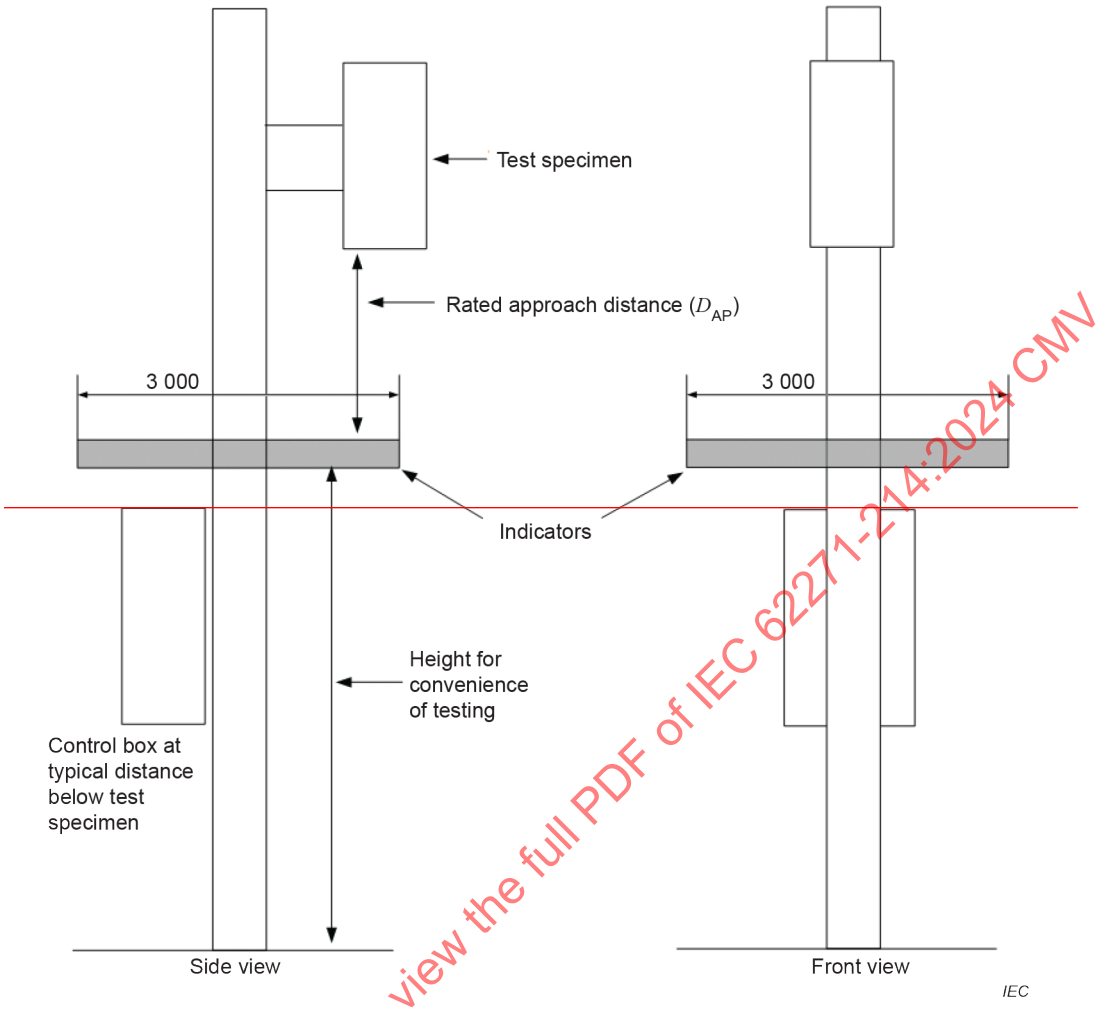
Any device (for example, protection relay) that may automatically trip the circuit before the end of the prospective duration of the test shall be made inoperative during the test. If pole-mounted switchgear and controlgear is equipped with devices intended to limit the duration of the arc itself by other means (for example, by transferring the current to a metallic short circuit), they shall be made inoperative during the test. If these devices are an integral part of the design of the high-voltage compartment or assembly which prevents them being made inoperative without modification of the construction, the relevant high-voltage compartment of the switchgear and controlgear may be tested with the device operative; but this switchgear and controlgear shall be qualified according to the actual duration of the arc. The test current shall be maintained for the rated arc fault duration of the switchgear and controlgear.

NOTE Because in general arc limiting devices are out of the scope of this document and if the switchgear and controlgear has previously been tested with the limiting device made inoperative, an additional test can be performed to demonstrate the behaviour of this arc limiting device.

### 7.101.3 Arrangement of the equipment

The test arrangement for ~~overhead connected~~ pole-mounted switchgear and controlgear shall be configured as indicated in Figure 2.

Dimensions in millimetres



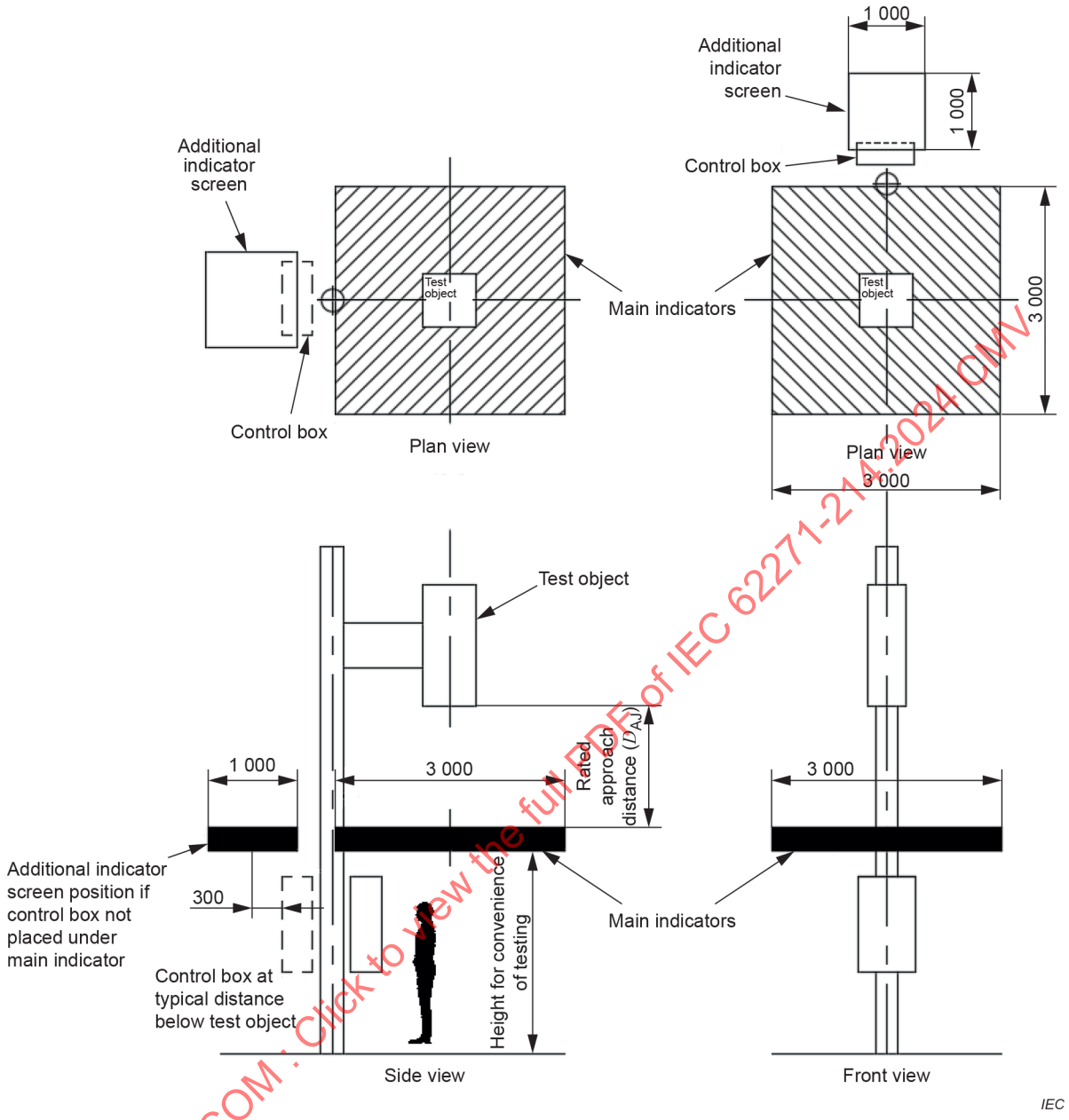



**Figure 2 – Test arrangement for pole-mounted switchgear and controlgear** 5

The equipment shall be arranged as follows:

– mock-ups of internal components are permitted provided they have the same volume and external material as the original items, and they do not affect the main and earthing circuits;

– the test object shall be mounted on a pole. If there is a control box and/or electrical/mechanical linkages to the base of the pole, these shall be fitted at a distance below the test object typical of a service installation. The test object shall be at a convenient height allowing for the indicators as specified in 7.101.5, and for the control box and/or electrical/mechanical linkages (if applicable);

– In the case the control box is not fully covered by the main indicators the test shall include a 1 000 mm × 1 000 mm indicator screen above control box, refer to Figure 2;

– the test object shall be earthed at the earthing point provided;

– tests shall be carried out on high-voltage compartments not previously subjected to arcing, or, if subjected, being in a condition which does not affect the result of the test;

– in the case of fluid-filled compartments (other than $SF_6$) the test shall be made with the original fluid at its ~~rated~~ filling pressure (±10 %);
– for environmental reasons, it is recommended to replace $SF_6$ with air at the ~~rated~~ filling pressure (±10 %).

NOTE 1 Test results with air instead of $SF_6$ are considered to be representative.

NOTE 2 Nitrogen at the ~~rated~~ filling pressure (±10 %) ~~can~~ is also ~~be~~ considered a substitute for $SF_6$ [9] ~~rather than air~~.

NOTE 3 It is assumed that the physical dimensions of the test ~~room should be considered~~ laboratory are large enough to prevent hot gas reflection towards the indicators.

### 7.101.4 Indicators (for assessing the thermal effects of the gases)

#### 7.101.4.1 General

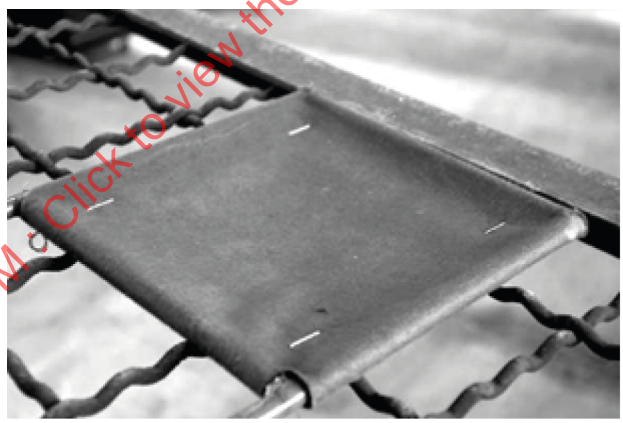
Indicators are pieces of black cotton cloth so arranged that their cut edges do not point toward the test object.

Black cotton-interlining lawn (approximately 40 g/m$^2$) shall be used for indicators.

NOTE Cotton-interlining lawn (approximately 40 g/m$^2$) is considered to represent light summer wear of the general public.

Care shall be taken that glowing particles do not accumulate. This is achieved if the indicators are mounted without a frame (refer to Figure 3).

The indicator dimensions shall be 150 mm × 150 mm ($^{+15}_{0}$ mm).



IEC

**Figure 3 – Horizontal indicator**

Figure 3 provides an indication of a typical arrangement of a horizontal indicator.

### 7.101.5 Arrangement of indicators

Indicators shall be arranged horizontally, at the rated approach distance (±50 mm) below the lowest point of the test object. The indicators shall cover the whole area of a 3 m × 3 m square frame centered about the ~~pole~~ test object. They shall be evenly distributed, arranged in a checkerboard pattern, covering 40 % to 50 % of the area (refer to Figure 2 and Figure 3).

The indicators may be located at any convenient height above the ground allowing for the control box and/or electrical/mechanical linkages if applicable. If the control box's location is not fully located under the 3 000 mm × 3 000 mm indicator area (refer to Figure 2), then an

additional indicator screen 1 000 mm × 1 000 mm shall be positioned above the mounting position of the control box. The additional screen shall be in the same plane as the 3 000 mm × 3 000 mm indicator screen and centered as detailed in Figure 2.

NOTE 1 The additional screen is used to determine if the operators standing position, when in front of the control box, is adequately protected from hot gases and flame.

~~NOTE 2 Cotton interlining lawn (approximately 40 g/m$^2$) is considered to represent light summer wear of the general public.~~

NOTE ~~1~~2 This test covers the verification of the protection of both authorized personnel and general public beneath the apparatus.

### 7.101.6 Test parameters

#### 7.101.6.1 General

A test performed at a given voltage, current and duration is generally valid for all lower values of current, voltage and duration.

#### 7.101.6.2 Voltage

The test shall be performed at any suitable voltage up to and including the rated voltage $U_r$. If a voltage lower than $U_r$ is chosen, the following conditions shall be met.

a) the ~~average RMS~~ current ~~value~~ during the test as computed by a digital recording device complies with current requirements of 7.101.6.3.1;

b) the arc is not extinguished prematurely in any of the phases in which it has been initiated. Temporary single-phase extinguishing is permitted, as long as the cumulated duration of the intervals without current does not exceed 2 % of the test duration and the single events last not longer than to the next prospective current zero, provided that the integral of the AC component of the current equals at least the value specified in 7.101.6.3.1 in the relevant phase.

#### 7.101.6.3 Current

#### 7.101.6.3.1 AC component

The test current shall be set within a ±5 % tolerance of the rated arc fault current ($I_A$, 87 % $I_A$ or $I_{Ae}$) as appropriate. If the applied voltage is equal to $U_r$, this tolerance applies only to the prospective current.

The current should remain constant. If the capability of the test plant does not permit this, the test shall be extended until the integral of the AC component of the current (~~$I^*t$~~ $I^2t$) equals the value specified within a tolerance of ($^{+10}_{0}$ %). In this case, the current shall be equal to the specified value at least during the first three half-cycles and shall not be less than 50 % of the specified value at the end of the test.

NOTE Information about the relationship between type of neutral earthing and the single-phase-to-earth arc fault current is provided in 9.101.6.

#### 7.101.6.3.2 Peak current

The instant of closing for a three-phase test shall be chosen so that the peak current is flowing in one of the outer phases, and a major loop also occurs in the other outer phase.

If the applied voltage is equal to $U_r$, the peak value of the prospective current shall be set to 2,5 times (for frequencies up to 50 Hz) or 2,6 times (for 60 Hz) the RMS value of the AC component defined in 7.101.6.3.1 with a tolerance of $^{+5}_{0}$ %.

If the voltage is lower than $U_r$, the peak value of the prospective current is irrelevant, but the peak value of the short-circuit current for the switchgear and controlgear under test shall not drop below 90 % of the rated peak value.

For higher DC time constants than the standard defined 45 ms of the feeding network, a uniform value of 2,7 times the RMS value of the AC component should be used as a rated value for both 50 Hz and 60 Hz applications.

In case of two-phase initiation of the arc, or single-phase-to-earth the instant of closing shall be chosen to provide the maximum possible DC component.

#### 7.101.6.3.3 Frequency

Tests performed at 50 Hz are also applicable for 60 Hz and vice a versa. At a rated frequency of 50 Hz or 60 Hz, the frequency at the beginning of the test shall be between 48 Hz and 62 Hz. At other frequencies, it shall not deviate from the rated value by more than ±10 %. The peak factor requirement of subclause 7.101.6.3.2 shall be met as appropriate.

### 7.101.7 Test procedure

#### 7.101.7.1 Supply circuit

#### 7.101.7.1.1 Three-phase tests

The supply circuit shall be three-phase and all three-phases of the switchgear and controlgear shall be energised. The neutral point of the supply circuit may be either isolated, solidly earthed or earthed through an impedance **6**~~, in such a way that the maximum earth current is less than 100 A. This~~ Any of these test configurations covers ~~all~~ in service neutral arrangements.

#### 7.101.7.1.2 Single-phase tests

One terminal of the supply circuit shall be connected to the earthing point provided on the switchgear and controlgear, ~~another~~ the other to the ~~terminal of the test object~~ phase under test.

NOTE Single-phase compartments and single-phase enclosures will only have the one phase under test as defined in Table 2.

