



IEEE

IEC/IEEE 62271-37-013

Edition 2.0 2021-10

INTERNATIONAL STANDARD



**High-voltage switchgear and controlgear –
Part 37-013: Alternating current generator circuit-breakers**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.130.10

ISBN 978-2-8322-1030-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	13
1 Scope.....	16
2 Normative references	16
3 Terms and definitions	17
3.1 General terms and definitions	17
3.2 Assemblies of switchgear and controlgear	20
3.3 Parts of assemblies	20
3.4 Switching devices	21
3.5 Parts of switchgear and controlgear	24
3.6 Operational characteristics of switchgear and controlgear.....	27
3.7 Characteristic quantities	31
3.8 Index of definitions.....	45
4 Normal and special service conditions	49
4.1 Normal service conditions	49
4.2 Special service conditions.....	49
4.2.1 General	49
4.2.2 Altitude	49
4.2.3 Exposure to pollution	49
4.2.4 Temperature and humidity	49
4.2.5 Exposure to abnormal vibrations, shock or tilting	49
4.2.6 Wind speed	49
4.2.7 Other parameters	50
5 Ratings.....	50
5.1 General.....	50
5.2 Rated voltage (U_r , U_{rgcb_side} , U_{rsd_side})	50
5.3 Rated insulation level (U_d , U_p)	51
5.4 Rated frequency (f_r).....	52
5.5 Rated continuous current (I_r)	52
5.6 Rated short-time withstand current (I_k)	55
5.7 Rated peak withstand current (I_p)	55
5.8 Rated duration of short circuit (t_k).....	55
5.9 Rated supply voltage of auxiliary and control circuits (U_a)	55
5.9.1 General	55
5.9.2 Rated supply voltage (U_a)	55
5.10 Rated supply frequency of auxiliary and control circuits	56
5.11 Rated pressure of compressed gas supply for controlled pressure systems.....	56
5.101 Rated short-circuit current (I_{sc})	56
5.102 Rated short-circuit making current I_{MC}	61
5.103 Rated load breaking current.....	62
5.104 Rated out-of-phase making and breaking current	62
5.105 Rated transient recovery voltage (TRV)	62
5.106 Rated operating sequence	65

5.107	Mechanical operation endurance capability of generator circuit-breakers, main-disconnectors, starting switches, BTB-switches and braking switches of classes M1, M2 and M3	65
5.108	Rated first-pole-to-clear factor	65
6	Design and construction	65
6.1	Requirements for liquids in switchgear and controlgear	65
6.2	Requirements for gases in switchgear and controlgear	65
6.3	Earthing of switchgear and controlgear	66
6.4	Auxiliary and control equipment and circuits	66
6.5	Dependent power operation	67
6.6	Stored energy operation	67
6.7	Independent unlatched operation (independent manual or power operation)	67
6.8	Manually operated actuators	67
6.9	Operation of releases	67
6.9.1	General	67
6.9.2	Shunt closing release	67
6.9.3	Shunt opening release	67
6.9.4	Capacitor operation of shunt releases	68
6.9.5	Under-voltage release	68
6.9.101	Multiple releases	68
6.9.102	Operation limits of releases	68
6.9.103	Power consumption of releases	68
6.10	Pressure/level indication	68
6.10.1	Gas pressure	68
6.10.2	Liquid level	68
6.11	Nameplates	68
6.11.1	General	68
6.11.2	Application	68
6.12	Locking devices	75
6.13	Position indication	75
6.14	Degrees of protection provided by enclosures	76
6.14.1	General	76
6.14.2	Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects (IP coding)	77
6.14.3	Protection against ingress of water (IP coding)	77
6.14.4	Protection against mechanical impact under normal service conditions (IK coding)	77
6.15	Creepage distances for outdoor insulators	77
6.16	Gas and vacuum tightness	77
6.17	Tightness for liquid systems	77
6.18	Fire hazard (flammability)	77
6.19	Electromagnetic compatibility (EMC)	77
6.20	X-ray emission	77
6.21	Corrosion	77
6.22	Filling levels for insulation, switching and/or operation	77
6.101	Requirements for simultaneity of poles during single closing and single opening operations	78
6.102	General requirement for operation	78
6.103	Pressure limits of fluids for operation	78
6.104	Vent outlets of generator circuit-breakers	78

