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Interested committees:

Title: Draft BS EN 62271-111 High-voltage switchgear and controlgear

Part 111: Automatic circuit reclosers for alternating current systems above 1 000 V

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Introduction

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For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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IEC SC 17A : SWITCHING DEVICES	
SECRETARIAT: Sweden	SECRETARY: Mr Arjan Bronsveld
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Electricity transmission and distribution, Electromagnetic Compatibility, Safety	

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TITLE:**High-voltage switchgear and controlgear – Part 111: Automatic circuit reclosers for alternating current systems above 1 000 V****NOTE FROM TC/SC OFFICERS:**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 111: Automatic circuit reclosers for alternating
current systems above 1 000 V**

FOREWORD

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International Standard IEC 62271-111/IEEE Std C37.60 has been jointly revised by the Switchgear Committee of the IEEE Power and Energy Society, in cooperation with subcommittee 17A: Switching devices, of IEC technical committee 17: High-voltage switchgear and controlgear, under the IEC/IEEE Dual Logo Agreement.

This fourth edition cancels and replaces the third edition, published in 2019, and constitutes a technical revision. The main changes with respect to the previous edition are as follows:

- a) removal of the upper voltage limit from the title and scope of the standard and inclusion of ratings for voltages up to 72.5kV;
- b) addition of non-earthed reclosers along with relevant design and test requirements;
- c) clarification in 4.1.1 regarding dependent manual close for cutout mounted reclosers;
- d) addition in 5.1 of rated values for very-low frequency (VLF) tests;
- e) addition in Clause 6, 7, 8 and 11 of informative references to IEEE C37.68 for control requirements;
- f) addition to 6.4.1 of power supply design requirements for line-powered devices;
- g) addition to 6.8 of specifications regarding operating handle status;
- h) addition to 6.101 of new optional specifications for pole simultaneity;
- i) addition to 6.105 of references for accuracy of current and voltage sensors used in reclosers;
- j) addition to 7.1.101.4 of a detailed treatment of 50Hz vs 60Hz applicability;
- k) clarification in 7.2.6 of preliminary impulses for impulse tests and addition of informative Annex M giving an example procedure;
- l) clarification in 7.103.1 of test requirements for "triple-single" reclosers;
- m) updates and improvements in 7.103.6 and Annex D regarding TRVs;
- n) addition of load current tests in 7.104 as a replacement for the low current tests;
- o) changes to 7.108 clearing time-current tests, including a new requirement to test O and CO operations separately on fast operations;
- p) changes to 7.111.2 SSAO, including simplification of the test conditions and the inclusion of new test circuits for cutout-mounted and non-earthed reclosers;
- q) clarification in 7.112 of post-test conditions;
- r) adoption in Annex J of the altitude correction formula found in IEC 60071-2:2023 Annex H and found increasingly across IEEE and IEC equipment standards;
- s) addition of Annex N giving an informative framework for the extension of type tests.

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

FDIS	Report on voting
17A/xxxx/FDIS	17A/xxxx/RVD

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

International standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

This standard is to be read in conjunction with IEC 62271-1:2017, 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.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 111: Automatic circuit reclosers for alternating current systems above 1 000 V

1 Scope

This part of IEC 62271 applies to all overhead, pad-mounted, dry vault and submersible single or multi-pole alternating current automatic circuit reclosers for rated maximum voltages above 1 000 V.

Devices that require a dependent manual operation are not covered by this document.

In order to simplify this document where possible, the term recloser (or reclosers) has been substituted for automatic circuit recloser(s) or cutout mounted recloser(s) or both.

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.

NOTE In this dual logo standard, normative references are made to both IEEE and IEC standards. In each case, the specifications in two referenced standards have been judged by the Maintenance Team to be technically equal even though the exact wording can be different. Differences in the wording are considered to be editorial only. Where the two standards are not technically equal, the differences are resolved in the text.¹

IEC 60050-151, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices* (available at: <http://www.electropedia.org>)

IEC 60050-441, *International Electrotechnical Vocabulary – Chapter 441: Switchgear, controlgear and fuses* (available at: <http://www.electropedia.org>)

IEC 60071-2:2023, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60255-26:2023, *Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements*

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

IEC 60480, *Specifications for the re-use of sulphur hexafluoride (SF₆) and its mixtures in electrical equipment*

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

¹ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement the standard.

36 IEC 62271-4, *High-voltage switchgear and controlgear – Part 4: Handling procedures for gases*
37 *for insulation and/or switching*

38 IEC 62271-100:2021+AMD1:2024, *High-voltage switchgear and controlgear – Part 100:*
39 *Alternating-current circuit-breakers*

40 IEEE Std 4™, *IEEE Standard for High-voltage Testing Techniques*

41 IEEE Std C37.90.1™-2012, *IEEE Standard Surge Withstand Capability (SWC) Tests for Relays*
42 *and Relay Systems Associated with Electric Power Apparatus*

43 3 Terms and definitions

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

46 ISO, IEC and IEEE maintain terminological databases for use in standardization at the following
47 addresses:

- 48 • IEC Electropedia: available at <http://www.electropedia.org/>
- 49 • ISO Online browsing platform: available at <http://www.iso.org/obp>
- 50 • IEEE Standards Online Dictionary: available at <http://dictionary.ieee.org>

51 NOTE Additional terms and definitions are organized so as to be aligned with the classification used in
52 IEC 60050-441.

53 3.1 General terms

54 3.1.101

55 automatic circuit recloser

56 self-controlled device for making, carrying, and automatically interrupting and reclosing an
57 alternating-current circuit, with a predetermined sequence of opening and reclosing followed by
58 resetting, hold-closed, or lockout operation.

59 Note 1 to entry: An automatic circuit recloser includes an assembly of control elements required to detect
60 overcurrents and control the recloser operation.

61 Note 2 to entry: Refer to Annex F for background information of an automatic circuit recloser.

62 3.1.102

63 cutout mounted recloser

64 single-phase automatic circuit recloser mounted in a fuse support or base as defined in
65 IEEE Std C37.41 [21]² and IEC 60282-2 [1]

66 3.1.103

67 dry vault

68 ventilated, enclosed area not subject to flooding

69 3.1.104

70 effectively earthed neutral system

71 system earthed through a sufficiently low impedance such that for all system conditions the
72 ratio of the zero-sequence reactance to the positive-sequence reactance (X_0/X_1) is positive and
73 less than 3, and the ratio of the zero-sequence resistance to the positive-sequence reactance
74 (R_0/X_1) is positive and less than 1

² Numbers in square brackets refer to the Bibliography.

75 Note 1 to entry: Normally such systems are solidly earthed (neutral) systems or low impedance earthed (neutral)
76 systems.

77 Note 2 to entry: The earthing conditions depend not only on the physical earthing conditions around the relevant
78 location but also on the total system.

79 Note 3 to entry: Throughout this document, the parameter $k_{pp} = 1,3$ is used to denote an effectively earthed neutral
80 system.

81 [SOURCE: IEC 62271-100:2021, 3.1.107, modified – Note 3 to entry is added.]

82 **3.1.105**
83 **non-effectively earthed neutral system**
84 system other than effectively earthed neutral system, not meeting the conditions given in
85 3.1.104

86 Note 1 to entry: Normally such systems are isolated neutral systems, high impedance earthed (neutral) systems or
87 resonant earthed (neutral) systems.