In the case of three-phase switchgear and controlgear or single-phase switchgear and controlgear intended to be used in a three-phase network, the two remaining phases of the test object, shall be energised at $U_r/\sqrt{3}$, which may be supplied from a separate voltage source and need not be synchronised. The separate source(s) may be low power and are not intended to supply any significant short-circuit current in case of ignition. If a separate source is used, the remaining two phases can be energised from the same single-phase voltage source. If either of the remaining phases ignites or the voltages collapse, the test shall be repeated as a three-phase internal arc test.

#### 7.101.7.1.3 Phase-to-phase tests

Two phases of the three-phase supply circuit shall be connected to the two adjacent phases of the test object. The neutral point of the supply circuit may be either isolated or earthed through an impedance, in such a way that the maximum earth current is less than 100 A. The one remaining phase of the test object, shall be energised at $U_r/\sqrt{3}$, which may be supplied from a separate voltage source and need not be synchronised. The separate source(s) may be low power and are not intended to supply any significant short-circuit current in case of ignition. If the one remaining phase ignites or the voltage collapses, the test shall be repeated as a three-phase internal arc test.

#### 7.101.7.1.4 ~~Feeding arrangements~~ Test supply connection direction

~~Feeding~~ The test supply connection direction shall be as follows:

– from the supply connection terminals, through the main switching device with this device in the closed position;
– for an enclosure with several main circuit components inside: supply through one available set of connection terminals, with all switching devices in closed position, except for earthing switches, if any, which shall remain in open position.

#### 7.101.7.2 Arc initiation

##### 7.101.7.2.1 General

The arc shall be initiated by means of a copper wire of about 0,5 mm in diameter.

The point of initiation shall be located at the furthest point, downstream in the current path from the supply, within the high-voltage compartment under test. If the main circuit of the high-voltage compartment under test includes current limiting devices (e.g. fuses), the point of initiation shall be chosen upstream from these limiting devices.

In the case of non-symmetrical designs, the most onerous internal arc initiation should be determined, with respect to arc energy and burn through.

The number of phases to be tested, the connection arrangements, and the action to be taken if other phases are affected, shall be in accordance with Table 2, according to the construction of the enclosure under test.

NOTE Refer to Figure 4 and examples in 7.101.7.2.5.

Inside the enclosure where the live parts are covered by solid insulating material, the arc shall be initiated at the following locations:

a) at gaps or joining surfaces between the insulation of insulation-embedded parts or insulating partitions;
b) when a) is not applicable, by perforation or partial removal of solid insulation from the internal conductors.

##### 7.101.7.2.2 Three-phase arc initiation

The arc shall be initiated between all the phases under test.

##### 7.101.7.2.3 Single-phase arc initiation

In the case of single-phase-to-earth ignition, the arc shall be initiated between the phase and closest earth (single-phase). In the case of a three-phase switchgear and controlgear the arc shall be initiated between the middle phase and closest earth.

For single-phase high-voltage compartments without any adjacent earthed metallic parts, a path for the arc initiating fuse wire shall be created to the closest earthed metallic part.

##### 7.101.7.2.4 Phase-to-phase arc initiation

In the case of a phase-to-phase ignition, the arc shall be initiated between the middle phase and one of the adjacent phases (phase-to-phase). The manufacturer may choose to perform a three-phase arc initiation test with any three-phase enclosure construction in place of the specified test in Table 2.

**Table 2 – Parameters for internal arc fault test according to enclosure and compartment construction**

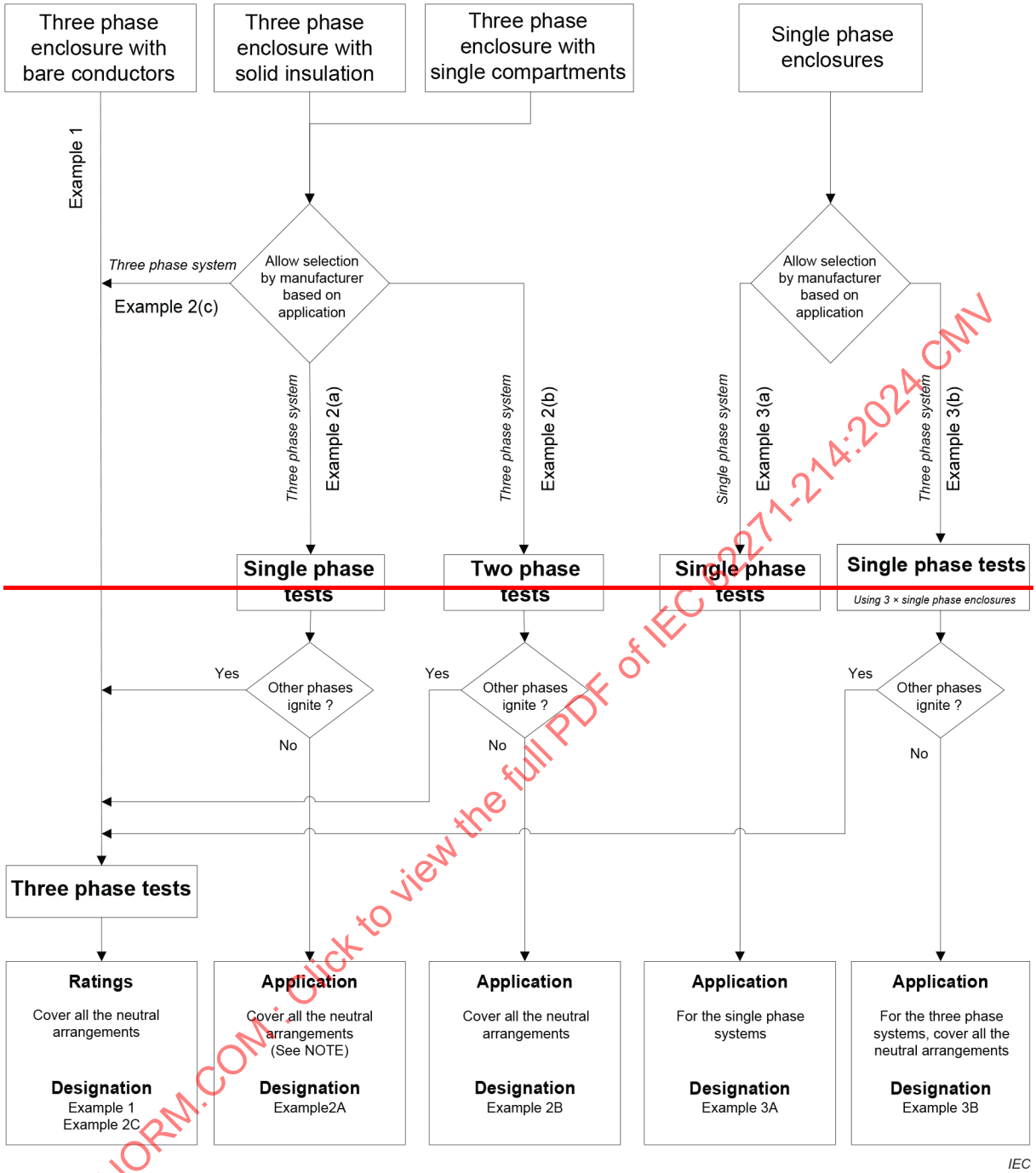
| | | Test current | Number of phases/earth for arc initiation | Action if other phase affected |
|---|---|---|---|---|
| Three-phase enclosures: | With bare conductors | $I_A$ | Three-phase | N/A |
| | Conductors with solid insulation | 87 % $I_A$ | Two | Repeat as three-phase test |
| | | $I_{Ae}$ | One phase and earth | |
| Single-phase compartments inside three-phase enclosure: | | 87 % $I_A$ | Two | Repeat as three-phase test |
| | | $I_{Ae}$ | One phase and earth | |
| Single-phase enclosure (s): | | $I_{Ae}$ | One phase and earth | Repeat as three-phase test if single-phase enclosures are tested in a three-phase configuration |

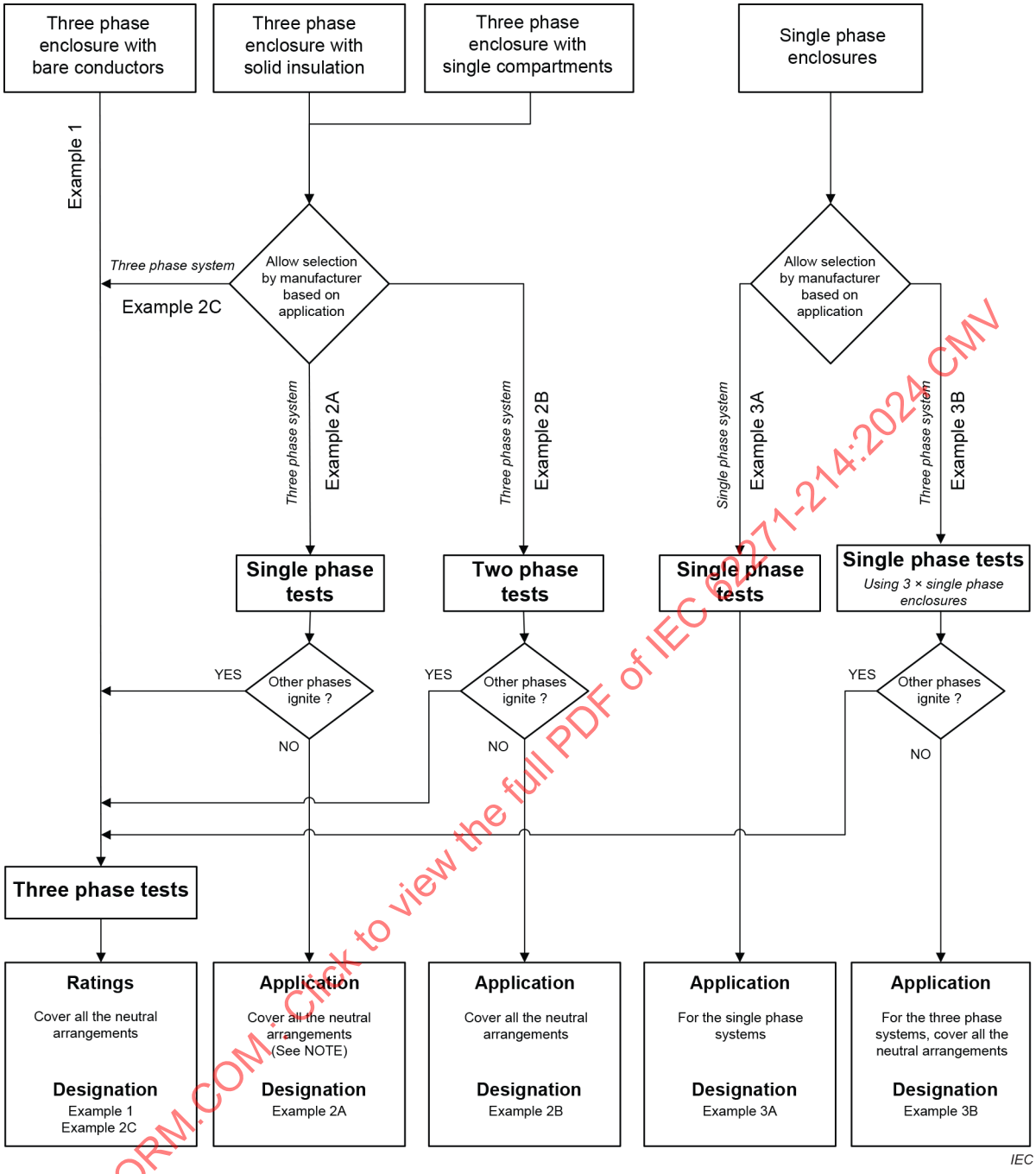
NOTE ~~1~~ More details about arc initiation according the construction can be found in 7.101.7.2.5.

~~NOTE 2 The manufacturer can choose to perform a three phase arc initiation test with any three phase enclosure construction in place of the specified test in table 2.~~

### 7.101.7.2.5 Arc initiation according to different construction types

Table 2 provides the parameters for an internal arc fault test according to enclosure and compartment construction. To further clarify the different test methods, refer to Figure 4 and examples in this subclause.








NOTE For systems with an isolated neutral, in the unlikely occurance of a double earth fault within the switchgear and controlgear (two phases fail to earth), then fault levels up to 87 % of the three-phase rated current might occur, and as such, a phase-to-phase fault might be a preferred option taken by the manufacturer.

**Figure 4 – Flow-chart for the choice of arc initiation depending on the construction**

a) Example 1: A pole-mounted switchgear and controlgear, with bare conductors, tested for a three-phase fault current (RMS) of 12,5 kA, for 0,5 s, intended to be installed on a pole, is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s;

In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network;

Designation: IAC 12,5 kA, 0,5 s.

b) Example 2: For a three-phase enclosure with solid insulated conductors with the three-phase switchgear and controlgear intended to be suitable for a 12,5 kA 3 phase network (An IAC rating of 12,5 kA for 0,5 s) the manufacturer may choose either a phase-to-phase test or a phase-to-earth test as indicated in the following:

NOTE In this example there is only one three-phase compartment/enclosure, so no other 3 phase tests will be performed.

Example 2A: Manufacturer chooses to perform a phase-to-earth test and ensure it is suitable for all Neutral earth networks by testing with 100 % of the three-phase rated arc fault current: Test performed on a three-phase enclosure with conductors with solid insulation.

IAC;

Arc fault current 12,5 kA assessed with a phase-to-earth test (100 % of the rated single-phase-to-earth arc fault current);

Arc fault duration 0,5 s.

Second and third phase energized during the tests but not affected. In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network.

Designation: IAC 12,5 kA, 0,5 s ($I_{Ae}$ = 12,5 kA).

Example 2B: Instead manufacturer chooses to perform a phase-to-phase test on a three-phase enclosure with conductors with solid insulation.

IAC;

Arc fault current 10,875 kA assessed with a phase-to-phase test;

Arc fault duration 0,5 s.

Third phase energized during the tests, but not affected.

In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network.

Designation: IAC 12,5 kA, 0,5 s.

Example 2C: The manufacturer chooses to perform a three-phase test independent of the type of three-phase switch conductor system. A pole-mounted switchgear and controlgear, tested for a three-phase fault current (RMS) of 12,5 kA, for 0,5 s, intended to be installed on a pole, is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s.

In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network.

Designation: IAC 12,5 kA, 0,5 s.

c) Example 3:

Example 3A: A single-phase enclosure pole-mounted switchgear and controlgear tested for a phase-to-earth fault current (RMS) of 12,5 kA, for 0,5 s, in a single-phase system, is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s.

Designation: IAC $I_{Ae}$ 12,5 kA, 0,5 s.

A single-phase enclosure pole-mounted switchgear and controlgear tested in a single-phase system shall not be IAC classified for a three-phase system.

Example 3B**:** Three independent single-phase pole-mounted switchgear and controlgear enclosures tested for a phase-to-earth fault current (RMS) of 12,5 kA, for 0,5 s, in a three-phase system is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s.

Designation: IAC 12,5 kA, 0,5 s ($I_{Ae}$ = 12,5 kA).

### 7.101.8 Criteria to pass the test

IAC designation is demonstrated for the pole-mounted switchgear and controlgear if the following criteria are met:

a) Criterion No. 1

- No fragmentation of the enclosure occurs.
- No ejection of fragments or of other parts of the switchgear of an individual mass of 60 g or more, occur.

Deformations are accepted.

The switchgear and controlgear does not need to comply with its IP code after the test.

b) Criterion No. 2

Arcing does not cause holes in the enclosure under test. Holes in the enclosure which are created after the duration of the test by other effects than burning through, are disregarded. **7**

The inclusion of a pressure relief vent and its operation is permitted and is not deemed as a structural failure; however, any ejected parts due to its operation shall comply with the 60 g limit for ejected parts. **8**

c) Criterion No. 3

Indicators do not ignite ~~due to the effect of hot gases or burning liquids~~ during the test and within 1 s after the current duration **9**. If indicators have been ignited~~, the assessment criterion may be regarded as having been met,~~ 1 s after the current duration and if proof is established of the fact that the ignition was caused by glowing particles rather than hot gases or burning liquids, the assessment criterion has also been met. Pictures taken by high-speed cameras, video or any other suitable means ~~can~~ should be used by the test laboratory to establish evidence.

Indicators ignited as a result of burning paint or stickers are also excluded.

d) Criterion No. 4

The switchgear and controlgear remains connected to its earthing point. Visual inspection is generally sufficient to assess compliance. In case of doubt, the continuity of the earthing connection shall be checked. To check the continuity, verify by testing with 30 A (DC) to the earthing point provided. The voltage drop shall be lower than 3 V.

### 7.101.9 Transferability of the test results

The validity of the results of a test carried out in a tested enclosure of a particular design of pole-mounted switchgear and controlgear can be extended to another test enclosure provided that the original test was more onerous and this other test enclosure can be considered as similar to the tested unit in the following aspects:

– mounting height of test enclosure with respect to the indicator positions;
– structure and strength of the enclosure;
– performance of the pressure relief device, if any;
– insulation system;
– physical influences (pressure rise, gas flow and thermal effects).