6.105	Warning labels	79
6.106	Instructions	79
6.107	Low-and high-pressure interlocking devices	79
7	Type tests	79
7.1	General.....	79
7.1.1	Basics	79
7.1.2	Information for identification of test objects.....	81
7.1.3	Information to be included in type test reports	81
7.2	Dielectric tests	81
7.2.1	General	81
7.2.2	Ambient air conditions during tests	82
7.2.3	Wet test procedure	84
7.2.4	Arrangement of the equipment.....	84
7.2.5	Criteria to pass the test	85
7.2.6	Application of the test voltage and test conditions.....	85
7.2.7	Tests of switchgear and controlgear of $U_T \leq 245$ kV	85
7.2.8	Tests of switchgear and controlgear of $U_T > 245$ kV	85
7.2.9	Artificial pollution tests for outdoor insulators.....	85
7.2.10	Partial discharge tests	85
7.2.11	Dielectric tests on auxiliary and control circuits.....	86
7.2.12	Voltage test as a condition check	86
7.3	Radio interference voltage (RIV) tests.....	86
7.4	Resistance measurement.....	86
7.4.1	Measurement of the resistance of auxiliary contacts class 1 and class 2	86
7.4.2	Measurement of the resistance of auxiliary contacts class 3	86
7.4.3	Electrical continuity of earthed metallic part tests	86
7.4.4	Resistance measurement of contacts and connections in the main circuit as a condition check.....	86
7.5	Continuous current tests	87
7.5.1	Condition of the test object.....	87
7.5.2	Arrangement of the equipment.....	87
7.5.3	Test current and duration.....	89
7.5.4	Temperature measurement during test	89
7.5.5	Resistance of the main circuit.....	89
7.5.6	Criteria to pass test	89
7.6	Short-time withstand current and peak withstand current tests	90
7.6.1	General	90
7.6.2	Arrangement of the equipment and of the test circuit	90
7.6.3	Test current and duration.....	90
7.6.4	Conditions of the test object after test.....	91
7.7	Verification of the protection	91
7.7.1	Verification of the IP coding.....	91
7.7.2	Verification of the IK coding.....	91
7.8	Tightness tests	91
7.9	Electromagnetic compatibility tests (EMC)	91
7.10	Additional tests on auxiliary and control circuits	91
7.10.1	General	91
7.10.2	Functional tests	91
7.10.3	Verification of the operational characteristics of auxiliary contacts	91

7.10.4	Environmental tests	91
7.10.5	Dielectric tests	92
7.11	X-radiation test for vacuum interrupters	92
7.101	Mechanical and environmental tests	92
7.102	Miscellaneous provisions for making and breaking tests	102
7.103	System-source short-circuit making and breaking tests	135
7.104	Load current breaking tests.....	142
7.105	Generator-source short-circuit current making and breaking tests	143
7.106	Out-of-phase making and breaking tests	158
7.107	Generator circuit-breakers with alternative operating mechanisms	163
8	Routine tests	164
8.1	General.....	164
8.2	Dielectric test on the main circuit	164
8.3	Tests on auxiliary and control circuits	165
8.3.1	Inspection of auxiliary and control circuits, and verification of conformity to the circuit diagrams and wiring diagrams	165
8.3.2	Functional tests	165
8.3.3	Verification of protection against electrical shock.....	165
8.3.4	Dielectric tests.....	165
8.4	Measurement of the resistance of the main circuit.....	166
8.5	Tightness test	166
8.5.1	General	166
8.5.2	Controlled pressure systems for gas.....	166
8.5.3	Closed pressure systems for gas	166
8.5.4	Sealed pressure systems.....	166
8.5.5	Liquid tightness tests	166
8.6	Design and visual checks.....	167
8.101	Mechanical operating tests of generator circuit-breakers.....	167
8.102	Dielectric tests on the enclosure of generator circuit-breaker systems	168
9	Guide to the selection of switchgear and controlgear	168
9.101	General.....	168
9.102	General application conditions	169
9.103	Application consideration	171
10	Information to be given with enquiries, tenders and orders (informative).....	202
10.1	General.....	202
10.2	Information with enquiries and orders	202
10.3	Information with tenders.....	203
11	Transport, storage, installation, operating instructions and maintenance	205
11.1	General.....	205
11.2	Conditions during transport, storage and installation	205
11.3	Installation	205
11.3.1	General	205
11.3.2	Unpacking and lifting	205
11.3.3	Assembly.....	206
11.3.4	Mounting	206
11.3.5	Connections	206
11.3.6	Information about gas and gas mixtures for controlled and closed pressure systems	206
11.3.7	Final installation inspection.....	206