88 Note 2 to entry: The earthing conditions depend not only on the physical earthing conditions around the relevant
89 location but also on the total system.

90 Note 3 to entry: Throughout this document, the parameter $k_{pp} = 1,5$ is used to denote a non-effectively earthed
91 neutral system.

92 [SOURCE: IEC 62271-100:2021, 3.1.108, modified – Note 3 to entry is added.]

93 **3.1.106**
94 **pad-mounted reclosers**
95 enclosed reclosers, the exterior enclosure of which is at earth potential, positioned on a surface-
96 mounted pad

97 Note 1 to entry: This definition is similar to that given in the National Electrical Safety Code® (NESC®) C2-2023 [2]
98 (US).³

99 **3.1.107**
100 **publicly accessible**
101 situated in an area where no means are implemented to expressly prevent access and where
102 any person can access without authorization

103 **3.1.108**
104 **restrike**
105 <of an ac mechanical switching device> resumption of current between the contacts of a
106 mechanical switching device during a breaking operation with an interval of zero current of a
107 quarter cycle of power frequency or longer

108 [SOURCE: IEC 60050-441:1984, 441-17-46]

109 **3.1.109**
110 **re-ignition**
111 resumption of current between the contacts of a mechanical switching device during a breaking
112 operation with an interval of zero current of less than a quarter cycle of power frequency

113 [SOURCE: IEC 60050-441:1984, 441-17-45]

³ National Electrical Safety Code and NESC are both registered trademarks and service marks of the Institute of Electrical and Electronics Engineers, Inc.

3.1.110**series-trip recloser**

recloser in which main-circuit current above a specified value, flowing through a solenoid or operating coil, provides the energy necessary to open the main contacts

Note 1 to entry: This definition for a series-trip recloser originated in IEEE; it is similar to the definition for a self-tripping circuit-breaker in IEC 62271-100.

3.1.111**shunt-trip recloser**

recloser in which the tripping mechanism, by releasing the holding means, permits the main contacts to open, with both the tripping mechanism and the contact opening mechanism deriving operating energy from other than the main circuit

3.1.112**submersible**

constructed so as to be successfully operable when submerged in water under specified conditions of pressure and time

3.1.113**unit operation**

<of a recloser> interrupting operation followed by a closing operation within a specified reclosing interval

Note 1 to entry: The final interruption, after which lockout occurs, is also considered one unit operation.

Note 2 to entry: See Figure 1. See also Annex K for a comparison of terms between IEEE and IEC.

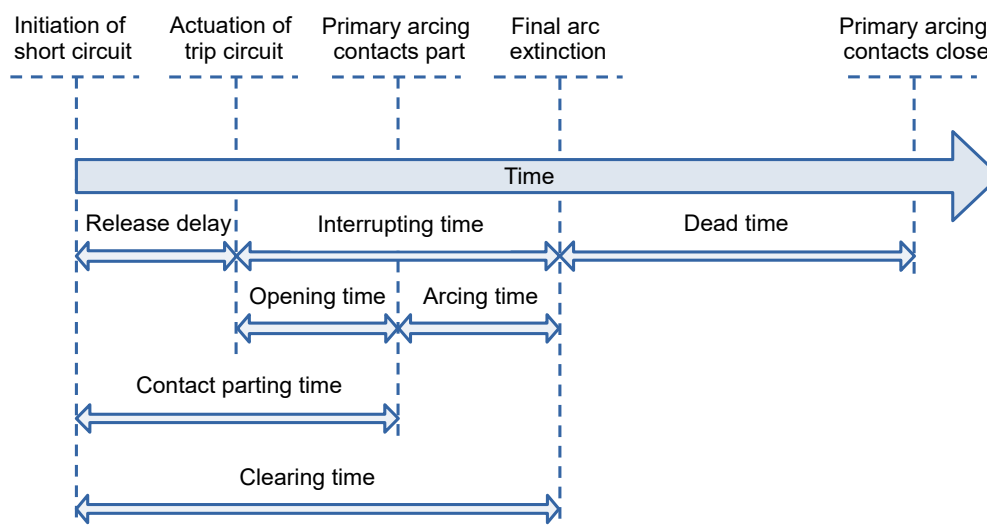


Figure 1 – Unit operation

3.1.114**non-earthed recloser****ungrounded recloser (US)**

an automatic circuit recloser other than a cutout-mounted recloser which does not have a connection to earth

3.2 Assemblies of switchgear and controlgear

No particular definitions.

3.3 Parts of assemblies

No particular definitions.

3.4 Switching devices

No particular definitions.

3.5 Parts of switchgear and controlgear

No particular definitions.

3.6 Operation

3.6.101

dependent manual operation

<of a mechanical switching device> operation solely by means of directly applied manual energy, such that the speed and force of the operation are dependent upon the action of the operator

3.6.102

non-reclose

operational setting that blocks the automatic reclose function of a recloser causing it to be on a one-trip-to-lockout sequence

3.6.103

pole simultaneity

the time interval between the first pole contact and the final pole contact mechanically closing or opening

[SOURCE: IEEE C37.66 [4], modified by deleting the reference to capacitor switch.]

3.7 Characteristic quantities

3.7.101

cable-charging current

current supplied to an unloaded shielded or belted cable

Note 1 to entry: Cable-charging current is expressed by its r.m.s. value in amperes.

3.7.102

definite-time delay

qualifying term indicating that there is purposely introduced a delay in action, which delay remains substantially constant regardless of the magnitude of the operating quantity that causes the action

3.7.103

inverse-time delay

purposely introduced delay in action, which delay decreases as the magnitude of the operating quantity (that causes the action) increases

3.7.104

line-charging current

current supplied to an unloaded overhead line

Note 1 to entry: Line-charging current is expressed by its r.m.s. value in amperes.

3.7.105**non-sustained disruptive discharge****NSDD**

disruptive discharge associated with current interruption that does not result in the resumption of power frequency current or, in the case of capacitive current interruption, does not result in current in the main load circuit

[SOURCE: IEC 62271-1:2017, 3.1.20]

3.7.106**partial discharge extinction voltage** U_e

applied voltage at which repetitive partial discharges cease to occur in the test object when the voltage applied to the object is gradually decreased from a higher value at which partial discharge pulse quantities are observed

Note 1 to entry: In practice, U_e is the highest applied voltage at which the magnitude of a chosen partial discharge pulse quantity becomes equal to, or less than, a specified low value.

Note 2 to entry: Although worded differently, this IEEE definition is equivalent to IEC 60076-1:2011-42.

3.7.107**partial discharge inception voltage** U_i

applied voltage at which repetitive partial discharges are first observed in the test object when the voltage applied to the object is gradually increased from a lower value at which no partial discharges are observed

Note 1 to entry: In practice, U_i is the lowest applied voltage at which the magnitude of a partial discharge pulse quantity becomes equal to or exceeds a specified low value.

Note 2 to entry: Although worded differently, this IEEE definition is equivalent to IEC 60076-1:2011-41.

3.7.108**prospective transient recovery voltage**

<of a circuit> transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

Note 1 to entry: The definition assumes that the switching device or the fuse, for which the prospective transient recovery voltage is sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow several different paths, e.g. a polyphase circuit, the definition further assumes that the breaking of the current by the ideal switching device takes place only in the pole considered.