NOTE IEC TR 62271-307[3] can be used as a reference.

## 8 Routine tests

Not applicable.

## 9 Guide to the selection of switchgear and controlgear (informative)

Subclauses of Clause 9 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 9.1 General

Subclause 9.1 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is replaced by following text:

Pole-mounted switchgear and controlgear have been constructed in various forms that have evolved with changing technologies and functional requirements. The selection of pole-mounted switchgear and controlgear essentially involves an identification of the functional requirements for the service installation.

Such requirements should take account of applicable legislation and user safety rules.

### 9.101 Internal arc fault

#### 9.101.1 General

If the switchgear and controlgear is installed, operated and maintained in accordance with the instructions of the manufacturer, there should be low probability that an internal arc occurs, but it cannot be completely disregarded. Failure within the enclosure of pole-mounted switchgear and controlgear due either to a defect or ~~an~~ exceptional ~~service condition~~ operating conditions or maloperation can initiate an internal arc, which constitutes a hazard, if persons are present.

When selecting pole-mounted switchgear and controlgear, the possibility of the occurrence of internal arc faults should be properly addressed, with the aim of providing an acceptable protection level for operators and, where applicable, for the general public.

This protection is achieved by reducing the risk to a tolerable level. According to ISO/IEC Guide 51, risk is the combination of the probability of occurrence of harm and the severity of the harm. (Refer to Clause 5 of ISO/IEC Guide 51:2014 on the concept of safety.[4])

Therefore, the selection of adequate equipment, in relation to internal arc, should be governed by a procedure to achieve a level of tolerable risk. Such a procedure is described in Clause 6 of ISO/IEC Guide 51:2014 [4]. This procedure is based on the assumption that the user has a role to play in the risk reduction.

### 9.101.2 Causes and preventive measures

Experience has shown that faults are more likely to occur in some locations inside an enclosure than in others. For guidance, Table 3 gives a list of locations where experience shows that faults are most likely to occur. It also gives causes of failure and possible measures to decrease the probability of internal arc faults. If necessary, the user should implement applicable preventive measures to the installation, commissioning, operation and maintenance.

**Table 3 – Locations, causes and examples of measures to decrease the probability of internal arc faults**

| **Locations where internal arc faults are most likely to occur**<br>(1) | **Possible causes of internal arc faults**<br>(2) | **Examples of possible preventive measures**<br>(3) |
|---|---|---|
| Connections (Inside the enclosure) | Inadequate design | Selection of adequate dimensions<br>Use of appropriate materials |
| | Faulty assembly | Checking of workmanship and/or dielectric test on site. |
| | Failure of solid or liquid insulation (defective or missing) | Checking of workmanship and/or dielectric test on site.<br>Regular checking of fluid levels, where applicable |
| Disconnectors<br>Switches<br>Earthing switches | Maloperation | Interlocks. Delayed reopening. Independent manual operation. Making capacity for switches and earthing switches. Instructions to personnel |
| Bolted connections and contacts | Corrosion | Use of corrosion inhibiting coating and/or greases.<br>Use of plating. Encapsulation, where possible<br>Supplemental heating to prevent condensation. |
| | Faulty assembly | Checking of workmanship by suitable means. Correct torque. Adequate locking means |
| | | ~~Checking of workmanship at site.~~ |
| Instrument transformers | Ferro-resonance | Avoidance of these electrical influences by suitable design of the circuit |
| | Short circuit on low-voltage side for VTs | Avoid short circuit by proper means for example, protection cover, low-voltage fuses |
| Circuit-breakers | Insufficient maintenance | Regular programmed maintenance<br>Instructions to personnel |
| All locations | Error by personnel | Limitation of access by compartmentalisation. Insulation embedded live parts. Instructions to personnel |
| | Ageing under electric stresses | Partial discharge routine tests |
| | Pollution, moisture ingress of dust, vermin, etc. | Measures to ensure that the specified service conditions are achieved. Use of sealed compartments |
| | Overvoltages | Surge protection. Adequate insulation co-ordination. Dielectric tests on site |

### 9.101.3 Supplementary protective measures

The first protective measure if the risk of an internal arc fault is not negligible is to specify IAC classified assemblies.

Other measures can be adopted to provide ~~the highest possible level of~~ protection to persons in case of an internal arc. These measures are aimed to limit the external consequences of such events.

Following are some examples of these measures:

– rapid fault clearance times initiated by detectors sensitive to light, pressure or heat;
– application of suitable fuses in combination with switching devices to limit the let-through current and fault duration;
– fast elimination of arc by diverting it to metallic short circuit by means of fast-sensing and fast-closing devices;
– remote operation instead of operation at the base of the switchgear and controlgear;
– pressure-relief device.

### 9.101.4 Considerations for the selection and installation

The user shall make a selection, taking into account the characteristics of the network, operating procedures and service conditions.

As a guide for the selection of the adequate switchgear and controlgear with respect to internal arcs, the following criteria can be used:

– where the risk is considered negligible, IAC designated switchgear and controlgear is not necessary;
– where the risk is considered to be relevant, IAC designated switchgear and controlgear should be used.

For the second case, the selection should be made by taking into account the foreseeable maximum level of current and duration of the fault, in comparison with the rated values of the tested equipment. In addition, the installation instructions of the manufacturer should be followed (refer to Clause 11). In particular, the location of personnel during an internal arc event is important.

The protection of persons in case of an internal arc is not only a matter of design and IAC designation of the switchgear and controlgear but depends also on the installation conditions. Internal arc faults inside pole-mounted switchgear and controlgear can occur in a number of locations and can cause various physical phenomena. For example, the arc energy resulting from an arc developed in any insulating fluid within the enclosure will cause an internal overpressure and local overheating which will result in mechanical and thermal stressing of the equipment. Moreover, the materials involved can produce hot decomposition products, either gaseous or vaporous, which can be discharged to the outside of the enclosure. Therefore, appropriate measures should be considered for the installation site.

For pole-mounted switchgear and controlgear, the minimum installation height of the enclosure of the high-voltage is based on the rated approach distance declared by the manufacturer plus ~~a suitable distance above the general public~~ 2 m.

### 9.101.5 Internal arc test

The internal arc test is intended to verify the effectiveness of the design in protecting persons in case of an internal arc, during normal operating condition. The test does not assess the behaviour of the switchgear and controlgear under any condition of maintenance or work, when parts of the enclosure, including the low-voltage compartment, are open or dismantled.

The internal arc test is applicable to pole-mounted switchgear and controlgear, to which an Internal Arc Classification is to be assigned.

NOTE It is in general not possible to calculate the permissible arc duration for a current which differs from that used in the test. The maximum pressure during the test will generally not decrease with a shorter arcing time and there is no universal rule according to what arc duration is permissible with a lower test current.

### 9.101.6 IAC designation

IAC designation indicates a tested level of protection of persons under normal operating condition as stated in 7.101.2. It is concerned with personnel protection under these conditions; it is not concerned with personnel protection under maintenance conditions nor with service continuity.

~~When an Internal Arc Classification is assigned, according to ,~~ The pole-mounted switchgear and controlgear will be designated as follows.

– General: designation IAC (~~initials~~ acronym for Internal Arc ~~Classified~~ Classification).

– Rated values: arc fault current in kiloamperes (kA), and duration in seconds (s) (according to 7.101.6). Single-phase values can be assigned to switchgear and controlgear, having one or more high-voltage compartments where its construction will prevent the arc from becoming multiphase, as demonstrated during the internal arc test. The relationship between neutral earthing and single-phase-to-earth arc fault current is given in Table 4. Users should specify a single-phase-to-earth arc fault current rating when they require a value higher than 87 % of the three-phase rating, or can accept a lower value, depending on the neutral earthing.

**Table 4 – Single-phase-to-earth arc fault current depending on the network neutral earthing**

| Type of network neutral earthing | Single-phase-to-earth arc fault current |
|---|---|
| Isolated neutral | Up to 87 % of the three-phase rated arc fault current |
| Impedance earthed neutral | 100 % of the rated single-phase-to-earth arc fault current |
| Solidly earthed neutral | 100 % of the three-phase rated arc fault current |

NOTE 1 If the rated single-phase-to-earth arc fault current covers the condition of solidly earthed neutral, all other earthing conditions of the network are also covered.

NOTE 2 For systems with isolated neutral, the maximum single-phase-to-earth fault current could theoretically reach levels up to 87 % of the three-phase rated arc fault current (single-phase-to-earth fault current under conditions of double-earth fault). However, double-earth faults at independent locations in the proximate vicinity of a single-phase-to-earth fault subjected switchgear and controlgear have a very low probability. Therefore, this condition could not be applicable and the user can specify a reduced single-phase-to-earth arc fault current rating.

NOTE 3 Resonant earthed (neutral) systems are covered in this table by the term "isolated neutral".



## 10 Information to be given with enquiries, tenders and orders (informative)

Clause 10 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable for this document, except 10.1 which is replaced as follows.

### 10.1 General

When enquiring about or ordering an installation of IAC specified pole-mounted switchgear and controlgear the IAC pole-mounted designation, rated approach distance, arc fault currents and duration ~~shall~~ should be included.

## 11 Transport, storage, installation, operation instruction and maintenance

Clause 11 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable for this document, except 11.1, 11.2 and 11.3 which are replaced as follows.

### 11.1 General

It is essential that the transport, storage and installation of switchgear and controlgear, as well as their operation and maintenance in service, be performed in accordance with instructions given by the manufacturer.

### 11.2 Conditions during transport, storage and installation

A special agreement should be made between manufacturer and user if the service conditions of temperature and humidity defined in the order cannot be guaranteed during transport, storage and installation. Special precautions may be essential for the protection of insulation during transport, storage and installation, and prior to energizing, to prevent moisture absorption due, for instance, to rain, snow or condensation. Vibrations during transport shall be considered. Appropriate instructions should be provided by the manufacturer.

### 11.3 Installation

#### 11.3.1 General

For IAC classified switchgear and controlgear, guidance on safe installation conditions for the case of an internal arc should be provided. The hazards of the actual installation condition should be assessed with respect to installation conditions validated during the internal arc classification (refer to 7.101). However, if the purchaser (user) considers that the risk is not relevant, the switchgear and controlgear can be installed without the restrictions indicated by the manufacturer. The minimum installation height is the declared rated approach distance plus 2 m.

### 11.101 Maintenance

~~11.101.1 General~~

Where necessary, the manufacturer shall provide guidance on any maintenance requirements in order to maintain the integrity of the IAC designation over the life of the product. Refer to the sections of Table 3 as examples where maintenance can be considered over the life of the switchgear and controlgear.

## 12 Safety

Clause 12 of IEC 62271-1:2017 is not applicable for this document except 12.1 modified as follows:

### 12.1 General

As far as the protection of persons is concerned, the correct performance of the pole-mounted switchgear and controlgear in the event of an internal arc is not only a matter of design of the equipment itself, but also of the installation conditions, operating procedure and if applicable maintenance procedures, for instance, see 9.101.

## 13 Influence of the product on the environment

Clause 13 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable for this document and is replaced as follows:

The manufacturer shall be prepared to provide on request, relevant information about the environmental impact of the switchgear and controlgear. The manufacturer shall give guidance on request, concerning disassembly and end-of-life procedures for the different materials and components of the equipment and indicate recycling suitability.

# Annex A
(normative)

# Identification of the test objects

## A.1 General

For identification of a test object, the following topics shall be covered.

## A.2 Data

– Manufacturer's name;
– Type designation, ratings and unique identifier of test object;
– Outline description of test object (including number of poles, interlocking system, busbar system, earthing system, and the arc extinguishing process);
– Make, type, and ratings of essential parts, where applicable (for example, drive mechanisms, interrupters, shunt impedances, relays, fuse links, insulators);
– Rated characteristics of fuse links and protective devices;
– Whether the apparatus is intended for operation in the vertical and horizontal plane;
– Mock-ups (if used) details shall also be given.

## A.3 Drawings

| Drawings to be submitted | Drawing content (as applicable) |
|---|---|
| Single-line diagram of main circuit | Type designation of principal components |
| General layout<br><br>NOTE For an assembly it ~~may~~ can be necessary to provide drawings of the complete assembly and of each switching device. | Overall dimensions<br>Supporting structure and mounting points<br>Enclosure(s)<br>Pressure-relief devices<br>Conducting parts of main circuit<br>Earthing conductors and earthing connections<br>Electrical clearances:<br>to earth, between open contacts;<br>between poles.<br>Location and dimensions of barriers between poles<br>Location of earthed metallic screens, shutters or partitions in relation to live parts<br>Liquid insulation level<br>Location and type designation of insulators<br>Location and type designation of instrument transformers |
| Detailed drawings of insulators | Material<br>Dimensions (including profile and creepage distances) |
| Arrangement drawings of cable boxes | Electrical clearances<br>Principal dimensions<br>Terminals<br>Level or quantity and specifications of insulant in filled boxes<br>Cable termination details |

# Bibliography

[1] IEC 60050-601:1985, *International Electrotechnical Vocabulary (IEV) – Part 601: Generation, transmission and distribution of electricity – General*
IEC 60050-601:1985/AMD1:1998
IEC 60050-601:1985/AMD2:2020

~~[2] IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*~~

~~[3] IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*~~
~~IEC 60529:1989/AMD1:1999~~
~~IEC 60529:1989/AMD2:2013~~

~~[4] IEC 60909-0:2016, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*~~

~~[5] IEC 60243-1:2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*~~

~~[6] IEC 62271-100, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*~~

~~[7] IEC 62271-203:2003, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*~~

~~[8] IEC TR 62271-303:2008, *High-voltage switchgear and controlgear – Part 303: Use and handling of sulphur hexafluoride (SF6)*~~

~~[9] EN 50187:1996, *Gas-filled compartments for AC switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*~~

~~[10] IEEE C37.20.7:2001, *IEEE Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults*~~

~~[11] IEC 62271-102:2001, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*~~
~~IEC 62271-102:2001/AMD1:2011~~
~~IEC 62271-102:2001/AMD2:2013~~

~~[12] IEC 62271-103, *High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV*~~

~~[13] IEC 62271-111:2012, *High-voltage switchgear and controlgear – Part 111: Automatic circuit reclosers and fault interrupters for alternating current systems up to 38 kV*~~

[2] IEC 62271-200:~~2011~~2021, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

[3] IEC TR 62271-307:2015, *High-voltage switchgear and controlgear – Part 307: Guidance for the extension of validity of type tests of AC metal and solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

[4] ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

[5] CIGRE TECHNICAL BROCHURE 686:2017, *Mitigating the effects of arcs in M.V. Switchgear*

[6] IEC 60038:2009, *IEC standard voltages*
IEC 60038:2009/AMD1:2021

[7] IEC 60059:1999, *IEC standard current ratings*
IEC 60059:1999/AMD1:2009

[8] IEC 60050-466:1990, *International Electrotechnical Vocabulary (IEV) – Part 466: Overhead lines*
IEC 60050-466:1990/AMD1:2020
IEC 60050-466:1990/AMD2:2021
IEC 60050-466:1990/AMD3:2021

[9] CIGRE TECHNICAL BROCHURE 602:2014, *Tools for the Simulation of the Effects of the Internal Arc in Transmission and Distribution Switchgear*

# List of comments

1 Because of the increase of the documents referred to DC inside IEC TC 17 and its Subcommittees, this change is added to clarify that this document is only applicable for AC.

2 IAC classification is not a mandatory requirement. This change is added to clarify that this document is only applicable for metal-enclosed pole-mounted switchgear and controlgear for which IAC is assigned.

3 The IAC classification is linked to the way that the test object is installed, and the area being protected is worker's area. It means the area beneath the apparatus.

4 Pole-mounted switchgear and controlgear are installed in different conditions worldwide. This text is added to precise that the test performed according to this standard only provide protection for persons beneath the apparatus, as it is demonstrated by the type test.

5 Arrangement of the main indicators is changed to improve the protection of the authorized persons and general public beneath the apparatus. Before indicators were centred to the pole and now indicators are centred to the test object.

Additionally, a second set of indicators is proposed, only for the cases for which the control box is not fully covered by the main indicators.

6 There are differences between IEEE and IEC in the way to connect the neutral point of the supply circuit during internal arc test. For pole-mounted metal-enclosed switchgear and controlgear, the way that the neutral point is connected does not have any impact on the test result and then both neutral arrangements are permitted and covering each other.

7 Alignment of the criteria used in IEC 62271-200:2021 to evaluate the holes in the enclosure but adapted to the pole-mounted installation conditions (out of reach).

8 Precision requested by some testing stations to clarify that the pressure relief operation is not considered a structural failure.