11.3.8	Basic input data by the user	207
11.3.9	Basic input data by the manufacturer	207
11.4	Operating instructions	211
11.5	Maintenance	211
11.5.1	General	211
11.5.2	Information about fluids and gas to be included in maintenance manual	211
11.5.3	Recommendations for the manufacturer	211
11.5.4	Recommendations for the user	213
11.5.5	Failure report	213
12	Safety	214
12.1	General	214
12.2	Precautions by manufacturers	215
12.3	Precautions by users	215
13	Influence of the product on the environment	216
Annex A (normative) Tolerances on test quantities during type tests		217
Annex B (normative) Records and reports of type tests specified in 7.6, 7.103, 7.104, 7.105 and 7.106		224
B.1	Information and results to be recorded	224
B.2	Information to be included in type test reports	224
B.2.1	General	224
B.2.2	Apparatus tested	224
B.2.3	Rated characteristics of generator circuit-breaker, including its operating devices and auxiliary equipment	224
B.2.4	Test conditions (for each series of tests)	225
B.2.5	Short-circuit making and breaking tests	225
B.2.6	Short-time withstand current test	226
B.2.7	No-load operation	226
B.2.8	Out-of-phase making and breaking tests	226
B.2.9	Load current breaking tests	227
B.2.10	Graphical records	227
Annex C (normative) Method for determining the reference travel band closing and the reference travel band opening of the mechanical characteristics		228
C.1	General	228
C.2	Reference travel band closing	228
C.3	Reference travel band opening	228
Annex D (informative) Example of the application of a generator circuit-breaker		230
D.1	General	230
D.2	System characteristics	230
D.3	System-source short-circuit current	232
D.3.1	AC component of the system-source short-circuit breaking current	232
D.3.2	Asymmetrical system-source short-circuit breaking current	233
D.4	Generator-source short-circuit current	235
D.4.1	AC component of the generator-source short-circuit breaking current	235
D.4.2	Asymmetrical generator-source short-circuit breaking current	236
D.5	Transient recovery voltage	239
D.6	Out-of-phase conditions	239
D.7	Continuous current application	242
D.8	Generator circuit-breaker electrical characteristics	243