Note 2 to entry: The terms "inherent transient recovery voltage" and "prospective transient recovery voltage" are often used interchangeably.

[SOURCE: IEC 60050-441:1984, 441-17-29]

3.7.109**dead time**

<of an automatic circuit recloser> open-circuit time between an automatic opening and the succeeding automatic reclosure

Note 1 to entry: This definition is similar to the definition of "dead time" in IEC 62271-100. See Annex K.

3.8 Index of definitions

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non-earthed recloser	3.1.114

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252 **4 Normal and special service conditions**

253 **4.1 Normal service conditions**

254 **4.1.1 General**

255 Subclause 4.1.1 of IEC 62271-1:2017 is applicable with the following addition:

256 Cutout fuse supports and bases do not have a fault closing rating. As such, cutout mounted
257 reclosers that install into the fuse support with interrupting contacts in the closed position should
258 not be installed into the cutout fuse support while the fuse support is energized.

259 **4.1.2 Indoor switchgear and controlgear**

260 Subclause 4.1.2 of IEC 62271-1:2017 is applicable.

261 **4.1.3 Outdoor switchgear and controlgear**

262 Subclause 4.1.3 of IEC 62271-1:2017 is applicable with the following modifications and
263 addition:

- 264 a) the ambient air temperature does not exceed 40 °C and its average value, measured over a
265 period of 24 h does not exceed 35 °C;
- 266 b) the ambient air temperature does not drop below -30 °C;

NOTE Rapid temperature changes can occur, for example a hot sunny day followed by a sudden rain.

c) solar radiation does not exceed a level of 1 044 W/m²;

d) ice coating does not exceed 1 mm.

Add the following specification:

For submersible units, the water head does not exceed 3 m above the base of the enclosure for a duration not to exceed 10 d. Exposure to chemical or electrochemical reactions may be encountered in a sub-grade environment. The sub-grade environment may contain chemicals that contribute to mild corrosive reactions.

4.2 Special service conditions

4.2.1 General

Subclause 4.2.1 of IEC 62271-1:2017 is applicable.

4.2.2 Altitude

Subclause 4.2.2 of IEC 62271-1:2017 is not applicable.

The basis of rating for switchgear is standard reference atmosphere, commonly known as sea level conditions. Historically, switchgear has been successfully applied at altitudes up to 1 000 m without the use of an altitude correction factor.

For installations at an altitude higher than 1 000 m, the required insulation withstand level of external insulation at the service location shall be determined by multiplying the rated insulation levels at sea level by the altitude correction factor K_a in accordance with Figure J.1.

In this document, the rated symmetrical interrupting current (rated short-circuit breaking current), related required capabilities and interrupting times need not be corrected for altitude.

4.2.3 Exposure to pollution

Subclause 4.2.3 of IEC 62271-1:2017 is applicable.

4.2.4 Temperature and humidity

Subclause 4.2.4 of IEC 62271-1:2017 is not applicable.

For installation in a location where the ambient temperature can be outside the normal service condition range stated in 4.1.2 and 4.1.3, the usual ranges of minimum and maximum temperature to be specified should be

a) -50 °C to +40 °C for extremely cold climates,

b) -40 °C to +40 °C for very cold climates,

c) this range is not used, see note,

d) -15 °C to +40 °C for moderate climates,

e) -5 °C to +55 °C for very hot climates,

f) -15 °C to +55 °C for hot and dry desert regions.

NOTE Range c) of IEC 62271-1, -30 °C to +40 °C, is not used in this document, because it is the same as the normal service conditions in 4.1.3.

4.2.5 Exposure to abnormal vibrations, shock or tilting

Subclause 4.2.5 of IEC 62271-1:2017 is applicable.

4.2.6 Wind speed

Subclause 4.2.6 of IEC 62271-1:2017 is applicable.

4.2.7 Other parameters

Subclause 4.2.7 of IEC 62271-1:2017 is applicable.

5 Ratings

5.1 General

Subclause 5.1 of IEC 62271-1:2017 is not applicable.

The ratings of the automatic circuit recloser and the cutout mounted recloser shall be as specified in Table 1.

**Table 1 – Ratings for automatic circuit reclosers,
cutout mounted reclosers and non-earthed reclosers**

Item	Rating description	Reference subclause	Automatic circuit recloser	Cutout mounted recloser	Non-earthed recloser
1	Rated maximum voltage (V) or (U_r)	5.2	X	X	X
2	Rated insulation level (U_d), (U_p)	5.3	X	X ^{b,c}	X ^e
3	Rated frequency (f_r)	5.4	X	X	X
4	Rated continuous (normal) current (I_r)	5.5	X	X	X
5	Rated short-time withstand current (I_k)	5.6	X	X	X
6	Rated peak withstand current (I_p)	5.7	X	X	X
7	Rated duration of short circuit (t_k)	5.8	X	X	X
8	Rated supply voltage of closing and opening devices and of auxiliary circuits (U_a)	5.9	X	--	X
9	Rated minimum tripping current (series-trip reclosers only)	5.101	X	X	X
10	Rated short-circuit breaking current (I_{sc})	5.102	X	X	X
11	Rated symmetrical (fault) making current	5.103	X	X	X
12	Rated operating sequence	5.104	X	X	X
13	Rated line-charging (I_l) and cable-charging (I_c) current switching	5.106 ^a	X	X ^d	X
14	Rated first-pole-to-clear factor, k_{pp}	5.105			
^a Line-charging, cable charging and load current switching are related required capabilities. ^b Rated insulation levels for a cutout mounted recloser are derived in part from the fuse support or base in which it is installed. The fuse support or base shall be considered a part of the cutout mounted recloser for the purpose of type testing. ^c Open position tests for cutout mounted reclosers are given for the device in the “dropped-out” position unless an operating sequence allows the device to rest with an open interrupter gap and a closed isolation gap in which case, both the isolation gap alone and the interrupter gap alone shall be tested for the open position test cases. ^d Switching capability for a cutout mounted recloser may require the use of an auxiliary open and closing device. The auxiliary open and closing device shall be considered a part of the cutout mounted recloser for the purpose of type testing. Consult manufacturer for operating details. ^e Rated insulation levels for a non-earthed recloser are dependent on the mounting arrangement and its potential proximity to any localized earthing system and with reference to alternate phases when in a three-phase system for the purpose of type testing.					

5.2 Rated voltage (U_r)

Subclause 5.2 of IEC 62271-1:2017 is not applicable.

The rated voltage (rated maximum voltage) indicates the upper limit of the highest voltage of the system for which reclosers are intended to operate.

NOTE 1 For purposes of this document, the term “rated voltage” (U_r) in IEC is equivalent to the term “rated maximum voltage” (V) in IEEE.

NOTE 2 Although Table 2 and Table 3 list only rated voltage up to 72,5 kV, the scope of this document does not have an upper limit. The listing of values up to 72,5 kV reflects the devices currently available on the market.

The values of rated voltage of reclosers are those shown in column 2 of Table 2 and Table 3.

5.3 Rated insulation level (U_d), (U_p)

Subclause 5.3 of IEC 62271-1:2017 is applicable, with the following modifications:

Table 1 and Table 2 of IEC 62271-1:2017 are replaced by Table 2 and Table 3 of this document.