9 Alignment with the criteria used in IEC 62271-200:2021.

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IEC 62271-214

Edition 2.0 2024-04

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

colour inside



## High-voltage switchgear and controlgear – Part 214: Internal arc classification for AC metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

## Appareillage à haute tension – Partie 214 : Classification arc interne des appareillages sous enveloppe métallique à courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV montées sur poteau

IEC 62271-214:2024-04(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

# Part 214: Internal arc classification for AC metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

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IEC 62271-214 has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High voltage switchgear and controlgear. It is an International Standard.

This second edition cancels and replaces the first edition published in 2019. This edition constitutes a technical revision.

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

a) indicators positioning update;
b) neutral earthing connection of the test circuit for three-phase tests;
c) general review for consistency with IEC 62271-200, Ed.3.0:2021.

The text of this International Standard is based on the following documents:

| Draft | Report on voting |
|---|---|
| 17C/924/FDIS | 17C/931/RVD |

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This standard shall be read in conjunction with IEC 62271-1, second edition, published in 2017, to which it refers, and which is applicable unless otherwise specified in this standard. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1. Amendments to these clauses and subclauses are given under the same references whilst additional subclauses are numbered from 101. Any clause with the term "Not applicable" relates to the clause not being relevant to IEC 62271-214, and does not infer the clause is or is not relevant for its applicable switchgear standard.

A list of all parts of the IEC 62271 series, published under the general title *High-voltage switchgear and controlgear*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

# INTRODUCTION

IEC 62271-214 has been developed due to the requirement to remove IAC Type C designated pole-mounted switchgear from IEC 62271-200. IEC 62271-214 is to be considered independent of IEC 62271-200, however it is still related to other product standards of the IEC 62271 series.

Only open terminal pole-mounted switchgear and controlgear has been considered within this document.

This equipment relates to operation in three-phase, two-phase and single-phase systems.

# HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

# Part 214: Internal arc classification for AC metal-enclosed pole-mounted switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

## 1 Scope

This part of IEC 62271 specifies requirements for internal arc classification of AC metal-enclosed pole-mounted switchgear and controlgear with rated voltages above 1 kV and up to and including 52 kV with service frequencies up to and including 60 Hz.

This document is applicable to three-phase, two-phase and single-phase open terminal equipment for which an internal arc classification is assigned. Enclosures may include fixed and removable components and may be filled with fluid (liquid or gas) to provide insulation.

NOTE 1 The IAC classification takes into account the installation disposition of the high-voltage switchgear and controlgear and worker's operating area.

NOTE 2 For the use of this document, high-voltage (IEC 60050-601:1985, 601-01-27) is the rated voltage above 1 000 V. However, medium voltage (IEC 60050-601:1985, 601-01-28) is commonly used for distribution systems with voltages above 1 kV and generally applied up to and including 52 kV; refer to [1][1].

This document does not preclude that other equipment may be included in the same enclosure. In such a case, any possible influence of that equipment on the switchgear and controlgear is to be taken into account.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-151:2001, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*
IEC 60050-151:2001/AMD1:2013
IEC 60050-151:2001/AMD2:2014
IEC 60050-151:2001/AMD3:2019
IEC 60050-151:2001/AMD4:2020
IEC 60050-151:2001/AMD5:2021

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses*
IEC 60050-441:1984/AMD1:2000

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*
IEC 62271-1:2017/AMD1:2021



[1] Numbers in square brackets refer to the Bibliography.

IEC 62271-200:2021, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1, IEC 60050-151 and IEC 60050-441, as well as the following apply.

NOTE 1 The classification system for definitions of IEC 62271-1:2017 is not followed. Terms and definitions are referenced and prioritized in the following order:

– Clause 3 of this document;

– IEC 62271-1:2017;

– IEC 60050-441;

– IEC 60050-151.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

NOTE 2 Additional definitions are classified so as to be aligned with the classification system used in IEC 60050-441.

### 3.1 General terms and definitions

**3.1.101**
**metal-enclosed switchgear and controlgear**
switchgear and controlgear assemblies with an external metal enclosure intended to be earthed, and completely assembled except for external connections

[SOURCE: IEC 60050-441:1984, 441-12-04, modified – "complete" has been replaced by "completely assembled"; NOTE has been deleted.]

**3.1.102**
**enclosure**
part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts and against contact with moving parts

[SOURCE: IEC 60050-441:1984, 441-13-01, modified – <of an assembly> has been deleted.]

**3.1.103**
**high-voltage compartment**
compartment of switchgear and controlgear, containing high-voltage conducting parts, enclosed except for openings necessary for interconnection, control or ventilation, where one segment of the compartment can be part of the outer earthed metallic enclosure

**3.1.104**
**component**
essential part of the high-voltage or earthing circuits of pole-mounted switchgear and controlgear which serves a specific function (e.g. circuit-breaker, disconnector, switch, fuse, instrument transformer, bushing, busbar)

**3.1.105**
**main circuit**
all the high-voltage conductive parts of pole-mounted switchgear and controlgear included in a circuit which is intended to carry the rated continuous current

[SOURCE: IEC 60050-441:1984, 441-13-02, modified – "high voltage" has been added, "assembly" has been substituted by "pole-mounted switchgear and controlgear" and "transmit electrical energy" has been substituted by "carry the rated continuous current".]

**3.1.106**
**earthing circuit**
conductors, connections, and the conducting parts of earthing devices intended to connect the high-voltage conductive parts to the earthing system of the installation

Note 1 to entry: Parts of metallic enclosures connected to the earthing system can be part of the earthing circuit.

**3.1.107**
**normal operating condition**
in service condition with all covers properly closed and secured

Note 1 to entry: The term "in service" implies "under live conditions".

[SOURCE: IEC 62271-200:2021[2], 3.1.106, modified – "<of an assembly>" and "doors and" have been removed and Note 1 to entry has been added.]

**3.1.108**
**pressure relief device**
device incorporated as part of an enclosure or compartment intended to operate to prevent excessive pressure in the enclosure or compartment

**3.1.109**
**fluid-filled compartment**
high-voltage compartment of pole-mounted switchgear and controlgear filled with a fluid, either gas, other than ambient air, or liquid, for insulation purposes

**3.1.110**
**pole**
vertical single member support in wood, concrete, steel or other material, with one end buried in the ground, either directly or by means of a foundation

Note 1 to entry: The term pole as defined here is not to be mixed up with the use of the same term as synonymous for phase as used in other standards.

[SOURCE: IEC 60050-466:1990, 466-07-01[8], modified – Note 1 to entry has been added.]

**3.1.111**
**pole-mounted switchgear and controlgear**
metal-enclosed switchgear and controlgear, typically connected to overhead lines, installed on one or more poles or equivalent structures at a defined height, with restricted accessibility by installation out of reach

**3.1.112**
**internal arc classification**
**IAC**
metal-enclosed switchgear and controlgear for which prescribed criteria, for protection of authorized persons and the general public beneath the apparatus, are met in the event of internal arc for specified installation conditions, as demonstrated by type tests

Note 1 to entry: The internal arc classification is described by the characteristics given from 3.1.114 to 3.1.116.

[SOURCE: IEC 62271-200:2021, 3.6.117, modified – "authorized" and "and general public beneath the apparatus" have been added, "assembly" has been changed by "metal-enclosed switchgear and controlgear".]

**3.1.113**
**arc fault current**
three-phase and where applicable the single-phase-to-earth RMS value of the internal arc fault current for which the switchgear and controlgear is designed to protect persons in the event of an internal arc

[SOURCE: IEC 62271-200:2021, 3.7.101]

**3.1.114**
**arc fault duration**
duration of the internal arc fault current for which the switchgear and controlgear is designed to protect persons in the event of an internal arc

[SOURCE: IEC 62271-200:2021, 3.7.102]

**3.1.115**
**approach distance**
distance between the test object and indicators arranged in an IAC test

**3.1.116**
**arc mitigation device**
device dedicated to reacting to internal arc fault conditions to decrease the arc energy

[SOURCE: CIGRE TECHNICAL BROCHURE 686:2017][5]

## 3.8 Index of definitions

**A – C**



**E – F**

**H – I**



**M – N**



**P**



## 4 Normal and special service conditions

Clause 4 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable.

## 5 Ratings

Subclauses of Clause 5 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 5.1 General

Subclause 5.1 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable and replaced by following text:

The relevant ratings for the internal arc classification are the following:

a) rated voltage ($U_r$);

b) rated frequency ($f_r$);

c) ratings of the internal arc classification (IAC).

### 5.2 Rated voltage ($U_r$)

Subclause 5.2 of IEC 62271-1:2017 is applicable with following addition to 5.2.1.

#### 5.2.1 General

The rated voltage is equal to the maximum system voltage for which the equipment is designed. It indicates the maximum value of the "highest system voltage" of networks for which the equipment may be used (refer to Clause 9 of IEC 60038:2009 [6]).

NOTE It is possible that components forming part of pole-mounted switchgear and controlgear have differing values of rated voltage in accordance with their relevant standards.

### 5.3 Rated insulation level ($U_d$, $U_p$, $U_s$)

Not applicable.

### 5.4 Rated frequency ($f_r$)

Subclause 5.4 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is applicable.

### 5.101 Ratings of the internal arc classification (IAC)

#### 5.101.1 General

An IAC classified pole-mounted switchgear and controlgear shall have the following ratings: rated approach distance, arc fault currents and arc fault durations.

#### 5.101.2 Rated approach distance ($D_{AP}$)

The rated approach distance shall be stated by the manufacturer (refer to Figure 2).

#### 5.101.3 Rated arc fault currents ($I_A$, $I_{Ae}$)

The value of rated arc fault currents should be selected from the R 10 series specified in IEC 60059 [7].

Two ratings of the arc fault currents are recognised:

a) three-phase and phase-to-phase arc fault current ($I_A$), when applicable;

b) single-phase-to-earth arc fault current ($I_{Ae}$), when applicable.

When only a three-phase rating is specified, the single-phase rating is by default 87 % of the three-phase rating, and need not be specified.

NOTE 1 The rationale for this 87 % is the arc fault test with 2-phase ignition; refer to 7.101.7.2.

The manufacturer shall specify the compartments to which the single-phase-to-earth arc fault current rating applies. Such value is assigned to switchgear and controlgear where its construction will prevent the arc from becoming multiphase, as demonstrated during the internal arc test.

In the case where all high-voltage compartments are only designed for single-phase-to-earth arc faults, instead of $I_A$ rating, the $I_{Ae}$ rating shall be assigned (refer to 7.101.7.2).

NOTE 2 Information about the relationship between type of neutral earthing and the single-phase-to-earth arc fault current is provided in 9.101.6.

#### 5.101.4 Rated arc fault duration ($t_A$, $t_{Ae}$)

Recommended values for the arc fault duration ($t_A$, $t_{Ae}$) are 0,1 s, 0,5 s and 1 s.

NOTE It is in general not possible to calculate the permissible arc duration for a current which differs from that used in the test.

## 6 Design and construction

Subclauses of Clause 6 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 6.11 Nameplate

#### 6.11.2 Application

Subclause 6.11.2 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is applicable, except for Table 9, with the following additions:

Pole-mounted switchgear and controlgear, with a rated internal arc classification shall include in the nameplate the additional IAC information in accordance with Table 1.

**Table 1 – Nameplate information**

| | Abbreviation | Unit | ** | Condition: Marking only required if |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Internal arc classification | IAC | | X | |
| Rated approach distance | $D_{AP}$ | m | X | |
| Arc fault current and duration | $I_A$, $t_A$ | kA, s | Y | Three-phase test or phase-to-phase test are applicable |
| Single-phase-to-earth arc fault current and duration | $I_{Ae}$, $t_{Ae}$ | kA, s | Y | A single-phase test is applicable or $I_{Ae}$ differs from 87 % of $I_A$ |
| Fitted with arc mitigation device | | | Y | Arc mitigation device fitted and not disabled during testing |
| (**) X : the marking of these values is mandatory Y : conditions for marking of these values are given in column (5) | | | | |
| NOTE If there is an abbreviation in column (2) it can be used instead of the terms in column (1). | | | | |

### 6.101 Internal arc fault

Pole-mounted switchgear and controlgear, in principle, are designed and manufactured, to prevent the occurrence of internal arc faults.

However, the switchgear and controlgear shall be designed to give a defined level of protection of persons in the event of an internal arc, when the switchgear and controlgear is in normal operating condition.

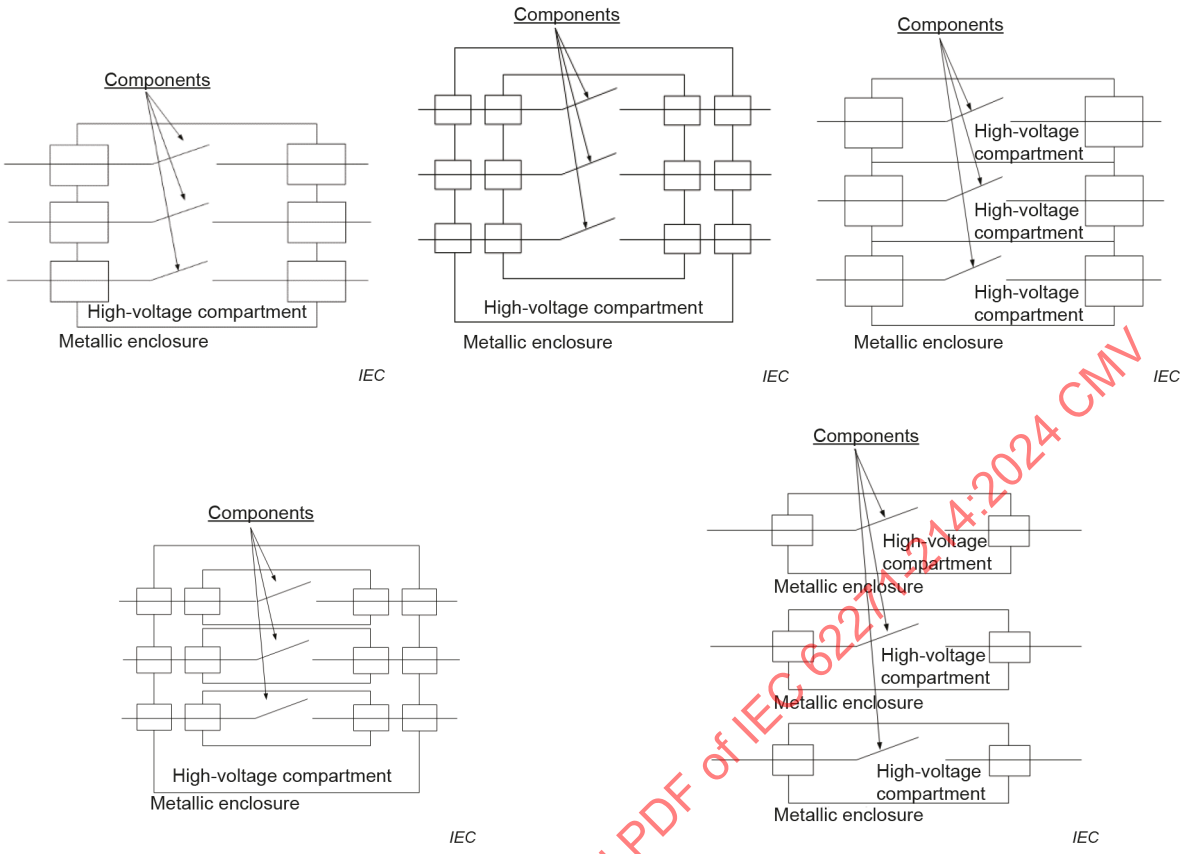
The designation shall be included in the nameplate (refer to 6.11).

Some examples for internal arc classification are given in 7.101.7.2.5.

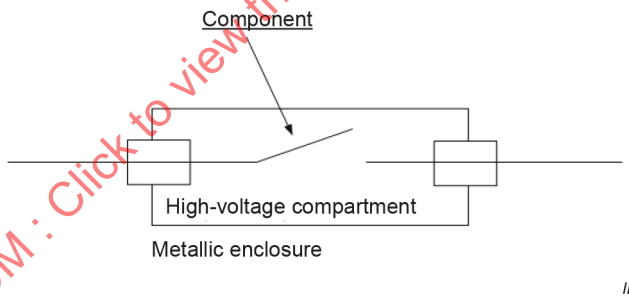
### 6.102 Enclosure

The enclosure is designed for withstanding the mechanical, electrical, thermal and environmental stresses likely to be encountered in normal operating condition and under conditions of internal arc fault.

Figure 1 shows examples of different arrangements of components in high voltage compartment(s) within an enclosure.