Annex E (informative) Example of the application of a generator circuit-breaker with multiple generators	245
E.1 General.....	245
E.2 System-source short-circuit current with additional generator contribution	246
E.2.1 General	246
E.2.2 AC component of the system-source short-circuit breaking current	246
E.2.3 Asymmetrical system-source short-circuit breaking current.....	246
E.3 Generator-source short-circuit current.....	246
E.4 Calculation based on power plant layout	247
E.4.1 System-source short-circuit current with additional generator contribution	247
E.4.2 Generator-source short-circuit current	247
E.5 Power plant layout with additional generator circuit-breaker connected at the generator voltage terminals of the step-up transformer	247
E.5.1 General	247
E.5.2 System-source short-circuit breaking current	248
E.5.3 Multiple generator-source short-circuit breaking current.....	248
E.6 Transient recovery voltage.....	248
Annex F (informative) Effects on TRV requirements due to the capacitance added when shielded cables connect generator circuit-breakers to the step-up transformer	249
Annex G (informative) Symbols and related terminology	252
G.1 Comparison of IEEE and IEC electrical terms and symbols	252
G.2 Comparison between TRV terminology and symbols	253
Annex H (informative) Determination of the degree of asymmetry for generator-source short-circuit breaking tests.....	255
Annex I (informative) Faults in circuits with a three-winding step-up transformer.....	257
Annex J (normative) Requirements for testing and application of Tee-OFF generator circuit-breakers in power plant layouts	260
Annex K (normative) Requirements for doubly-fed induction machines (DFIMs) applications	267
K.1 General.....	267
K.2 Transient stator and rotor currents	267
K.3 Stator currents in case of a three-phase fault.....	268
K.4 DC component of the short-circuit current	268
K.5 AC component of the short-circuit current	268
K.6 Influence of rotor's slip.....	269
K.7 Influence of the crowbar resistor	269
K.8 Influence of pre-fault loading conditions	269
K.9 Specific requirements for the application of generator circuit-breakers.....	269
Annex L (normative) Requirements for wind farm applications	271
L.1 General.....	271
L.2 Generators without power electronic converters	271
L.3 Generators with full-scale power electronic converters connected at the stator of the generator	271
L.4 Generators with partial-scale power electronic converters connected at the rotor of the generator	272
L.5 Breaking tests.....	272
L.5.1 General	272
L.5.2 Low frequency breaking tests	272
L.5.3 High frequency breaking tests	275

Annex M (normative) Assessment of TRV test parameters for out-of-phase current breaking in the case of generator circuit-breakers equipped with capacitors	279
Annex N (normative) Assessment of TRV test parameters for load current breaking in the case of generator circuit-breakers equipped with capacitors	281
Annex O (normative) Requirements for pumped-storage applications	283
O.1 General.....	283
O.2 Phase-reversal-disconnector.....	285
O.3 Starting switch and BTB-switch.....	285
O.4 Braking switch	285
O.5 Breaking tests.....	287
O.5.1 General	287
O.5.2 Low frequency breaking tests	287
Annex P (informative) Derivation of the humidity exponent w	288
Bibliography.....	292
Figure 1 – Example of a graphical record of a three-phase short-circuit make-break test	40
Figure 2 – Generator circuit-breaker without resistors – Opening operation	41
Figure 3 – Generator circuit-breaker without resistors – Close-open cycle	41
Figure 4 – Generator circuit-breaker with opening resistors – Opening operation.....	42
Figure 5 – Generator circuit-breaker with opening resistors – Close-open cycle.....	43
Figure 6 – Example of a three-phase asymmetrical current.....	43
Figure 7 – Examples of possible interruptions in a phase with intermediate level of asymmetry after a major loop and a corresponding time t_1	44
Figure 8 – Examples of possible interruptions in a phase with intermediate level of asymmetry after a minor loop and a corresponding time t_2	44
Figure 9 – Effect of various cooling failures and subsequent load reductions on generator circuit-breaker (system) temperature.....	54
Figure 10 – Typical asymmetrical system-source short-circuit current.....	58
Figure 11 – Degree of asymmetry as a function of time after fault initiation	59
Figure 12 – Typical asymmetrical generator-source short-circuit current with a strong decrement of the AC component.....	60
Figure 13 – Two-parameter representation of prospective TRV waveform for interrupting three-phase symmetrical faults.....	63
Figure 14 – Typical continuous current test setup for single-phase enclosed generator circuit-breaker systems (top view).....	88
Figure 15 – Test sequences for low and high temperature tests.....	102
Figure 16 – Reference travel curve measured during the three-phase breaking test (idealised curve)	107
Figure 17 – Reference travel curve measured during the three-phase breaking test (idealised curve) with the specified envelopes centred over the reference travel curve	108
Figure 18 – Reference travel curve measured during the three-phase breaking test (idealised curve) with the specified envelopes fully displaced upward from the reference travel curve	108
Figure 19 – Reference travel curve measured during the three-phase breaking test (idealised curve) with the specified envelopes fully displaced downward from the reference travel curve	109
Figure 20 – Equivalent testing set-up for unit testing of generator circuit-breakers with more than one separate interrupters	110