Table 2 – Rated maximum voltages and rated voltage withstand values for reclosers applied on overhead line distribution circuits ^a

Line No.	Rated maximum voltage	Rated lightning impulse withstand voltage ^b	Rated short-duration power-frequency withstand voltage
	kV, r.m.s.	kV, peak	kV, r.m.s.
Col. 1	Col. 2	Col. 3	Col. 4
1	12	75	28
2	15 ^c	95	36
3	15,5	110	50
4	17,5	95	38
5	24	125	50
6	27	125	60
7	36	150	70
8	36	170	70
9	38	150	70
10	38	170	70
11	40,5	185	80
12	48,3	250	105
13	52	250	95
14	72,5	350	160

^a The test values shown in Table 2 are for type tests; refer to 11.101 for field-testing.

^b These performance characteristics specified as test requirements in this document.

^c The 15 kV rating is used in North America and some other countries. It has historically been associated with metal-clad and metal-enclosed switchgear used for applications that are primarily indoors and/or outdoors where the insulation level is less than that required for outdoor overhead applications. For applications other than metal-clad or metal-enclosed switchgear, the 15,5 kV rating is preferred.

Table 3 – Rated maximum voltages and rated voltage withstand values for reclosers applied on cable connected distribution circuits ^a

Line No.	Rated maximum voltage	Rated lightning impulse withstand voltage	Rated short-duration power-frequency withstand voltage ^b	Related dc withstand test 15 min ^{b,c,d}	VLF ac withstand test 15-30 min ^{b,c,d}
	kV, r.m.s.	kV, peak	kV, r.m.s.	kV	kV, peak
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
1	12	60	28	42	25
3	15,5	95	35	53	31
4	17,5	95	38	57	34
5	24	95	50	78	43
6	27	125	40	78	49
7	36	150	70	103	64
8	36	170	70	103	64
9	38	150	50	103	67
10	38	170	70	103	67
11	40,5	185	80	–	72
12	48,3	250	105	–	85
13	48,3	250	120	–	85
14	52	250	95	–	91
15	72,5	325	160	–	125
16	72,5	350	175	–	125

^a The test values shown in Table 3 are for type tests; refer to 11.101 for field-testing.

^b These are performance characteristics specified as test requirements in this document.

^c DC withstand or very low frequency (VLF) tests are required for pad-mounted, dry vault and submersible gear since this type of equipment is interfaced with the power system via separable connectors. The test requirements for dc withstand testing of separable connectors are specified IEEE Std 386 [5]; requirements for testing of extruded and laminated dielectric shielded cable joints are specified in IEEE Std 404 [34]. These values are reproduced here in column 5. Shielded power cable requirements for VLF testing are specified in IEEE Std 400.2 [6] as reproduced in column 6.

^d DC withstand testing of 36/38 kV cables is not a recommended practice. Very low frequency (VLF) testing is used as an alternative to the dc withstand test. Reference IEEE Std 400.2 [6].

5.4 Rated frequency (f_r)

Subclause 5.4 of IEC 62271-1:2017 is not applicable.

The rated power-frequency shall be the frequency at which the recloser and its components are designed to operate. The values of the rated power-frequency are 50 Hz or 60 Hz.

5.5 Rated continuous current (I_r)

Subclause 5.5 of IEC 62271-1:2017 is applicable with the following addition:

The historic values of 560 A, 600 A, and 1 200 A, while not part of the R10 series, are also recognized as accepted commonly used values.

5.6 Rated short-time withstand current (I_k)

Subclause 5.6 of IEC 62271-1:2017 is applicable with the following addition:

The historic values of 6 000 A and 12 000 A, while not part of the R10 series, are also recognized as accepted commonly used values.

NOTE The R10 series comprises the numbers 1 – 1,25 – 1,6 – 2 – 2,5 – 3,15 – 4 – 5 – 6,3 – 8 and their products by 10^n .

5.7 Rated peak withstand current (I_p)

Subclause 5.7 of IEC 62271-1:2017 is applicable.

5.8 Rated duration of short-circuit (t_k)

Subclause 5.8 of IEC 62271-1:2017 is applicable with the following addition:

The standard rated duration of short-circuit (t_k) is 0,5 s unless otherwise stated by the manufacturer and listed on the nameplate. Optional values are 1 s, 2 s and 3 s.

5.9 Rated supply voltage of auxiliary and control circuits (U_a)

5.9.1 General

Subclause 5.9.1 of IEC 62271-1:2017 is applicable.

5.9.2 Rated supply voltage (U_a)

Subclause 5.9.2 of IEC 62271-1:2017 is applicable with the following modification:

The values in Table 6 and Table 7 of IEC 62271-1:2017 do not apply to line-powered or self-powered devices such as series trip reclosers or controls supplied by integrally mounted current transformers or internal batteries.

Refer to 6.4.1 and 6.9 for applicable voltage operating ranges.

NOTE The values of 60, 110, and 220 V dc from Table 6 of IEC 62271-1:2017 are not common in IEEE standards.

5.10 Rated supply frequency of auxiliary and control circuits

Subclause 5.10 of IEC 62271-1:2017 is applicable.

5.11 Rated pressure of compressed gas supply for controlled pressure systems

Subclause 5.11 of IEC 62271-1:2017 is not applicable.

For devices that use a compressed gas supply, the rated pressure of compressed gas supply for insulation and/or operation shall be stated by the manufacturer.

5.101 Rated minimum tripping current ($I_{>\min}$)

The minimum tripping current shall be stated by the manufacturer with a tolerance not to exceed the greater of $\pm 10\%$ or ± 3 A.

The minimum tripping current for shunt-trip reclosers is variable and is independent of the rated continuous (normal) current. Information on specific reclosers should be obtained from the manufacturer.

NOTE The term rated minimum tripping current ($I_{>\min}$) is similar to the term G_T in IEC 60255-151 [7].

5.102 Rated short-circuit breaking current (I_{sc})

The rated short-circuit breaking current is the highest value of the symmetrical component of the short circuit current that the recloser shall be capable of breaking under the conditions of use and behaviour prescribed in this document. This implies that the circuit has a power-frequency recovery voltage corresponding to the rated voltage of the recloser and having a transient recovery voltage equal to the value specified in 7.103.6.

The preferred rated short-circuit breaking current of reclosers shall be selected from the R10 series specified in IEC 60059 [8]. See Annex H for ratings for hydraulically controlled series-trip reclosers and oil interrupting reclosers.

NOTE 2 The R10 series comprises the numbers 1 – 1,25 – 1,6 – 2 – 2,5 – 3,15 – 4 – 5 – 6,3 – 8 and their products by 10^n .

The rated short-circuit breaking current shall be based on the capability of the recloser to interrupt the corresponding asymmetrical current in circuits having X/R values as given in columns 5, 7, and 9 of Table 10 and with a power-frequency recovery voltage equal to the rated maximum voltage and with transient recovery voltages as defined in 7.103.6.

5.103 Rated short-circuit making current

Reclosers shall be capable of making, at any applied voltage up to and including that corresponding to their rated voltage, any current up to and including their rated short-circuit making current.

The rated short-circuit making current shall be the same value as the rated short-circuit breaking current, with maximum asymmetry corresponding to the X/R ratio in column 9 of Table 10. Refer to Annex A for information on calculating the peak current value.