**a) three-phase**




**b) single-phase**

**Figure 1 – Examples of enclosures and compartment(s) in different arrangements**



## 7 Type tests

Subclauses of Clause 7 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 7.1 General

#### 7.1.1 Basics

The type test is performed to verify the internal arc ratings and characteristics of pole-mounted switchgear and controlgear.

### 7.1.2 Information for identification of test object

Subclause 7.1.2 of IEC 62271-1:2017 does not apply for this document and is replaced by following text.

The manufacturer shall submit to the testing laboratory, drawings and other data containing sufficient information to unambiguously identify by type the essential details and parts of the switchgear and controlgear presented for test. A summary list of the drawings and data schedules shall be supplied by the manufacturer and shall be uniquely referenced and shall contain a statement to the effect that the manufacturer guarantees that the drawings or data schedules listed are the correct version and truly represent the switchgear and controlgear to be tested.

The testing laboratory shall check that drawings and data sheets adequately represent the essential details and parts of the test object, but is not responsible for the accuracy of the detailed information.

Particular drawings or data required to be submitted by the manufacturer to the test laboratory for identification of essential parts of test object are specified in Annex A.

### 7.1.3 Information to be included in type-test reports

The results shall be recorded in type-test reports containing sufficient data to prove compliance with the test clauses of this document for the test(s) conducted. Sufficient information shall be included so that the essential parts of the test object can be identified. In particular, the following information shall be included:

– manufacturer;
– type designation and unique identifier for the test object;
– rated characteristics of the test object;
– photographs to illustrate the condition of the test object before and after test;
– sufficient outline drawings and data schedules to represent the test object;
– the reference numbers of all drawings including revision number submitted to identify the essential parts of the test object;
– details of the testing arrangement (including diagram of test circuit);
– statements of the behaviour of the test object during test and its condition after test;
– description of the test object with a drawing showing the main dimensions, details relevant to the mechanical strength, the arrangement of the pressure relief device(s) and the method of fixing the test object to the pole(s), including the pole characteristics;
– point and method of initiation of the internal arc fault;
– drawings of test arrangement (test object, source side connection point, and mounting frame of indicators, pole dimensions) and any other relevant installation conditions; applied voltage and frequency;
  - IAC designation validated by test;
  - include use of fuse protection if used;
  - include the use of arc mitigation device if used;
– for the prospective and/or test current (refer to 7.101.6.3):
  a) RMS value of the AC component during:
    - the first three half-cycles;
    - the last three half-cycles;
  b) highest peak value (actual and/or prospective);
  c) average RMS value of the AC component over the actual duration of the test;

d) duration of arc fault current;

e) prospective RMS value and duration of the test current;

– oscillogram(s) showing currents and voltages;

– optionally, total arc energy, peak arc power;

– optionally, measurement of pressure in compartments;

– assessment of the test results, including a record of the observations in accordance with 7.101.8;

– other relevant remarks.

### 7.101 Internal arc type test

#### 7.101.1 General

The test is applicable to pole-mounted switchgear and controlgear for which internal arc classification is assigned, covering the event of an arc fault within the enclosure(s) or within components having housings which form part of the enclosure in normal operating condition. The internal arc test makes allowance for effects acting on all parts of the enclosure, such as internal overpressure, thermal effects of the arc or its roots, and for the effects of ejected hot gases and glowing particles on the persons situated beneath the apparatus under test.The tests are not intended to cover e.g.:

– the influences of an internal arc between compartments;

– the effect of an arc on the external connections outside the enclosure;

– the effects caused by an explosion of high-voltage components;

– the presence of gases with potential toxic characteristics, or the hazard of fire propagation to combustible materials or equipment placed in the proximity of the pole-mounted switchgear and controlgear.

#### 7.101.2 Test conditions

The test shall be carried out with the switchgear and controlgear in normal operating condition. This means the position of high-voltage switching devices is set according to 7.101.7.1.4. All other equipment, for example measuring instruments and monitoring equipment shall be in the position as it is in normal operating condition.

Pole-mounted switchgear and controlgear which are protected by type-tested current-limiting fuses, integrated inside the switchgear and controlgear, shall be tested with the fuse type that causes the highest cut-off current (let-through current). The actual duration of the current flow will be controlled by the fuses. The tests shall be performed at the rated voltage of the equipment. The tested switchgear and controlgear will be designated as 'fuse-protected'. The specific fuse, including manufacturer, part number, and ratings, used for protection shall be specified in the instructions manual.

Application of suitable current-limiting fuses in combination with switching devices can limit the short-circuit current and minimize the fault duration. It is well documented that the arc energy transferred during such tests is not predictable by $I^2t$. In the case of current-limiting fuses, the maximum arc energy may occur at current levels below the maximum interrupting rating. Further, the effects of using current-limiting devices that employ pyrotechnic means to commutate current to a current-limiting fuse shall be considered when evaluating designs utilizing such devices.

Any device (for example, protection relay) that may automatically trip the circuit before the end of the prospective duration of the test shall be made inoperative during the test. If pole-mounted switchgear and controlgear is equipped with devices intended to limit the duration of the arc itself by other means (for example, by transferring the current to a metallic short circuit), they shall be made inoperative during the test. If these devices are an integral part of the design of the high-voltage compartment or assembly which prevents them being made inoperative without modification of the construction, the relevant high-voltage compartment of the switchgear and controlgear may be tested with the device operative; but this switchgear and controlgear shall be qualified according to the actual duration of the arc. The test current shall be maintained for the rated arc fault duration of the switchgear and controlgear.

NOTE Because in general arc limiting devices are out of the scope of this document and if the switchgear and controlgear has previously been tested with the limiting device made inoperative, an additional test can be performed to demonstrate the behaviour of this arc limiting device.

### 7.101.3 Arrangement of the equipment

The test arrangement for pole-mounted switchgear and controlgear shall be configured as indicated in Figure 2.

Dimensions in millimetres

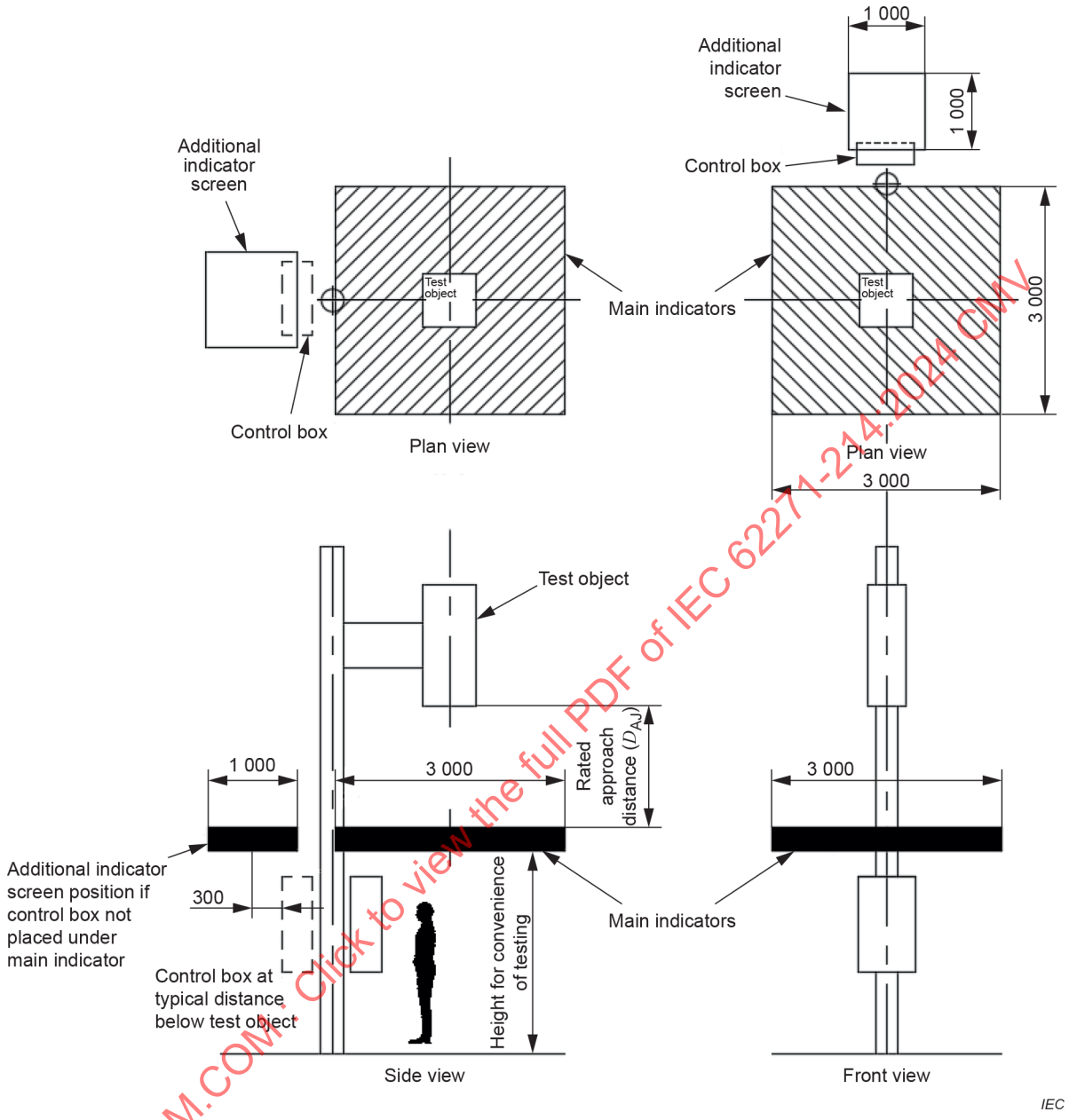



**Figure 2 – Test arrangement for pole-mounted switchgear and controlgear**



The equipment shall be arranged as follows:

– mock-ups of internal components are permitted provided they have the same volume and external material as the original items, and they do not affect the main and earthing circuits;

– the test object shall be mounted on a pole. If there is a control box and/or electrical/mechanical linkages to the base of the pole, these shall be fitted at a distance below the test object typical of a service installation. The test object shall be at a convenient height allowing for the indicators as specified in 7.101.5, and for the control box and/or electrical/mechanical linkages (if applicable);

– In the case the control box is not fully covered by the main indicators the test shall include a 1 000 mm × 1 000 mm indicator screen above control box, refer to Figure 2;

– the test object shall be earthed at the earthing point provided;

– tests shall be carried out on high-voltage compartments not previously subjected to arcing, or, if subjected, being in a condition which does not affect the result of the test;
– in the case of fluid-filled compartments (other than $SF_6$) the test shall be made with the original fluid at its filling pressure (±10 %);
– for environmental reasons, it is recommended to replace $SF_6$ with air at the filling pressure (±10 %).

NOTE 1 Test results with air instead of $SF_6$ are considered to be representative.

NOTE 2 Nitrogen at the filling pressure (±10 %) is also considered a substitute for $SF_6$ [9].

NOTE 3 It is assumed that the physical dimensions of the test laboratory are large enough to prevent hot gas reflection towards the indicators.

### 7.101.4 Indicators (for assessing the thermal effects of the gases)

#### 7.101.4.1 General

Indicators are pieces of black cotton cloth so arranged that their cut edges do not point toward the test object.

Black cotton-interlining lawn (approximately 40 g/m$^2$) shall be used for indicators.

NOTE Cotton-interlining lawn (approximately 40 g/m$^2$) is considered to represent light summer wear of the general public.

Care shall be taken that glowing particles do not accumulate. This is achieved if the indicators are mounted without a frame (refer to Figure 3).

The indicator dimensions shall be 150 mm × 150 mm ($^{+15}_{0}$ mm).

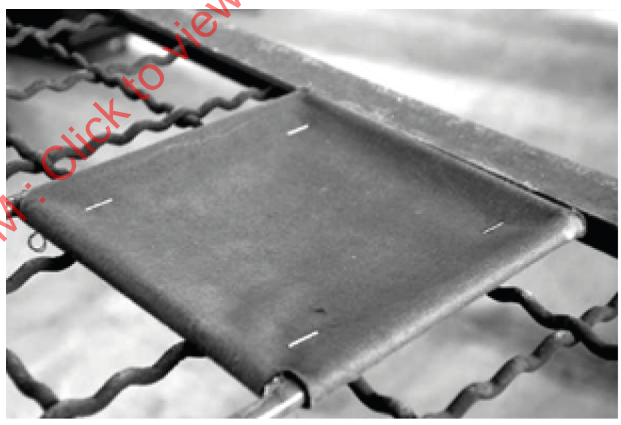


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**Figure 3 – Horizontal indicator**

Figure 3 provides an indication of a typical arrangement of a horizontal indicator.

### 7.101.5 Arrangement of indicators

Indicators shall be arranged horizontally, at the rated approach distance (±50 mm) below the lowest point of the test object. The indicators shall cover the whole area of a 3 m × 3 m square frame centered about the test object. They shall be evenly distributed, arranged in a checkerboard pattern, covering 40 % to 50 % of the area (refer to Figure 2 and Figure 3).

The indicators may be located at any convenient height above the ground allowing for the control box and/or electrical/mechanical linkages if applicable. If the control box's location is

not fully located under the 3 000 mm × 3 000 mm indicator area (refer to Figure 2), then an additional indicator screen 1 000 mm × 1 000 mm shall be positioned above the mounting position of the control box. The additional screen shall be in the same plane as the 3 000 mm × 3 000 mm indicator screen and centered as detailed in Figure 2.

NOTE 1 The additional screen is used to determine if the operators standing position, when in front of the control box, is adequately protected from hot gases and flame.

NOTE 2 This test covers the verification of the protection of both authorized personnel and general public beneath the apparatus.

### 7.101.6 Test parameters

#### 7.101.6.1 General

A test performed at a given voltage, current and duration is generally valid for all lower values of current, voltage and duration.

#### 7.101.6.2 Voltage

The test shall be performed at any suitable voltage up to and including the rated voltage $U_r$. If a voltage lower than $U_r$ is chosen, the following conditions shall be met.

a) the current during the test as computed by a digital recording device complies with current requirements of 7.101.6.3.1;

b) the arc is not extinguished prematurely in any of the phases in which it has been initiated. Temporary single-phase extinguishing is permitted, as long as the cumulated duration of the intervals without current does not exceed 2 % of the test duration and the single events last not longer than to the next prospective current zero, provided that the integral of the AC component of the current equals at least the value specified in 7.101.6.3.1 in the relevant phase.

#### 7.101.6.3 Current

##### 7.101.6.3.1 AC component

The test current shall be set within a ±5 % tolerance of the rated arc fault current ($I_A$, 87 % $I_A$ or $I_{Ae}$) as appropriate. If the applied voltage is equal to $U_r$, this tolerance applies only to the prospective current.

The current should remain constant. If the capability of the test plant does not permit this, the test shall be extended until the integral of the AC component of the current ($I^2t$) equals the value specified within a tolerance of ($^{+10}_{0}$ %). In this case, the current shall be equal to the specified value at least during the first three half-cycles and shall not be less than 50 % of the specified value at the end of the test.

NOTE Information about the relationship between type of neutral earthing and the single-phase-to-earth arc fault current is provided in 9.101.6.

##### 7.101.6.3.2 Peak current

The instant of closing for a three-phase test shall be chosen so that the peak current is flowing in one of the outer phases, and a major loop also occurs in the other outer phase.

If the applied voltage is equal to $U_r$, the peak value of the prospective current shall be set to 2,5 times (for frequencies up to 50 Hz) or 2,6 times (for 60 Hz) the RMS value of the AC component defined in 7.101.6.3.1 with a tolerance of $^{+5}_{0}$ %.

If the voltage is lower than $U_r$, the peak value of the prospective current is irrelevant, but the peak value of the short-circuit current for the switchgear and controlgear under test shall not drop below 90 % of the rated peak value.

For higher DC time constants than the standard defined 45 ms of the feeding network, a uniform value of 2,7 times the RMS value of the AC component should be used as a rated value for both 50 Hz and 60 Hz applications.

In case of two-phase initiation of the arc, or single-phase-to-earth the instant of closing shall be chosen to provide the maximum possible DC component.

#### 7.101.6.3.3 Frequency

Tests performed at 50 Hz are also applicable for 60 Hz and vice a versa. At a rated frequency of 50 Hz or 60 Hz, the frequency at the beginning of the test shall be between 48 Hz and 62 Hz. At other frequencies, it shall not deviate from the rated value by more than ±10 %. The peak factor requirement of subclause 7.101.6.3.2 shall be met as appropriate.

### 7.101.7 Test procedure

#### 7.101.7.1 Supply circuit

#### 7.101.7.1.1 Three-phase tests

The supply circuit shall be three-phase and all three-phases of the switchgear and controlgear shall be energised. The neutral point of the supply circuit may be either isolated, solidly earthed or earthed through an impedance. Any of these test configurations cover all in service neutral arrangements.