Figure 21 – Two valid three-phase symmetrical breaking operations	118
Figure 22 – Three-phase asymmetrical breaking operation – Minimum arcing time in a phase with intermediate level of asymmetry after a major loop ($t_{arc\ asym\ min\ 1}$).....	120
Figure 23 – Three-phase asymmetrical breaking operation – Maximum arcing time for a first-pole-to-clear at maximum asymmetry criteria after a major loop ($t_{arc\ asym\ max\ 1}$).....	121
Figure 24 – Three-phase asymmetrical breaking operation – Minimum arcing time in a phase with intermediate level of asymmetry after a minor loop ($t_{arc\ asym\ min\ 2}$).....	122
Figure 25 – Three-phase asymmetrical breaking operation – Maximum arcing time for a last-pole-to-clear at maximum asymmetry criteria after a major extended loop ($t_{arc\ asym\ max\ 2}$).....	123
Figure 26 – Single-phase asymmetrical breaking operation – Minimum arcing time in a phase with intermediate level of asymmetry after a major loop ($t_{arc\ asym\ min\ 1}$).....	127
Figure 27 – Single-phase asymmetrical breaking operation – Maximum arcing time for a first-pole-to-clear at maximum asymmetry criteria after a major loop ($t_{arc\ asym\ max\ 1}$).....	128
Figure 28 – Single-phase asymmetrical breaking operation – Minimum arcing time in a phase with intermediate level of asymmetry after a minor loop ($t_{arc\ asym\ min\ 2}$).....	130
Figure 29 – Single-phase asymmetrical breaking operation – Maximum arcing time for a last-pole-to-clear at maximum asymmetry criteria after a major extended loop ($t_{arc\ asym\ max\ 2}$).....	130
Figure 30 – Earthing of test circuits for three-phase short-circuit tests, first-pole-to-clear factor 1,5.....	136
Figure 31 – Earthing of test circuits for single-phase short-circuit tests, first-pole-to-clear factor 1,5.....	136
Figure 32 – Example of a valid prospective test current for test-duty 5.....	147
Figure 33 – Example of a valid test for test-duty 5	148
Figure 34 – Example of a valid test with a subsequent minor loop for test-duty 5	148
Figure 35 – Example of an invalid test for test-duty 5.....	149
Figure 36 – Example of an invalid test with a subsequent minor loop for test-duty 5	149
Figure 37 – Second example of a valid test for test-duty 5	150
Figure 38 – Second example of a valid test with a subsequent minor loop for test-duty 5	150
Figure 39 – Example of a valid prospective test current for test-duties 6A and 6B.....	151
Figure 40 – Example of a valid test for test-duties 6A and 6B	152
Figure 41 – Example of a valid test for test-duties 6A and 6B	153
Figure 42 – Example of a valid test with a subsequent minor loop for test-duties 6A and 6B	153
Figure 43 – Example of an invalid test for test-duties 6A and 6B.....	154
Figure 44 – Example of an invalid test with a subsequent minor loop for test-duties 6A and 6B.....	154
Figure 45 – Example of a valid test for test-duties 6A and 6B after adapting the contact separation compared to Figure 43 or Figure 44	155
Figure 46 – Test circuit for single-phase out-of-phase tests	161
Figure 47 – Test circuit for out-of-phase tests using two voltages separated by 120 electrical degrees	161
Figure 48 – Test circuit for out-of-phase tests with one terminal of the generator circuit-breaker earthed (subject to agreement of the manufacturer)	161