5.104 Rated operating sequence

The rated characteristics of the recloser are referred to the rated operating sequence. The preferred rated operating sequence for automatic circuit reclosers shall be:

$$O - t - CO - t' - CO - t'' - CO,$$

where

O represents an open operation,

CO represents a closing operation followed by an opening operation with a time delay controlled by the automatic control of the device.

Other sequences may be used.

The preferred values for the reclosing intervals are: $t = 0,5$ s, $t' = 2$ s and $t'' = 5$ s representing the fastest rapid reclosing interval capability of the device controlled by its automatic control. Other reclosing intervals may be used. See Annex H for rated operating sequence for oil interrupting reclosers.

The operating sequence and reclosing intervals represent the minimum required capability of the device and shall be demonstrated in the standard operating duty test specified in 7.103.4.

Other operating sequences, delays and reclosing intervals may be available for selection by the user.

5.105 Rated first-pole-to-clear factor

The first-pole-to-clear factor (k_{pp}) is a function of the earthing of the system neutral. The rated values of k_{pp} are:

- 1,3 for systems with effectively earthed neutral;
- 1,5 for systems with non-effectively earthed neutral.

All reclosers shall be rated for a k_{pp} of 1,5; a rating for a k_{pp} of 1,3 is optional.

Single-phase reclosers that have completed the standard operating duty test at the required full U_r voltage are automatically qualified for both non-effectively earthed and effectively earthed neutral systems.

5.106 Rated line- (I_l) and cable-charging (I_c) interrupting currents

Line-charging current interruption tests are applicable to all reclosers for switching unloaded three-phase overhead lines. Cable-charging current interrupting tests are applicable to all reclosers for switching the charging current of unloaded lengths of cables. Line- and cable-charging current interruption are related required capabilities of all single- and three-phase reclosers. The tests are also applicable to the case of an overhead line in series with short lengths of cable.

Single-phase reclosers are frequently applied in a set of three on a three-phase circuit. Accordingly, single-phase reclosers are required to meet the line- and cable-charging current tests.

NOTE No capacitive current switching class similar to IEEE C37.09 [31] and IEC 62271-100 is assigned to reclosers.

Cables are considered to be short if the total charging current does not exceed 20 % of the overhead line-charging current and the charging current of any cable adjacent to the recloser does not exceed 10 % of the overhead line-charging current. In any case, the total current shall not exceed the rated line-charging interrupting current.

The preferred line- and cable-charging interrupting current ratings for reclosers are as given in Table 4.

Table 4 – Preferred line- and cable-charging interrupting current ratings

Rated maximum voltage kV	Rated breaking current A (r.m.s.)	
	Line charging	Cable charging
12	2	10
15 and 15,5	2	10
17,5	2	10
24	5	25
27	5	25
36	5	40
38	5	40
40,5	5	40
48,3	10	50
52	10	50
72,5	20	125

6 Design and construction

6.1 Requirements for liquids in switchgear and controlgear

Subclause 6.1 of IEC 62271-1:2017 is applicable with the following addition:

Oil sampling provision (submersible reclosers): when oil is used as the insulating medium, provision shall be made to obtain a bottom oil sample.

6.2 Requirements for gases in switchgear and controlgear

Subclause 6.2 of IEC 62271-1:2017 is applicable.

6.3 Earthing of switchgear and controlgear

NOTE The terms “ground” and “grounding” in IEEE are equivalent to the IEC terms “earth” and “earthing”.

Subclause 6.3 of IEC 62271-1:2017 is not applicable.

Reclosers intended to be earthed shall be provided with a reliable earthing point for connection of an equipment earth conductor suitable for the specified fault conditions. Parts of metallic enclosures connected to the earthing system may be designed to be part of the earth circuit.

All conductive components and enclosures that may be touched during normal operating conditions and are intended to be earthed shall be designed to carry 30 A (DC) with a voltage drop of maximum 3 V to the earthing point provided at the recloser. For purposes of this subclause, the term “conductive” does not include semi-conductive surfaces.

A recloser control housing that may be mounted separately from the recloser or that contains control elements that rely on solid earthing for surge immunity shall also have provisions for the connection of an earth lead.

Pad mounted, dry vault and submersible reclosers shall have an additional earthing connection for each three-phase set of cable entrances.

Cutout mounted reclosers shall have the fuse support or base earthed.

Non-earthed reclosers shall not be connected to earth.

6.4 Auxiliary and control equipment

6.4.1 Power supply operating requirements

6.4.1.1 General

Subclause 6.4.1 of IEC 62271-1:2017 is not applicable.

In some jurisdictions and when specified by the user, conformance to clause 6 of IEEE Std C37.68 [30] may be required.

6.4.1.2 Reclosers with power supply voltage inputs

Reclosers, including all auxiliary circuits (electronic controls, supervision, monitoring and communication), shall be able to operate normally when the power supply voltage measured at the supply terminals of the auxiliary equipment is such that:

- the voltage variation is within 85 % to 110 % of rated supply voltage,
- in the case of a dc supply voltage, the ripple voltage is limited to a value not greater than 5 % of the dc value.

The requirements for voltage variation do not apply to line-powered or self-powered control equipment, e.g. powered by integrally mounted current transformers or battery powered controls.

6.4.1.3 Line-powered or self-powered reclosers

The manufacturer shall specify the minimum values and duration of application of the power source (current, voltage, solar, or other) required for full operation of the recloser without the aid of a secondary or alternative power source. If limited recloser functionality is operational at lower values and duration of application of the main source, the manufacturer shall document the functionality and power values.

The manufacturer shall specify any dependency of using an alternative power source during the absence of the main power source to perform any functions such as close operation after lockout, status indication and remote communications.

6.4.1.4 Primary and back-up battery powered reclosers

When equipped with a battery used to operate the recloser, the recloser shall include a notification for battery health. The manufacturer shall document how the notification indicates an inoperable condition due to the battery status.

6.4.2 Protection against electric shock

Subclause 6.4.2 of IEC 62271-1:2017 is applicable with the following modification.

Special access restrictions may be required for overhead/pole mounted reclosers. See 6.4.3.

6.4.3 Components installed in enclosures**6.4.3.1 General**

Subclause 6.4.3 of IEC 62271-1:2017 is not applicable.

6.4.3.2 Accessibility

Closing and opening actuators and emergency shut-down system actuators shall be located between 0,4 m and 2 m above the floor, ground or operating platform normally used by operating personnel. This requirement does not apply to separately mounted control enclosures where they may need to be elevated to prevent access by the general public according to local requirements and work practices.

Other actuators should be located at such a height that they can be easily operated, and indicating devices should be located at such a height as to be readily legible.

6.4.3.3 Identification

Identification of components installed in enclosures shall be in agreement with the indication on the wiring diagrams and drawings.

6.4.3.4 Auxiliary switches

Auxiliary switches shall be suitable for the number of electrical and mechanical operating cycles specified for the switching device.

6.4.3.5 Auxiliary and control contacts

Auxiliary and control contacts shall be suitable for the number of electrical and mechanical operating cycles specified for the switching device. This requirement shall be verified by the mechanical endurance test of the switching devices.

6.4.3.6 Heating elements

All heating elements shall be of the non-exposed type.

Where contact with a heater or shield can occur accidentally, the surface temperature shall not exceed the temperature limits for accessible parts not to be touched in normal operation, as specified in 7.5.6.