#### 7.101.7.1.2 Single-phase tests

One terminal of the supply circuit shall be connected to the earthing point provided on the switchgear and controlgear, the other to the phase under test.

NOTE Single-phase compartments and single-phase enclosures will only have the one phase under test as defined in Table 2.

In the case of three-phase switchgear and controlgear or single-phase switchgear and controlgear intended to be used in a three-phase network, the two remaining phases of the test object, shall be energised at $U_r/\sqrt{3}$, which may be supplied from a separate voltage source and need not be synchronised. The separate source(s) may be low power and are not intended to supply any significant short-circuit current in case of ignition. If a separate source is used, the remaining two phases can be energised from the same single-phase voltage source. If either of the remaining phases ignites or the voltages collapse, the test shall be repeated as a three-phase internal arc test.

#### 7.101.7.1.3 Phase-to-phase tests

Two phases of the three-phase supply circuit shall be connected to the two adjacent phases of the test object. The neutral point of the supply circuit may be either isolated or earthed through an impedance, in such a way that the maximum earth current is less than 100 A. The one remaining phase of the test object, shall be energised at $U_r/\sqrt{3}$, which may be supplied from a separate voltage source and need not be synchronised. The separate source(s) may be low power and are not intended to supply any significant short-circuit current in case of ignition. If the one remaining phase ignites or the voltage collapses, the test shall be repeated as a three-phase internal arc test.

#### 7.101.7.1.4 Test supply connection direction

The test supply connection direction shall be as follows:

– from the supply connection terminals, through the main switching device with this device in the closed position;
– for an enclosure with several main circuit components inside: supply through one available set of connection terminals, with all switching devices in closed position, except for earthing switches, if any, which shall remain in open position.

#### 7.101.7.2 Arc initiation

##### 7.101.7.2.1 General

The arc shall be initiated by means of a copper wire of about 0,5 mm in diameter.

The point of initiation shall be located at the furthest point, downstream in the current path from the supply, within the high-voltage compartment under test. If the main circuit of the high-voltage compartment under test includes current limiting devices (e.g. fuses), the point of initiation shall be chosen upstream from these limiting devices.

In the case of non-symmetrical designs, the most onerous internal arc initiation should be determined, with respect to arc energy and burn through.

The number of phases to be tested, the connection arrangements, and the action to be taken if other phases are affected, shall be in accordance with Table 2, according to the construction of the enclosure under test.

NOTE Refer to Figure 4 and examples in 7.101.7.2.5.

Inside the enclosure where the live parts are covered by solid insulating material, the arc shall be initiated at the following locations:

a) at gaps or joining surfaces between the insulation of insulation-embedded parts or insulating partitions;
b) when a) is not applicable, by perforation or partial removal of solid insulation from the internal conductors.

##### 7.101.7.2.2 Three-phase arc initiation

The arc shall be initiated between all the phases under test.

##### 7.101.7.2.3 Single-phase arc initiation

In the case of single-phase-to-earth ignition, the arc shall be initiated between the phase and closest earth (single-phase). In the case of a three-phase switchgear and controlgear the arc shall be initiated between the middle phase and closest earth.

For single-phase high-voltage compartments without any adjacent earthed metallic parts, a path for the arc initiating fuse wire shall be created to the closest earthed metallic part.

##### 7.101.7.2.4 Phase-to-phase arc initiation

In the case of a phase-to-phase ignition, the arc shall be initiated between the middle phase and one of the adjacent phases (phase-to-phase). The manufacturer may choose to perform a three-phase arc initiation test with any three-phase enclosure construction in place of the specified test in Table 2.

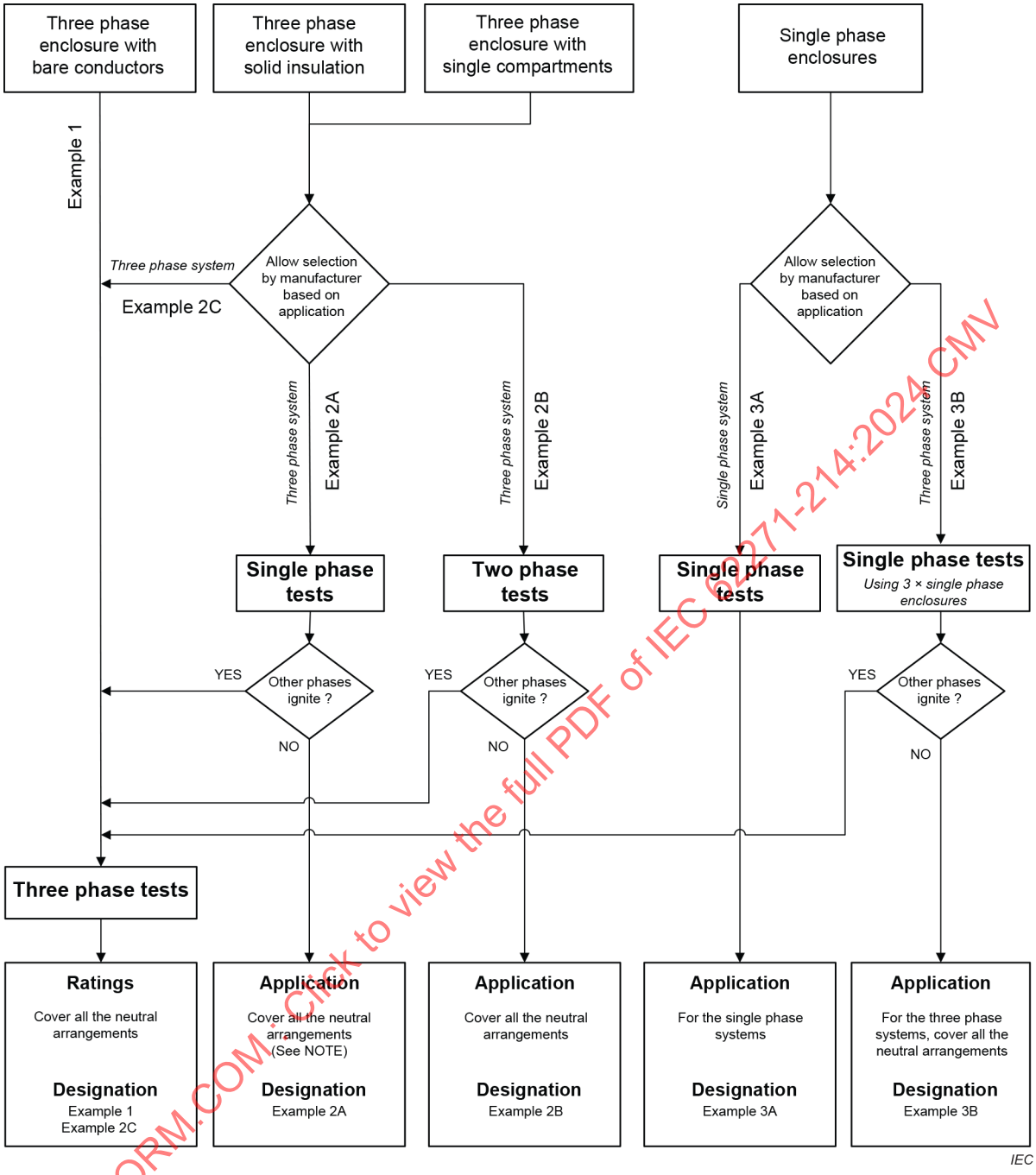
**Table 2 – Parameters for internal arc fault test according to enclosure and compartment construction**

| | | Test current | Number of phases/earth for arc initiation | Action if other phase affected |
|---|---|---|---|---|
| Three-phase enclosures: | With bare conductors | $I_A$ | Three-phase | N/A |
| | Conductors with solid insulation | 87 % $I_A$ | Two | Repeat as three-phase test |
| | | $I_{Ae}$ | One phase and earth | |
| Single-phase compartments inside three-phase enclosure: | | 87 % $I_A$ | Two | Repeat as three-phase test |
| | | $I_{Ae}$ | One phase and earth | |
| Single-phase enclosure (s): | | $I_{Ae}$ | One phase and earth | Repeat as three-phase test if single-phase enclosures are tested in a three-phase configuration |

NOTE More details about arc initiation according the construction can be found in 7.101.7.2.5.

#### 7.101.7.2.5 Arc initiation according to different construction types

Table 2 provides the parameters for an internal arc fault test according to enclosure and compartment construction. To further clarify the different test methods, refer to Figure 4 and examples in this subclause.






NOTE For systems with an isolated neutral, in the unlikely occurance of a double earth fault within the switchgear and controlgear (two phases fail to earth), then fault levels up to 87 % of the three-phase rated current might occur, and as such, a phase-to-phase fault might be a preferred option taken by the manufacturer.

**Figure 4 – Flow-chart for the choice of arc initiation depending on the construction**

a) Example 1: A pole-mounted switchgear and controlgear, with bare conductors, tested for a three-phase fault current (RMS) of 12,5 kA, for 0,5 s, intended to be installed on a pole, is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s;

In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network;

Designation: IAC 12,5 kA, 0,5 s.

b) Example 2: For a three-phase enclosure with solid insulated conductors with the three-phase switchgear and controlgear intended to be suitable for a 12,5 kA 3 phase network (An IAC rating of 12,5 kA for 0,5 s) the manufacturer may choose either a phase-to-phase test or a phase-to-earth test as indicated in the following:

NOTE In this example there is only one three-phase compartment/enclosure, so no other 3 phase tests will be performed.

Example 2A: Manufacturer chooses to perform a phase-to-earth test and ensure it is suitable for all Neutral earth networks by testing with 100 % of the three-phase rated arc fault current: Test performed on a three-phase enclosure with conductors with solid insulation.

IAC;

Arc fault current 12,5 kA assessed with a phase-to-earth test (100 % of the rated single-phase-to-earth arc fault current);

Arc fault duration 0,5 s.

Second and third phase energized during the tests but not affected. In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network.

Designation: IAC 12,5 kA, 0,5 s ($I_{Ae}$ = 12,5 kA).

Example 2B: Instead manufacturer chooses to perform a phase-to-phase test on a three-phase enclosure with conductors with solid insulation.

IAC;

Arc fault current 10,875 kA assessed with a phase-to-phase test;

Arc fault duration 0,5 s.

Third phase energized during the tests, but not affected.

In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network.

Designation: IAC 12,5 kA, 0,5 s.

Example 2C: The manufacturer chooses to perform a three-phase test independent of the type of three-phase switch conductor system. A pole-mounted switchgear and controlgear, tested for a three-phase fault current (RMS) of 12,5 kA, for 0,5 s, intended to be installed on a pole, is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s.

In this case the device may be installed in any neutral earth configuration three-phase 12,5 kA network.

Designation: IAC 12,5 kA, 0,5 s.

c) Example 3:

Example 3A: A single-phase enclosure pole-mounted switchgear and controlgear tested for a phase-to-earth fault current (RMS) of 12,5 kA, for 0,5 s, in a single-phase system, is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s.

Designation: IAC $I_{Ae}$ 12,5 kA, 0,5 s.

A single-phase enclosure pole-mounted switchgear and controlgear tested in a single-phase system shall not be IAC classified for a three-phase system.

Example 3B**:** Three independent single-phase pole-mounted switchgear and controlgear enclosures tested for a phase-to-earth fault current (RMS) of 12,5 kA, for 0,5 s, in a three-phase system is designated as follows:

IAC;

Arc fault current 12,5 kA;

Arc fault duration 0,5 s.

Designation: IAC 12,5 kA, 0,5 s ($I_{Ae}$ = 12,5 kA).

### 7.101.8 Criteria to pass the test

IAC designation is demonstrated for the pole-mounted switchgear and controlgear if the following criteria are met:

a) Criterion No. 1

- No fragmentation of the enclosure occurs.
- No ejection of fragments or of other parts of the switchgear of an individual mass of 60 g or more, occur.

Deformations are accepted.

The switchgear and controlgear does not need to comply with its IP code after the test.

b) Criterion No. 2

Arcing does not cause holes in the enclosure under test. Holes in the enclosure which are created after the duration of the test by other effects than burning through, are disregarded.

The inclusion of a pressure relief vent and its operation is permitted and is not deemed as a structural failure; however, any ejected parts due to its operation shall comply with the 60 g limit for ejected parts.

c) Criterion No. 3

Indicators do not ignite during the test and within 1 s after the current duration. If indicators have been ignited 1 s after the current duration and if proof is established of the fact that the ignition was caused by glowing particles rather than hot gases or burning liquids, the assessment criterion has also been met. Pictures taken by high-speed cameras, video or any other suitable means should be used by the test laboratory to establish evidence.

Indicators ignited as a result of burning paint or stickers are also excluded.

d) Criterion No. 4

The switchgear and controlgear remains connected to its earthing point. Visual inspection is generally sufficient to assess compliance. In case of doubt, the continuity of the earthing connection shall be checked. To check the continuity, verify by testing with 30 A (DC) to the earthing point provided. The voltage drop shall be lower than 3 V.

### 7.101.9 Transferability of the test results

The validity of the results of a test carried out in a tested enclosure of a particular design of pole-mounted switchgear and controlgear can be extended to another test enclosure provided

that the original test was more onerous and this other test enclosure can be considered as similar to the tested unit in the following aspects:

– mounting height of test enclosure with respect to the indicator positions;
– structure and strength of the enclosure;
– performance of the pressure relief device, if any;
– insulation system;
– physical influences (pressure rise, gas flow and thermal effects).

NOTE IEC TR 62271-307[3] can be used as a reference.

## 8 Routine tests

Not applicable.

## 9 Guide to the selection of switchgear and controlgear (informative)

Subclauses of Clause 9 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 not mentioned below are not applicable for this document.

### 9.1 General

Subclause 9.1 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is replaced by following text:

Pole-mounted switchgear and controlgear have been constructed in various forms that have evolved with changing technologies and functional requirements. The selection of pole-mounted switchgear and controlgear essentially involves an identification of the functional requirements for the service installation.

Such requirements should take account of applicable legislation and user safety rules.

### 9.101 Internal arc fault

#### 9.101.1 General

If the switchgear and controlgear is installed, operated and maintained in accordance with the instructions of the manufacturer, there should be low probability that an internal arc occurs, but it cannot be completely disregarded. Failure within the enclosure of pole-mounted switchgear and controlgear due either to a defect or exceptional operating conditions or maloperation can initiate an internal arc, which constitutes a hazard, if persons are present.

When selecting pole-mounted switchgear and controlgear, the possibility of the occurrence of internal arc faults should be properly addressed, with the aim of providing an acceptable protection level for operators and, where applicable, for the general public.

This protection is achieved by reducing the risk to a tolerable level. According to ISO/IEC Guide 51, risk is the combination of the probability of occurrence of harm and the severity of the harm. (Refer to Clause 5 of ISO/IEC Guide 51:2014 on the concept of safety.[4])

Therefore, the selection of adequate equipment, in relation to internal arc, should be governed by a procedure to achieve a level of tolerable risk. Such a procedure is described in Clause 6 of ISO/IEC Guide 51:2014 [4]. This procedure is based on the assumption that the user has a role to play in the risk reduction.

### 9.101.2 Causes and preventive measures

Experience has shown that faults are more likely to occur in some locations inside an enclosure than in others. For guidance, Table 3 gives a list of locations where experience shows that faults are most likely to occur. It also gives causes of failure and possible measures to decrease the probability of internal arc faults. If necessary, the user should implement applicable preventive measures to the installation, commissioning, operation and maintenance.

**Table 3 – Locations, causes and examples of measures to decrease the probability of internal arc faults**

| **Locations where internal arc faults are most likely to occur**<br>(1) | **Possible causes of internal arc faults**<br>(2) | **Examples of possible preventive measures**<br>(3) |
|---|---|---|
| Connections (Inside the enclosure) | Inadequate design | Selection of adequate dimensions<br>Use of appropriate materials |
| | Faulty assembly | Checking of workmanship and/or dielectric test on site. |
| | Failure of solid or liquid insulation (defective or missing) | Checking of workmanship and/or dielectric test on site. Regular checking of fluid levels, where applicable |
| Disconnectors<br>Switches<br>Earthing switches | Maloperation | Interlocks. Delayed reopening. Independent manual operation. Making capacity for switches and earthing switches. Instructions to personnel |
| Bolted connections and contacts | Corrosion | Use of corrosion inhibiting coating and/or greases. Use of plating. Encapsulation, where possible<br>Supplemental heating to prevent condensation. |
| | Faulty assembly | Checking of workmanship by suitable means. Correct torque. Adequate locking means |
| Instrument transformers | Ferro-resonance | Avoidance of these electrical influences by suitable design of the circuit |
| | Short circuit on low-voltage side for VTs | Avoid short circuit by proper means for example, protection cover, low-voltage fuses |
| Circuit-breakers | Insufficient maintenance | Regular programmed maintenance<br>Instructions to personnel |
| All locations | Error by personnel | Limitation of access by compartmentalisation. Insulation embedded live parts. Instructions to personnel |
| | Ageing under electric stresses | Partial discharge routine tests |
| | Pollution, moisture ingress of dust, vermin, etc. | Measures to ensure that the specified service conditions are achieved. Use of sealed compartments |
| | Overvoltages | Surge protection. Adequate insulation co-ordination. Dielectric tests on site |



### 9.101.3 Supplementary protective measures

The first protective measure if the risk of an internal arc fault is not negligible is to specify IAC classified assemblies.