Figure 49 – General circuit diagram of a power plant	173
Figure 50 – Generator-source short-circuit current	176
Figure 51 – Generator-source short-circuit current in the case of generator delivering power with lagging or leading power factor prior to fault initiation	177
Figure 52 – Short-circuit current for generator-source fault	178
Figure 53 – Short-circuit current with circuit-breaker arc voltage after contact separation	180
Figure 54 – Single-line diagram of a power plant with two generators connected to the high-voltage system by means of a three-winding step-up transformer	189
Figure 55 – Single-line diagram of unit generator system	191
Figure 56 – Single-line diagram of half-sized transformer unit system	191
Figure 57 – Single-line diagram of system with half-sized generators	192
Figure 58 – Single-line diagram of power system	196
Figure 59 – Equivalent circuit of power system	196
Figure 60 – Voltage diagram for lagging power factor load	197
Figure 61 – Voltage diagram for unity power factor load	197
Figure 62 – Recovery voltage across the generator circuit-breaker	197
Figure 63 – TRV curve for the first-pole-to-clear	198
Figure C.1 – Reference travel band closing	229
Figure C.2 – Reference travel band opening	229
Figure D.1 – Single-line power plant diagram	230
Figure D.2 – Asymmetrical generator-source short-circuit current with no arc at the fault location	238
Figure D.3 – Asymmetrical generator-source short-circuit current with arc at the fault location	238
Figure D.4 – Schematic diagram of power plant (single-line diagram as in Figure 55)	240
Figure D.5 – Prospective fault current considering the moment of inertia of the synchronous machine and resulting from synchronising under out-of-phase conditions	241
Figure D.6 – Generator circuit-breaker temperature and load current with loss of coolant	243
Figure E.1 – Single-line power plant diagram with two generators	245
Figure E.2 – Single-line power plant diagram with two generators and three GCBs	247
Figure F.1 – TRV rate-of-rise for system-source faults: transformers rated from 65,5 MVA to 100 MVA	250
Figure F.2 – TRV peak (u_C) multipliers for system-source faults: transformers rated from 65,5 MVA to 100 MVA	250
Figure F.3 – TRV rate-of-rise for system-source faults: transformers rated from 10 MVA to 50 MVA	251
Figure F.4 – TRV peak (u_C) multipliers for system-source faults: transformers rated from 10 MVA to 50 MVA	251
Figure G.1 – Two-parameter TRV envelope representation of 1-cosine TRV when interrupting three-phase symmetrical fault currents	254
Figure H.1 – Prospective generator-source short-circuit current (fault initiation at voltage zero)	256
Figure I.1 – Single-line diagram of a power plant with two generators connected to the high-voltage system by means of a three-winding step-up transformer	257
Figure I.2 – Prospective fault current to be interrupted by Generator circuit-breaker #1	258