6.4.3.7 Operation counter

Operation counters shall be suitable for their intended duty in terms of environmental conditions and for the number of electrical and mechanical operating cycles specified for the switching device.

6.5 Dependent power operation

Subclause 6.5 of IEC 62271-1:2017 is applicable.

6.6 Stored energy operation**6.6.1 General**

Subclause 6.6 of IEC 62271-1:2017 is not applicable.

A switching device arranged for stored energy operation shall be capable of making and breaking all currents up to its rated values when the energy storage device is suitably charged. Except for slow operation during maintenance, the main contacts shall only move under the action of the drive mechanism and in the designed manner, and not in the case of re-application of the energy supply to the energy storage device after a loss of energy.

A device indicating when the energy storage device is charged shall be mounted on the switching device except in the case of an independent unlatched operation, see 6.7.

It shall not be possible for the moving contacts to move from one position to the other, unless the stored energy is sufficient for satisfactory completion of the opening or closing operation. Stored energy systems for both opening and closing shall be capable of being discharged, restrained or otherwise reduced to a condition consistent with personnel safety during maintenance operations by properly trained personnel.

When indicators are used on stored energy operating mechanisms, the following colours are suggested subject to any local codes:

- a) yellow background with CHARGED in black letters for charged mechanisms,
- b) white background with DISCHARGED in black letters for discharged mechanisms.

As an alternative, red letters on a white background for both indicators may be used.

The words “CHARGED” and “DISCHARGED” are given in the English language as an example. The actual language used shall be as specified or as is customary for the intended user.

NOTE Further guidance on the colours or symbols can be found in IEC 60073 [9] and IEC 60417 [10].

Customer (user) preferences or local codes for indicators should be specified by the user.

6.6.2 Energy storage in gas receivers or hydraulic accumulators

When the energy storage device is a gas receiver or hydraulic accumulator, the requirements of 6.6.1 apply at operating pressures between the limits specified in items a) and b).

- a) External pneumatic or hydraulic supply

Unless otherwise specified by the manufacturer, the limits of the operating pressure are 85 % and 110 % of their specified rated pressure.

Higher limits may apply where receivers also store compressed gas for interruption. The applicable equipment standard should address as needed the maximum limit if applicable.

- b) Compressor or pump integral with the switching device or the operating device

The limits of operating pressure shall be stated by the manufacturer.

6.6.3 Energy stored in springs (or weights)

When the energy storage device is a spring (or weight), the requirements of 6.6.1 apply when the spring is charged (or the weight lifted).

6.6.4 Manual charging

If a spring (or weight) is charged by hand, the direction of motion of the handle shall be marked.

The manual charging facility shall be designed such that the handle is not driven by the operation of the switching device.

The maximum actuating force required for manually charging a spring (or weight) shall not exceed 250 N (56 lb_f (pound-force)).

6.6.5 Motor charging

Motors, and their electrically operated auxiliary equipment for charging a spring (or weight) or for driving a compressor or pump, shall operate satisfactorily within the limits of the voltages in 5.9, the frequency, in the case of AC, being the rated supply frequency.

NOTE For electric motors, the limits do not imply the use of non-standard motors but only the selection of a motor which at these values provides the necessary effort, and the rated voltage of the motor need not coincide with the rated supply voltage of the closing device.

6.6.6 Energy storage in capacitors

When the energy storage is a charged capacitor, the requirements of 6.6.1 apply when the capacitor is charged except that indication of the charged state may be placed on the energy storage device rather than the switching device. In the case of an energy storage device embedded within electronic controls of the recloser, a 'readiness to operate' indicator satisfies this requirement.

6.7 Independent unlatched operation (independent manual or power operation)

Subclause 6.7 of IEC 62271-1:2017 is applicable.

6.8 Manually operated actuators

Subclause 6.8 of IEC 62271-1:2017 is applicable with the following addition:

Reclosers shall be provided with a manual operating handle to open the recloser. The operating handle shall be suitable for operation with a hot line stick or insulating stick.

Some applications may require that the operating handle on a submersible recloser be located such that one person standing on the surface can operate it without standing directly over the recloser. These special applications should be specified by the user.

The manufacturer shall provide a description of the manual operating handle. The description shall include

- the positions of the operating handle,
- the operations that can be performed by the operating handle,
- the behavior of the recloser when the operating handle is moved from one position to another, and
- the description of any contacts which change status when the operating handle is moved from one position to another.

NOTE—IEEE Std C37.2 [33] provides descriptions of contacts.

6.9 Operation of releases**6.9.1 General**

Subclause 6.9.1 of IEC 62271-1:2017 is applicable.

6.9.2 Shunt closing release

Subclause 6.9.2 of IEC 62271-1:2017 is applicable.

6.9.3 Shunt opening release

Subclause 6.9.3 of IEC 62271-1:2017 is applicable.

6.9.4 Capacitor operation of shunt releases

Subclause 6.9.4 of IEC 62271-1:2017 is applicable

6.9.5 Under-voltage release

Subclause 6.9.5 of IEC 62271-1:2017 is applicable.

6.10 Pressure/level indication

Subclause 6.10 of IEC 62271-1:2017 is applicable.

6.11 Nameplates

Subclause 6.11 of IEC 62271-1:2017 is applicable, with the following addition:

The nameplates for recloser shall be marked in accordance with Table 5.

If the recloser consists of several poles with independent operating mechanisms, each pole shall be provided with a nameplate. This requirement does not apply if all of the pole mechanisms are mounted to a common structure.

For submersible reclosers, a nameplate of stainless steel or other corrosion resistant material shall be provided. The nameplate shall be securely attached to the top of the tank by means of stainless steel screws, rivets, or other corrosion resistant fasteners. All letters, schematics and numbers shall be permanently stamped, embossed or engraved on the nameplate.

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Table 5 – Nameplate markings

Term	Abbreviation ^a	Unit	Condition: Marking only required if	Marking requirement ^b
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5
Manufacturer's name or trademark				X
Manufacturer's type designation				X
Equipment type		c		X
Rated maximum voltage	V or U_r	kV		X
Rated power-frequency withstand voltage	U_d	kV		X
Rated lightning impulse withstand voltage	U_p	kV		X
Rated power-frequency	f_r	Hz	Rating is not applicable at both 50 Hz and 60 Hz	Y
Rated continuous (normal) current	I_r	A		X
Rated duration of short circuit	t_k	s	Different from 0,5 s	Y
Rated short-circuit breaking current	I_{sc}	A or kA		X
Rated first pole-to-clear factor	k_{pp}		Specify 1,3 if rated for both 1,5 and 1,3	Y
Rated minimum tripping current	$I_{>min}$	A	Non-adjustable series-trip reclosers	Y
Ice breaking capability		mm	Greater than 1 mm thickness and if type testing is required, see 7.110	Y
Type and quantity (volume of liquid or mass of gas) of insulating material		l or kg ^d	Contains liquid or gas	Y
Mass (including oil for oil-filled devices)		kg (lbs) ^d		X
Serial number and date of manufacture				X

A separate auxiliary nameplate or label may be used for supply voltage information.

^a The abbreviation in column 2 may be used instead of the term in column 1. When the term in column 1 is used, the word "rated" is not required.