Other measures can be adopted to provide protection to persons in case of an internal arc. These measures are aimed to limit the external consequences of such events.

Following are some examples of these measures:

– rapid fault clearance times initiated by detectors sensitive to light, pressure or heat;

– application of suitable fuses in combination with switching devices to limit the let-through current and fault duration;
– fast elimination of arc by diverting it to metallic short circuit by means of fast-sensing and fast-closing devices;
– remote operation instead of operation at the base of the switchgear and controlgear;
– pressure-relief device.

### 9.101.4 Considerations for the selection and installation

The user shall make a selection, taking into account the characteristics of the network, operating procedures and service conditions.

As a guide for the selection of the adequate switchgear and controlgear with respect to internal arcs, the following criteria can be used:

– where the risk is considered negligible, IAC designated switchgear and controlgear is not necessary;
– where the risk is considered to be relevant, IAC designated switchgear and controlgear should be used.

For the second case, the selection should be made by taking into account the foreseeable maximum level of current and duration of the fault, in comparison with the rated values of the tested equipment. In addition, the installation instructions of the manufacturer should be followed (refer to Clause 11). In particular, the location of personnel during an internal arc event is important.

The protection of persons in case of an internal arc is not only a matter of design and IAC designation of the switchgear and controlgear but depends also on the installation conditions. Internal arc faults inside pole-mounted switchgear and controlgear can occur in a number of locations and can cause various physical phenomena. For example, the arc energy resulting from an arc developed in any insulating fluid within the enclosure will cause an internal overpressure and local overheating which will result in mechanical and thermal stressing of the equipment. Moreover, the materials involved can produce hot decomposition products, either gaseous or vaporous, which can be discharged to the outside of the enclosure. Therefore, appropriate measures should be considered for the installation site.

For pole-mounted switchgear and controlgear, the minimum installation height of the enclosure of the high-voltage is based on the rated approach distance declared by the manufacturer plus 2 m.

### 9.101.5 Internal arc test

The internal arc test is intended to verify the effectiveness of the design in protecting persons in case of an internal arc, during normal operating condition. The test does not assess the behaviour of the switchgear and controlgear under any condition of maintenance or work, when parts of the enclosure, including the low-voltage compartment, are open or dismantled.

The internal arc test is applicable to pole-mounted switchgear and controlgear, to which an Internal Arc Classification is to be assigned.

NOTE It is in general not possible to calculate the permissible arc duration for a current which differs from that used in the test. The maximum pressure during the test will generally not decrease with a shorter arcing time and there is no universal rule according to what arc duration is permissible with a lower test current.

### 9.101.6 IAC designation

IAC designation indicates a tested level of protection of persons under normal operating condition as stated in 7.101.2. It is concerned with personnel protection under these conditions; it is not concerned with personnel protection under maintenance conditions nor with service continuity.

The pole-mounted switchgear and controlgear will be designated as follows.

– General: designation IAC (acronym for Internal Arc Classification).
– Rated values: arc fault current in kiloamperes (kA), and duration in seconds (s) (according to 7.101.6). Single-phase values can be assigned to switchgear and controlgear, having one or more high-voltage compartments where its construction will prevent the arc from becoming multiphase, as demonstrated during the internal arc test. The relationship between neutral earthing and single-phase-to-earth arc fault current is given in Table 4. Users should specify a single-phase-to-earth arc fault current rating when they require a value higher than 87 % of the three-phase rating, or can accept a lower value, depending on the neutral earthing.

**Table 4 – Single-phase-to-earth arc fault current depending on the network neutral earthing**

| Type of network neutral earthing | Single-phase-to-earth arc fault current |
|---|---|
| Isolated neutral | Up to 87 % of the three-phase rated arc fault current |
| Impedance earthed neutral | 100 % of the rated single-phase-to-earth arc fault current |
| Solidly earthed neutral | 100 % of the three-phase rated arc fault current |
| NOTE 1 If the rated single-phase-to-earth arc fault current covers the condition of solidly earthed neutral, all other earthing conditions of the network are also covered.<br><br>NOTE 2 For systems with isolated neutral, the maximum single-phase-to-earth fault current could theoretically reach levels up to 87 % of the three-phase rated arc fault current (single-phase-to-earth fault current under conditions of double-earth fault). However, double-earth faults at independent locations in the proximate vicinity of a single-phase-to-earth fault subjected switchgear and controlgear have a very low probability. Therefore, this condition could not be applicable and the user can specify a reduced single-phase-to-earth arc fault current rating.<br><br>NOTE 3 Resonant earthed (neutral) systems are covered in this table by the term "isolated neutral". | |

## 10 Information to be given with enquiries, tenders and orders (informative)

Clause 10 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable for this document, except 10.1 which is replaced as follows.

### 10.1 General

When enquiring about or ordering an installation of IAC specified pole-mounted switchgear and controlgear the IAC pole-mounted designation, rated approach distance, arc fault currents and duration should be included.

## 11 Transport, storage, installation, operation instruction and maintenance

Clause 11 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable for this document, except 11.1, 11.2 and 11.3 which are replaced as follows.

### 11.1 General

It is essential that the transport, storage and installation of switchgear and controlgear, as well as their operation and maintenance in service, be performed in accordance with instructions given by the manufacturer.

### 11.2 Conditions during transport, storage and installation

A special agreement should be made between manufacturer and user if the service conditions of temperature and humidity defined in the order cannot be guaranteed during transport, storage and installation. Special precautions may be essential for the protection of insulation during transport, storage and installation, and prior to energizing, to prevent moisture absorption due, for instance, to rain, snow or condensation. Vibrations during transport shall be considered. Appropriate instructions should be provided by the manufacturer.

### 11.3 Installation

#### 11.3.1 General

For IAC classified switchgear and controlgear, guidance on safe installation conditions for the case of an internal arc should be provided. The hazards of the actual installation condition should be assessed with respect to installation conditions validated during the internal arc classification (refer to 7.101). However, if the purchaser (user) considers that the risk is not relevant, the switchgear and controlgear can be installed without the restrictions indicated by the manufacturer. The minimum installation height is the declared rated approach distance plus 2 m.

#### 11.101 Maintenance

Where necessary, the manufacturer shall provide guidance on any maintenance requirements in order to maintain the integrity of the IAC designation over the life of the product. Refer to the sections of Table 3 as examples where maintenance can be considered over the life of the switchgear and controlgear.

## 12 Safety

Clause 12 of IEC 62271-1:2017 is not applicable for this document except 12.1 modified as follows:

### 12.1 General

As far as the protection of persons is concerned, the correct performance of the pole-mounted switchgear and controlgear in the event of an internal arc is not only a matter of design of the equipment itself, but also of the installation conditions, operating procedure and if applicable maintenance procedures, for instance, see 9.101.

## 13 Influence of the product on the environment

Clause 13 of IEC 62271-1:2017 and IEC 62271-1:2017/AMD1:2021 is not applicable for this document and is replaced as follows:

The manufacturer shall be prepared to provide on request, relevant information about the environmental impact of the switchgear and controlgear. The manufacturer shall give guidance on request, concerning disassembly and end-of-life procedures for the different materials and components of the equipment and indicate recycling suitability.

# Annex A
(normative)

# Identification of the test objects

## A.1 General

For identification of a test object, the following topics shall be covered.

## A.2 Data

- Manufacturer's name;
- Type designation, ratings and unique identifier of test object;
- Outline description of test object (including number of poles, interlocking system, busbar system, earthing system, and the arc extinguishing process);
- Make, type, and ratings of essential parts, where applicable (for example, drive mechanisms, interrupters, shunt impedances, relays, fuse links, insulators);
- Rated characteristics of fuse links and protective devices;
- Whether the apparatus is intended for operation in the vertical and horizontal plane;
- Mock-ups (if used) details shall also be given.

## A.3 Drawings

| Drawings to be submitted | Drawing content (as applicable) |
|---|---|
| Single-line diagram of main circuit | Type designation of principal components |
| General layout<br><br>NOTE For an assembly it can be necessary to provide drawings of the complete assembly and of each switching device. | Overall dimensions<br>Supporting structure and mounting points<br>Enclosure(s)<br>Pressure-relief devices<br>Conducting parts of main circuit<br>Earthing conductors and earthing connections<br>Electrical clearances:<br>to earth, between open contacts;<br>between poles.<br>Location and dimensions of barriers between poles<br>Location of earthed metallic screens, shutters or partitions in relation to live parts<br>Liquid insulation level<br>Location and type designation of insulators<br>Location and type designation of instrument transformers |
| Detailed drawings of insulators | Material<br>Dimensions (including profile and creepage distances) |
| Arrangement drawings of cable boxes | Electrical clearances<br>Principal dimensions<br>Terminals<br>Level or quantity and specifications of insulant in filled boxes<br>Cable termination details |

# Bibliography

[1] IEC 60050-601:1985, *International Electrotechnical Vocabulary (IEV) – Part 601: Generation, transmission and distribution of electricity – General*
IEC 60050-601:1985/AMD1:1998
IEC 60050-601:1985/AMD2:2020

[2] IEC 62271-200:2021, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

[3] IEC TR 62271-307:2015, *High-voltage switchgear and controlgear – Part 307: Guidance for the extension of validity of type tests of AC metal and solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

[4] ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

[5] CIGRE TECHNICAL BROCHURE 686:2017, *Mitigating the effects of arcs in M.V. Switchgear*

[6] IEC 60038:2009, *IEC standard voltages*
IEC 60038:2009/AMD1:2021

[7] IEC 60059:1999, *IEC standard current ratings*
IEC 60059:1999/AMD1:2009

[8] IEC 60050-466:1990, *International Electrotechnical Vocabulary (IEV) – Part 466: Overhead lines*
IEC 60050-466:1990/AMD1:2020
IEC 60050-466:1990/AMD2:2021
IEC 60050-466:1990/AMD3:2021

[9] CIGRE TECHNICAL BROCHURE 602:2014, *Tools for the Simulation of the Effects of the Internal Arc in Transmission and Distribution Switchgear*

# SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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# APPAREILLAGE À HAUTE TENSION –

# Partie 214: Classification arc interne des appareillages sous enveloppe métallique à courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV montés sur poteau

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L'IEC 62271-214 a été établie par le sous-comité 17C: Ensembles, du comité d'études 17 de l'IEC: Appareillage haute tension. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2019. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) mise à jour du positionnement des indicateurs;
b) connexion de mise à la terre du neutre du circuit d'essai pour les essais triphasés;
c) révision générale à des fins de cohérence avec l'IEC 62271-200 Éd.3.0:2021.

Le texte de cette Norme internationale est issu des documents suivants:

| Projet | Rapport de vote |
|---|---|
| 17C/924/FDIS | 17C/931/RVD |

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

La version française de cette norme n'a pas été soumise au vote.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Cette norme doit être lue conjointement avec l'IEC 62271-1, deuxième édition, parue en 2017, à laquelle elle fait référence et qui s'applique sauf spécification contraire dans la présente norme. Afin de simplifier l'indication des exigences correspondantes, la numérotation des articles et paragraphes reprend celle de l'IEC 62271-1. Les amendements de ces articles et paragraphes sont indiqués sous les mêmes références, tandis que les paragraphes supplémentaires sont numérotés à partir de 101. Tout article qui comprend le terme "Non applicable" indique que l'article ne s'applique pas à l'IEC 62271-214, mais ne présume pas que l'article s'applique ou non à la norme d'appareillage applicable.

Une liste de toutes les parties de la série IEC 62271, publiées sous le titre général *Appareillage à haute tension*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
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- révisé.

# INTRODUCTION

L'IEC 62271-214 a été établie à la suite de la demande de supprimer de l'IEC 62271-200 les appareillages montés sur poteau classifiés arc interne (IAC) selon le Type C. L'IEC 62271-214 doit être considérée comme indépendante de l'IEC 62271-200. Toutefois elle reste reliée aux autres normes de produits de la série IEC 62271.

Seuls les appareillages à bornes ouvertes montés sur poteau sont pris en compte dans le présent document.

Ces équipements se rapportent aux systèmes triphasés, biphasés et monophasés.

# APPAREILLAGE À HAUTE TENSION –

# Partie 214: Classification arc interne des appareillages sous enveloppe métallique à courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV montés sur poteau

## 1 Domaine d'application

La présente partie de l'IEC 62271 spécifie les exigences relatives à la classification arc interne des appareillages sous enveloppe métallique à courant alternatif montés sur poteau, de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV, et de fréquences de service inférieures ou égales à 60 Hz.

Le présent document s'applique aux équipements à bornes ouvertes triphasés, biphasés et monophasés auxquels une classification arc interne est attribuée. Les enveloppes peuvent comprendre des composants fixes et amovibles et peuvent être remplies de fluide (liquide ou gaz) pour l'isolation.

NOTE 1 La classification IAC tient compte de la disposition de l'installation des appareillages à haute tension et de la zone opérationnelle du travailleur.

NOTE 2 Pour l'utilisation du présent document, la haute tension (IEC 60050-601:1985, 601-01-27) est la tension assignée supérieure à 1 000 V. Cependant, la moyenne tension (IEC 60050-601:1985, 601-01-28) est communément utilisée pour les réseaux de distribution avec des tensions supérieures à 1 kV et est généralement appliquée pour des tensions inférieures ou égales à 52 kV; se reporter à [1][1].

Le présent document n'exclut pas que d'autres équipements puissent être inclus dans la même enveloppe. Dans ce cas, toute influence possible dudit équipement sur l'appareillage doit être prise en compte.

## 2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-151:2001, *Vocabulaire Électrotechnique International (IEV) – Partie 151: Dispositifs électriques et magnétiques*
IEC 60050-151:2001/AMD1:2013
IEC 60050-151:2001/AMD2:2014
IEC 60050-151:2001/AMD3:2019
IEC 60050-151:2001/AMD4:2020
IEC 60050-151:2001/AMD5:2021

IEC 60050-441:1984, *Vocabulaire Électrotechnique International (IEV) – Partie 441: Appareillage et fusibles*
IEC 60050-441:1984/AMD1:2000



[1] Les chiffres entre crochets renvoient à la Bibliographie.

IEC 62271-1:2017, *Appareillage à haute tension – Partie 1: Spécifications communes pour appareillage à courant alternatif*
IEC 62271-1:2017/AMD1:2021

IEC 62271-200:2021, *Appareillage à haute tension – Partie 200: Appareillage sous enveloppe métallique pour courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV*

## 3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 62271-1, de l'IEC 60050-151 et de l'IEC 60050-441 ainsi que les suivants s'appliquent.

NOTE 1 Le système de classification des définitions de l'IEC 62271-1:2017 n'est pas respecté. Les termes et définitions sont référencés et priorisés dans l'ordre suivant:

– Article 3 du présent document;
– IEC 62271-1:2017;
– IEC 60050-441;
– IEC 60050-151.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

NOTE 2 Les définitions supplémentaires sont classées de façon à être alignées sur le système de classification de l'IEC 60050-441.

### 3.1 Termes et définitions généraux

**3.1.101**
**appareillage sous enveloppe métallique**
ensemble d'appareillage avec une enveloppe métallique externe destinée à être mise à la terre et complètement fermée, à l'exception des connexions extérieures

[SOURCE: IEC 60050-441:1984, 441-12-04, modifié – "entièrement terminé" a été remplacé par "et complètement fermée"; la NOTE a été supprimée.]

**3.1.102**
**enveloppe**
partie d'un ensemble procurant un degré de protection spécifié du matériel contre les influences externes et un degré de protection spécifié contre l'approche des parties actives ou le contact avec elles ou contre le contact avec des pièces en mouvement

[SOURCE: IEC 60050-441:1984, 441-13-01, modifié – <d'un ensemble> a été supprimé.]

**3.1.103**
**compartiment à haute tension**
compartiment d'un appareillage qui comprend des parties conductrices à haute tension, sous enveloppe, sauf au niveau des ouvertures nécessaires à l'interconnexion, à la commande ou à la ventilation, où un segment du compartiment peut être une partie de l'enveloppe métallique externe reliée à la terre

**3.1.104**
**composant**
partie principale des circuits haute tension ou de terre des appareillages montés sur poteau qui ont une fonction spécifique (par exemple disjoncteur, sectionneur, commutateur, fusible, transformateur de mesure, traversée, barre omnibus)

**3.1.105**
**circuit principal**
toutes les pièces conductrices à haute tension d'un appareillage monté sur poteau qui font partie d'un circuit destiné à transporter le courant permanent assigné

[SOURCE: IEC 60050-441:1984, 441-13-02, modifié – "à haute tension" a été ajouté, "ensemble" a été remplacé par "appareillage monté sur poteau" et "transporter l'énergie électrique" a été remplacé par "transporter le courant permanent assigné".]

**3.1.106**
**circuit de terre**
conducteurs, connexions et parties conductrices des appareils de mise à la terre destinés à raccorder les parties conductrices à haute tension à la prise de terre de l'installation

Note 1 à l'article: Les parties des enveloppes métalliques raccordées à l'installation de mise à la terre peuvent faire partie intégrante du circuit de terre.

**3.1.107**
**condition normale de fonctionnement**
condition en service avec tous les capots correctement fermés et sécurisés

Note 1 à l'article: Le terme "en service" implique "sous tension".

[SOURCE: IEC 62271-200:2021[2], 3.1.106, modifié – "<d'un ensemble>" et "toutes les portes et" ont été supprimés et la Note 1 à l'article a été ajoutée.]

**3.1.108**
**dispositif de décharge de pression**
dispositif incorporé en tant que partie d'une enveloppe ou d'un compartiment et destiné à éviter une pression excessive dans l'enveloppe ou le compartiment

**3.1.109**
**compartiment à remplissage de fluide**
compartiment à haute tension d'un appareillage monté sur poteau rempli d'un fluide, soit un gaz autre que l'air ambiant, soit un liquide, à des fins d'isolation

**3.1.110**
**poteau**
support vertical simple en bois, béton, acier ou autre matériau, implanté dans le sol directement, ou par l'intermédiaire d'une fondation

[SOURCE: IEC 60050-466:1990, 466-07-01[8], modifié – La Note 1 à l'article a été ajoutée.]

**3.1.111**
**appareillage monté sur poteau**
appareillage sous enveloppe métallique, généralement relié à des lignes aériennes, monté sur un ou plusieurs poteaux ou structures équivalentes à une hauteur définie, à accès restreint, car installé hors d'atteinte

**3.1.112**
**classification arc interne**
**IAC**
appareillage sous enveloppe métallique pour lequel les critères spécifiés de protection des personnes autorisées et du public sous l'appareil sont atteints en cas d'arc interne pour des conditions d'installation spécifiées comme le prouvent les essais de type

Note 1 à l'article: La classification d'arc interne est définie par les caractéristiques données du 3.1.114 au 3.1.116.

Note 2 à l'article: L'abréviation "IAC" est dérivée du terme anglais développé correspondant "internal arc classified".

[SOURCE: IEC 62271-200:2021, 3.6.117, modifié – "autorisées" et "et du public sous l'appareil" ont été ajoutés, "ensemble" a été remplacé par "appareillage sous enveloppe métallique".]

**3.1.113**
**courant de défaut d'arc**
valeur efficace triphasée et, le cas échéant, monophasée phase-terre du courant de défaut d'arc interne pour laquelle l'appareillage est conçu pour protéger les personnes en cas d'arc interne

[SOURCE: IEC 62271-200:2021, 3.7.101]

**3.1.114**
**durée de défaut d'arc**
durée du courant de défaut d'arc interne pour laquelle l'appareillage est conçu pour protéger les personnes en cas d'arc interne

[SOURCE: IEC 62271-200:2021, 3.7.102]

**3.1.115**
**distance d'approche**
distance entre l'objet d'essai et les indicateurs d'un essai IAC

**3.1.116**
**dispositif de limitation d'arc**
dispositif destiné à réagir aux conditions de défaut d'arc interne afin de réduire l'énergie de l'arc

[SOURCE: BROCHURE TECHNIQUE CIGRE 686:2017][5]

## 3.8 Index des définitions

**A – C**

**D – E**



**P**



## 4 Conditions de service normales et spéciales

L'Article 4 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 ne s'applique pas.

## 5 Caractéristiques assignées

Les paragraphes de l'Article 5 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 non mentionnés ci-après ne s'appliquent pas au présent document.

### 5.1 Généralités

Le 5.1 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 ne s'applique pas et est remplacé par le texte suivant:

Les caractéristiques assignées pertinentes pour la classification arc interne sont les suivantes:

a) tension assignée ($U_r$);

b) fréquence assignée ($f_r$);

c) caractéristiques assignées de la classification arc interne (IAC).

### 5.2 Tension assignée ($U_r$)

Le 5.2 de l'IEC 62271-1:2017 s'applique, avec l'ajout suivant au 5.2.1.

#### 5.2.1 Généralités

La tension assignée est égale à la tension maximale du réseau pour laquelle le matériel est conçu. Elle indique la valeur maximale de la "tension la plus élevée du réseau" des réseaux pour lesquels le matériel peut être utilisé (se reporter à l'Article 9 de l'IEC 60038:2009 [6]).

NOTE Il est possible que les composants qui font partie de l'appareillage monté sur poteau présentent des tensions assignées différentes conformément à leurs normes correspondantes.

### 5.3 Niveau d'isolement assigné ($U_d$, $U_p$, $U_s$)

Non applicable.

### 5.4 Fréquence assignée ($f_r$)

Le 5.4 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 s'applique.

### 5.101 Caractéristiques assignées de la classification arc interne (IAC)

#### 5.101.1 Généralités

Un appareillage monté sur poteau classifié IAC doit avoir les caractéristiques assignées suivantes: distance d'approche assignée, courants de défaut d'arc et durées de défaut d'arc.

#### 5.101.2 Distance d'approche assignée ($D_{AP}$)

La distance d'approche assignée doit être établie par le fabricant (se reporter à la Figure 2).

#### 5.101.3 Courants de défaut d'arc assignés ($I_A$, $I_{Ae}$)

Il convient de choisir les valeurs des courants de défaut d'arc assignés dans la série R 10, spécifiée dans l'IEC 60059 [7].

Deux caractéristiques assignées des courants de défaut d'arc sont reconnues:

a) le courant de défaut d'arc triphasé et biphasé ($I_A$), si applicable;

b) le courant de défaut d'arc phase-terre monophasé ($I_{Ae}$), si applicable.

Lorsque seule une caractéristique assignée triphasée est spécifiée, la caractéristique assignée monophasée est par défaut égale à 87 % de la caractéristique assignée triphasée, et n'a pas besoin d'être spécifiée.

NOTE 1 Les 87 % se justifient par l'essai de défaut d'arc biphasé; se reporter au 7.101.7.2.

Le fabricant doit spécifier les compartiments pour lesquels la caractéristique assignée de courant de défaut d'arc phase-terre monophasé s'applique. Une telle valeur est assignée aux appareillages pour lesquels la construction empêche l'arc d'évoluer en arc multiphasé, comme cela est démontré lors de l'essai d'arc interne.

Lorsque tous les compartiments à haute tension monophasés sont prévus uniquement pour des défauts d'arc phase-terre monophasés, la caractéristique assignée $I_{Ae}$ doit être attribuée en lieu et place de la caractéristique assignée $I_A$ (se reporter au 7.101.7.2).

NOTE 2 Des informations relatives à la relation entre le type de mise à la terre du neutre et le courant de défaut d'arc phase-terre monophasé sont fournies en 9.101.6.

#### 5.101.4 Durée de défaut d'arc assignée ($t_A$, $t_{Ae}$)

Les valeurs recommandées de durée de défaut d'arc ($t_A$, $t_{Ae}$) sont 0,1 s, 0,5 s et 1 s.

NOTE Il n'est pas possible en général de calculer la durée d'arc admissible pour un courant différent de celui utilisé dans l'essai.

## 6 Conception et construction

Les paragraphes de l'Article 6 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 non mentionnés ci-après ne s'appliquent pas au présent document.

### 6.11 Plaque signalétique

#### 6.11.2 Application

Le 6.11.2 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 s'applique, à l'exception du Tableau 9, avec les ajouts suivants:

Un appareillage monté sur poteau avec une IAC assignée doit inclure dans la plaque signalétique les informations IAC supplémentaires conformément au Tableau 1.

**Tableau 1 – Informations sur la plaque signalétique**

| | Abréviation | Unité | ** | Condition: Marquage exigé seulement si |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Classification arc interne | IAC | | X | |
| Distance d'approche assignée | $D_{AP}$ | m | X | |
| Courant et durée de défaut d'arc | $I_A$, $t_A$ | kA, s | Y | Un essai triphasé ou biphasé s'applique |
| Courant et durée de défaut d'arc phase-terre monophasé | $I_{Ae}$, $t_{Ae}$ | kA, s | Y | Un essai monophasé s'applique ou $I_{Ae}$ diffère de 87 % de $I_A$ |
| Equipé d'un dispositif de limitation d'arc | | | Y | Dispositif de limitation d'arc installé et non désactivé lors de l'essai |
| (**)<br>X : le marquage de ces valeurs est obligatoire<br>Y : les conditions de marquage de ces valeurs sont données dans la colonne (5) | | | | |
| NOTE S'il y a une abréviation dans la colonne (2), elle peut être utilisée à la place des termes de la colonne (1). | | | | |

### 6.101 Défaut d'arc interne

Les appareillages montés sur poteau sont, en principe, conçus et construits pour empêcher l'apparition de défauts d'arc interne.

Cependant, l'appareillage doit être conçu de façon à procurer un niveau défini de protection des personnes en cas d'arc interne lorsqu'il est en condition normale de fonctionnement.

La désignation doit figurer sur la plaque signalétique (se reporter au 6.11).

Des exemples de classification arc interne sont donnés en 7.101.7.2.5.

### 6.102 Enveloppe

L'enveloppe est conçue pour supporter les contraintes mécaniques, électriques, thermiques et environnementales susceptibles de se produire en condition normale de fonctionnement et en cas de défaut d'arc interne.

La Figure 1 représente des exemples de différentes dispositions de composants dans un ou des compartiments à haute tension à l'intérieur d'une enveloppe.

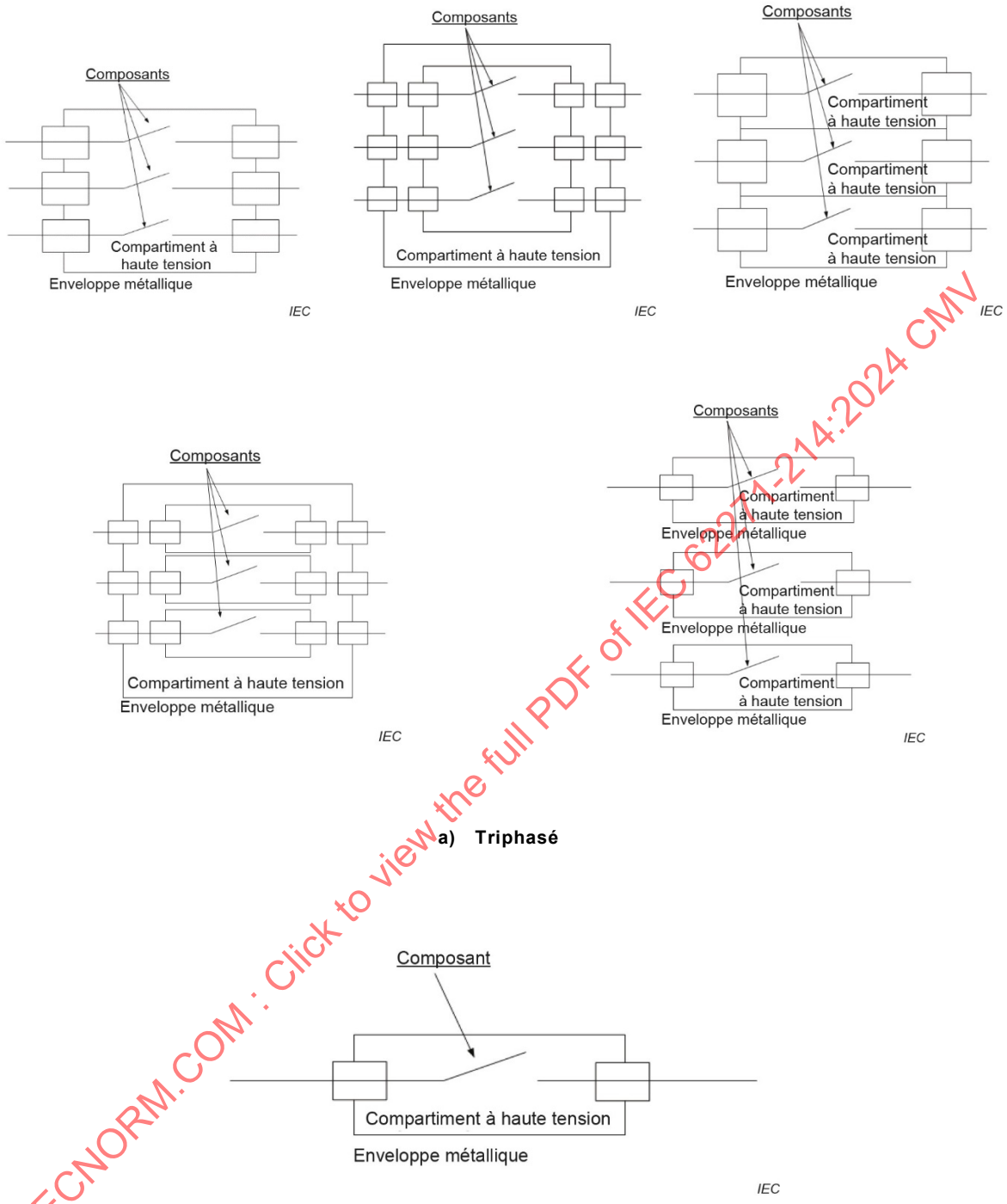




**Figure 1 – Exemples d'enveloppes et de compartiments dans différentes dispositions**

## 7 Essais de type

Les paragraphes de l'Article 7 de l'IEC 62271-1:2017 et de l'IEC 62271-1:2017/AMD1:2021 non mentionnés ci-après ne s'appliquent pas au présent document.

## 7.1 Généralités

### 7.1.1 Principes fondamentaux

L'essai de type est effectué afin de vérifier les caractéristiques assignées de l'arc interne et les caractéristiques de l'appareillage monté sur poteau.

### 7.1.2 Informations pour l'identification de l'objet d'essai

Le 7.1.2 de l'IEC 62271-1:2017 ne s'applique pas au présent document est remplacé par le texte suivant.

Le fabricant doit soumettre au laboratoire d'essai les plans et autres données qui fournissent les informations suffisantes pour identifier sans ambiguïté les détails et parties essentiels du type d'appareillages présenté à l'essai. Une liste récapitulative des plans et des tableaux de données doit être fournie par le fabricant et doit avoir une référence unique. Elle doit également inclure une déclaration selon laquelle le fabricant assure que les plans ou les tableaux de données répertoriés correspondent à la version correcte et représentent réellement l'appareillage à soumettre aux essais.

Le laboratoire d'essai doit vérifier que les plans et fiches techniques représentent correctement les détails et parties essentiels de l'objet d'essai, mais n'est pas responsable de la précision des informations détaillées.

Les plans particuliers et les données qui doivent être soumis par le fabricant au laboratoire d'essai pour l'identification des pièces essentielles de l'objet d'essai sont spécifiés à l'Annexe A.

### 7.1.3 Informations à inclure dans les rapports d'essais de type

Les résultats doivent être enregistrés dans des rapports d'essai qui contiennent suffisamment de données pour prouver la conformité aux articles du présent document relatifs aux essais effectués. Suffisamment d'informations doivent être incluses pour que les parties essentielles de l'objet d'essai puissent être identifiées. Les informations suivantes doivent notamment être incluses:

– le fabricant;
– la désignation du type et l'identificateur unique de l'objet d'essai;
– les caractéristiques assignées de l'objet d'essai;
– des photographies qui représentent l'état de l'objet d'essai avant et après l'essai;
– les plans d'encombrement et tableaux de données suffisants pour représenter l'objet d'essai;
– les numéros de référence de tous les plans, y compris le numéro de révision soumis pour identifier les parties essentielles de l'objet d'essai;
– les détails de la disposition d'essai (y compris le schéma du circuit d'essai);
– la description du comportement de l'objet d'essai pendant l'essai et son état après l'essai;
– la description de l'objet d'essai avec un plan qui représente les principales dimensions, les détails relatifs à la résistance mécanique, la disposition du ou des dispositifs de décharge de pression et la méthode de fixation de l'objet d'essai sur le ou les poteaux, y compris les caractéristiques du poteau;
– le point et la méthode d'amorçage du défaut d'arc interne;