^b X = the marking of these values is mandatory; blanks indicate the value zero.

Y = the marking of these values to the conditions in column 4.

^c Equipment type: the nameplate shall also contain the word(s) "recloser" or "cutout mounted recloser" in accordance with its operating sequence capability as given in 5.104.

^d SI metric units are preferred; however country specific units may be used, e.g. US gallons (US gal,) pound-force (lb_f), pound mass (lb_m).

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If the recloser is operated or controlled by a detachable control enclosure, this enclosure shall also have an appropriate nameplate containing at least the following information:

- manufacturer's name or trademark,
- manufacturer's type designation / model number,
- serial number, and
- date of manufacture.

The control enclosure nameplate may contain additional information subject to agreement between manufacturer and user, for example:

- voltage ratio settings,
- current ratio settings,
- input power range,
- battery voltage & A/hr rating, and
- enclosure IP rating.

6.12 Locking devices

Subclause 6.12 of IEC 62271-1:2017 is applicable.

6.13 Position indication

Subclause 6.13 of IEC 62271-1:2017 is applicable with the following addition:

For pad mounted, dry vault or submersible reclosers, viewing of the position indicator may require opening of the pad-mounted or underground enclosure.

In the absence of user specifications, the preferred colours to indicate an open or closed position are red to signify closed and green to signify open.

6.14 Degrees of protection provided by enclosures

6.14.1 General

Subclause 6.14 of IEC 62271-1:2017 is not applicable.

The degrees of protection provided by enclosures shall be in accordance with IEC 60529 [25] and 6.14.2 through 6.14.4.

6.14.2 Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects (IP coding)

6.14.2.1 Requirements for equipment in publicly accessible areas

Equipment including control enclosures that are intended for installation in publicly accessible areas shall conform to the degree of protection level IP4X or higher. Such enclosures shall be designed to mitigate the potential hazards of the equipment to unauthorized persons. Consideration for securing associated external cable and cable connections and the prevention of internal access other than by authorized personnel shall be agreed upon between the user and the manufacturer.

In order to secure the control enclosure, the following measures are typically used to address the hazards presented by publicly accessible equipment.

- a) Three-point door latching mechanisms, or equivalent, are used to secure a door of entry.

NOTE A three-point latching mechanism allows for all un-hinged sides of a door to be latched, thereby securing all sides of a door. Such a mechanism greatly increases the security of the door compared to a single-point latching mechanism.

b) Enclosure panels are fastened or hinged to resist disassembly, breaking, or prying open from the outside with the doors in the closed and locked position. No externally removable screws, bolts, or other fastening devices exist by which access to energized parts in the enclosure might be obtained without the use of special tools.

c) Locking bolts and associated threaded receptacles, hinges, and hinge pins are AISI type 304 stainless steel or material of equivalent corrosion resistance.

d) Enclosures have padlock provisions, utilizing a minimum of one padlocking means provided per entry door.

In some jurisdictions and when specified by the user, conformance to IEEE Std C37.75 [28] may be required.

6.14.2.2 Requirements for equipment which is not accessible to the public

6.14.2.2.1 Polemount applications

Reclosers intended for polemount installation in areas not accessible to the public shall conform to the degree of protection level IP1XB or higher according to IEC 60529 [25].

6.14.2.2.2 Wet/Dry vault applications

Reclosers intended for dry vault applications shall conform to the degree of protection level IP3X or higher according to IEC 60529 [25].

Reclosers intended for wet vault applications shall conform to the degree of protection level IP6X or higher according to IEC 60529 [25].

6.14.3 Protection against ingress of water (IP coding)

Reclosers intended for applications other than wet vault shall conform to the degree of protection level IPX3 or higher according to IEC 60529 [25].

Reclosers intended for wet vault applications shall conform to the degree of protection level IPX7 or higher according to IEC 60529 [25].

6.14.4 Protection of equipment against mechanical impact under normal service conditions (IK coding)

Subclause 6.14.4 of IEC 62271-1:2017 is not applicable.

6.15 Creepage distances for outdoor insulators

Subclause 6.15 of IEC 62271-1:2017 is applicable.

6.16 Gas and vacuum tightness

Subclause 6.16 of IEC 62271-1:2017 is applicable.

6.17 Tightness for liquid systems

Subclause 6.17 of IEC 62271-1:2017 is applicable with the following addition:

Tank construction for liquid filled or non-pressurized devices shall be such that leaks will not occur and the recloser will remain mechanically operable at the maximum pressure generated

by the normal operation of the recloser (for example, temperature rise, load interrupting and fault closing).

6.18 Fire hazard (flammability)

Subclause 6.18 of IEC 62271-1:2017 is applicable.

6.19 Electromagnetic compatibility (EMC)

Subclause 6.19 of IEC 62271-1:2017 is not applicable.

The control elements supplied with shunt-trip reclosers shall withstand, without damage, voltage surges originating in the low-voltage energy source, in either or both of the current and voltage transformers connected to the control elements, or in the control leads connecting the recloser and the control elements. The tests specified in 7.111 demonstrate this capability.

6.20 X-ray emission

Subclause 6.20 of IEC 62271-1:2017 is applicable.

6.21 Corrosion

Subclause 6.21 of IEC 62271-1:2017 is applicable.

6.22 Filling levels for insulation, switching and/or operation

Subclause 6.22 of IEC 62271-1:2017 is applicable.

6.101 Requirements for simultaneous operation

Simultaneous operation is not required unless agreed upon by the manufacturer and user.

Simultaneous operation is only applicable to three phase operations of the recloser.

A recloser is considered to have simultaneous closing or opening capability if its pole simultaneity meets the following requirements under normal service conditions:

- the closing pole simultaneity shall not exceed 1/4 of a cycle of rated frequency;
- the opening pole simultaneity shall not exceed 1/6 of a cycle of rated frequency.

6.102 Tank construction: submersible or dry vault reclosers

6.102.1 Tank material and finish

The tank and all attachments shall be made of corrosion resistant material or provided with an impact and corrosion resistant finish and shall also be suitable for storage in uncovered areas.

6.102.2 Water entrapment

External parts of the tank or accessories shall not trap or hold water.

6.102.3 Tank support

Tank supports shall include provision for anchoring the tank.

6.102.4 Lifting lugs

Attachment points for lifting the recloser shall be provided to permit lifting and installation in accordance with the manufacturer's instructions. They shall be designed and located on the tank to avoid interference between lifting slings and any attachments (bushings, operating handles, etc.), and to avoid scratching or marring the tank finish during handling.

6.103 Counters

An operations counter shall be provided to indicate the total number of unit operations of automatic reclosers. The counter shall be visible with the recloser in service.

6.104 Conductor terminal sizes

For connection of bare conductors, terminals shall accommodate conductors of a size adequate to conduct the rated continuous (normal) current of the recloser without exceeding the appropriate temperature rise shown in 7.5.5.

For reclosers fitted with cable terminations, bushings should accommodate cable terminations in accordance with IEEE Std 386 [5] or the IEC 60502 series [11] unless otherwise specified by the user.

6.105 Voltage and current sensors

All reclosers include a sensor for measuring line current, and some also include sensors for measuring line voltage.

Where such sensors are used, accuracy specifications should be published by the manufacturer.

NOTE Refer to IEC 61869-1 [36] for guidance regarding accuracy of voltage and current sensors.

7 Type tests

7.1 General

7.1.1 Overview

Subclause 7.1.1 of IEC 62271-1:2017 is applicable with the following addition:

Reclosers shall be capable of meeting the type tests described in 7.2 through 7.11 inclusive and 7.101 through 7.113 inclusive and as applicable. Once made, the type tests need not be repeated unless the design is changed so as to modify the performance characteristics of the recloser.

Reconditioning is not permitted during any individual type test. The complete standard operating duty test specified in 7.103 is considered as one type test.

Refer to Annex E for tolerances applied to test values.

NOTE The term "type test" in IEC is equivalent to the IEEE term "design test".

7.1.2 Information for identification of test objects

Subclause 7.1.2 of IEC 62271-1:2017 is applicable with the following addition:

The definition of an automatic circuit recloser includes its automatic control. The manufacturer shall include in the information provided to the testing laboratory sufficient information to identify

the control used in the type tests. Where appropriate, this information shall include model number, serial number, firmware revision, software revision and other appropriate control software information.

The definition of a cutout mounted recloser includes a fuse type mounting or support. This mounting or support is integral to the dielectric capability of the device. The manufacturer shall include in the information provided to the testing laboratory sufficient information to identify the mounting or support used in the type tests. Where appropriate, this information shall include make, model number and rating.

For non-earthed reclosers, details shall be provided regarding the positioning and minimum spacing to an earth plane and minimum spacing to alternate phases when in a three-phase system.

7.1.3 Information to be included in type-test reports

Subclause 7.1.3 of IEC 62271-1:2017 is applicable with the following addition:

The definition of an automatic circuit recloser includes its automatic control. The control shall be considered an essential part of the recloser in the test report including its model number, serial number, firmware revision, software revision and other appropriate control schemes.

The definition of a cutout mounted recloser includes a fuse type mounting or support. This mounting or support shall be considered an essential part of the recloser and noted in the test report including its make, model number and rating.

A cutout mounted recloser may require the temporary attachment of an auxiliary device to perform the related switching functions of a recloser. If such a device is required, it shall be considered an essential part of the recloser and noted in the test report including its make, model number and rating.

The test arrangement including mounting and use of auxiliary devices shall be noted in the test report.

NOTE An auxiliary device can be a separable attachment that is used to perform non-automatic switching functions and is then removed for normal automatic operation. Such a device can perform a quick-break or arc snubbing action to extinguish the arc when the cutout mounted recloser is opened manually.

For non-earthed reclosers, details shall be provided regarding the positioning and spacing to an earth plane and spacing to any alternate phases for the test.

In this document, the term “control voltage” has the same meaning as “auxiliary supply voltage”.

7.1.101 Test conditions

7.1.101.1 Condition of device to be tested

The recloser shall be new and in good condition.

7.1.101.2 Mounting of device

The recloser shall be mounted in a manner closely approximating the normal service conditions for which it is designed. If the recloser normally requires control apparatus, the control apparatus shall be connected during the tests observing the following minimum requirements:

- a) the control shall be mounted on the recloser as intended by the manufacturer’s design or positioned within 2 m of the recloser phase terminals under test;

b) the recloser shall be connected to the control apparatus with the manufacturer's approved cable whose length shall be the maximum allowed by the manufacturer except that it need not exceed 6 m;

c) the control shall be placed in the same room as the recloser without any additional shielding except that which is provided by the manufacturer for normal service.

If the control apparatus is intended by the manufacturer to always be integrally mounted to or within the recloser structure, it shall be considered in compliance with a) and b) above with a zero length control cable.

The connections to the terminals of the switchgear shall be arranged in such a way as to avoid unrealistic stressing of the terminals. The distance between the terminals and the nearest supports of the conductors on both sides of the switchgear shall be in accordance with the instructions of the manufacturer.

A cutout mounted recloser may require the temporary attachment of an auxiliary device to perform the related switching functions of a recloser. If such a device is required, it need not be mounted except for those tests requiring its use, see Note in 7.1.3.

For non-earthed reclosers, the mounting arrangement shall be based on the manufacturer's recommendations regarding the positioning and minimum spacing to an earth plane and minimum spacing to alternate phases when in a three-phase system.

7.1.101.3 Earthing of device

For reclosers intended to be earthed, all parts of the recloser, including control apparatus where used, shall be earthed by a lead attached to the earth terminal and other parts to be earthed, in a manner not to decrease the withstand voltage.

For non-earthed reclosers, the earth plane shall not be placed closer to the device than the minimum distance recommended by the manufacturer so as not to decrease the withstand voltage.

7.1.101.4 Power frequency

Reclosers shall be tested at rated frequency with a tolerance as shown in Table E.1. Reclosers may be tested at 50 Hz or 60 Hz to cover both frequencies with the testing conditions given in Table 6.

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Table 6 – Conditions for combining tests and alternative procedures

Test/Test duty	Subclause	Performed at 50 Hz and also valid for 60 Hz	Performed at 60 Hz and also valid for 50 Hz
Col. 1	Col. 2	Col. 3	Col. 4
Continuous current	7.5	See 7.5.3.1 of IEC 62271-1:2017	Yes
Power-frequency withstand voltage	7.2	Yes	Yes
Clearing time-current	7.108	Yes	Yes
T100 ($k_{pp} = 1,5$ and $k_{pp} = 1,3$)	7.103.4.3	Yes, if 60 Hz peak factor is used ^{a c}	Yes ^b
T50, T20	7.103.4.3	Yes	Yes
T10, T5	7.104	Yes	Yes
Preconditioning	7.101.8	Yes	Yes
Line and cable charging	7.101.8	Yes, if the prospective recovery voltage meets the requirements for 60 Hz, see 7.101.2	Yes
Short-time withstand current and peak withstand current	7.6	Yes, if 60 Hz peak factor is used	Yes
^a In particular, it is recognized that for vacuum interrupters, di/dt is not a relevant criterion for comparison and tests at 50 Hz are acceptable for 60 Hz ratings, but not vice versa. ^b While 50 Hz testing gives a longer arcing window than 60 Hz testing, the difference is small. Given the numerous T100 tests, it can be inferred that testing at 60 Hz effectively validates performance at 50 Hz. ^c Additional tests may be performed on a new recloser.			

NOTE 1 Refer to IEC TR 62271-306 [12] for additional information about the applicability of tests at different frequencies.

7.2 Dielectric tests

7.2.1 General

Subclause 7.2.1 of IEC 62271-1:2017 is applicable with the following addition and modifications:

Rated insulation levels for cutout mounted reclosers are based in part on the rating of the fuse support or base identified by the manufacturer in 7.1.1 and 7.1.2. See 7.2.6.3 for special test conditions for the cutout mounted recloser.

Rated insulation levels for non-earthed reclosers will be impacted by their proximity to any earth plane and spacing to alternate phases when in a three-phase system as identified by the manufacturer in 7.1.2 and 7.1.3.

Reclosers shall be capable of withstanding, without damage to either the recloser or its associated control apparatus, if any, the test voltages of Table 2 or Table 3, when tested in accordance with 7.1.

7.2.2 Ambient air conditions during tests

Subclause 7.2.2 of IEC 62271-1:2017 is applicable.

7.2.3 Wet test procedure

Subclause 7.2.3 of IEC 62271-1:2017 is applicable.