Figure I.3 – Prospective fault current to be interrupted by Generator circuit-breaker #2	259
Figure J.1 – Single-line diagram of a power plant with Tee-OFF generator circuit-breaker and generator circuit-breaker.....	260
Figure J.2 – Power plant electrical layout with Tee-OFF generator circuit-breaker – fault locations considered for setting the requirements for the application of the Tee-OFF generator circuit-breaker.....	261
Figure K.1 – Equivalent circuit of a DFIM.....	267
Figure K.2 – Example of influence of crowbar resistor on generator-source short-circuit current.....	270
Figure O.1 – Pumped-storage power plant – Typical single line diagram	284
Figure O.2 – Braking switch single line diagram.....	286
Figure P.1 – Humidity exponent w	289
Figure P.2 – Humidity correction factor k_2 (example 1)	290
Figure P.3 – Humidity correction factor k_2 (example 2)	291
Table 1 – Rated insulation levels for generator circuit-breakers and generator circuit-breaker systems	52
Table 2 – Preferred values of supply voltages and their ranges for auxiliary and control circuits of generator circuit-breakers and generator circuit-breaker systems	56
Table 3 – TRV parameters for system-source short-circuit tests.....	64
Table 4 – TRV parameters for generator-source short-circuit tests.....	64
Table 5 – TRV parameters for load current tests	64
Table 6 – TRV parameters for out-of-phase tests	65
Table 7 – Nameplate information for generator circuit-breakers	69
Table 8 – General nameplate information for generator circuit-breaker systems.....	71
Table 9 – Nameplate information for generator circuit-breakers, being part of a generator circuit-breaker system.....	72
Table 10 – Nameplate information for main-disconnector, switches and short-circuiting connections, being part of a generator circuit-breaker system.....	74
Table 11 – Type tests	81
Table 12 – Conditions during continuous current test.....	89
Table 13 – Number of operating sequences	96
Table 14 – Operations to be performed before and after the test programme	97
Table 15 – Test parameters for 50 Hz asymmetrical system-source fault test-duties for the first-pole-to-clear	131
Table 16 – Test parameters for 60 Hz asymmetrical system-source fault test-duties for the first-pole-to-clear	132
Table 17 – Test parameters for 50 Hz asymmetrical system-source fault test-duties for the last-pole-to-clear.....	133
Table 18 – Test parameters for 60 Hz asymmetrical system-source fault test-duties for the last-pole-to-clear.....	134
Table 19 – Test parameters for commutation tests at 50 Hz and 60 Hz.....	140
Table 20 – Test-duties to demonstrate the system-source short-circuit making and breaking current capability for three-phase tests.....	141
Table 21 – Test-duties to demonstrate the system-source short-circuit making and breaking current capability for single-phase tests.....	142

Table 22 – Test-duties to demonstrate the generator-source short-circuit making and breaking current capability for three-phase tests	156
Table 23 – Test-duties to demonstrate the generator-source short-circuit making and breaking current capability for single-phase tests.....	157
Table 24 – Test-duties to demonstrate the out-of-phase current making and breaking capability for three-phase tests	159
Table 25 – Test-duties to demonstrate the out-of-phase current making and breaking capability for single-phase tests	160
Table A.1 – Tolerances on test quantities for type tests	218
Table D.1 – System characteristics	231
Table G.1 – Comparison of IEEE and IEC electrical terms and symbols.....	252
Table G.2 – Comparison between the TRV terminology and symbols used in this document and those used in older IEEE/ANSI standards	254
Table I.1 – Comparison between prospective system-source short-circuit currents to be interrupted by Generator circuit-breaker #1 in the case of a three-phase earthed fault occurring at location F in Figure I.1	258
Table J.1 – TRV parameters related to the breaking of the Tee-OFF generator circuit-breaker short-circuit current	263
Table J.2 – Nameplate information for Tee-OFF generator circuit-breakers.....	265
Table L.1 – TRV parameters for low frequency generator-source faults	273
Table L.2 – Test-duties to demonstrate the low frequency breaking capability for three-phase tests.....	274
Table L.3 – Test-duties to demonstrate the low frequency breaking capability for single-phase tests	275
Table L.4 – TRV parameters for high frequency generator-source faults.....	276
Table L.5 – Test-duties to demonstrate the high frequency breaking capability for three-phase tests.....	277
Table L.6 – Test-duties to demonstrate the high frequency breaking capability for single-phase tests	278
Table M.1 – Reference values for MVA classes	280

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 37-013: Alternating current generator circuit-breakers

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation.
IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. *IEEE documents are made available for use subject to important notices and legal disclaimers (see <https://standards.ieee.org/IPR/disclaimers.html> for more information).*
IEC collaborates closely with IEEE in accordance with conditions determined by agreement between the two organizations. This Dual Logo International Standard was jointly developed by the IEC and IEEE under the terms of that agreement.
- 2) The formal decisions of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE standards document is given by the IEEE Standards Association (IEEE-SA) Standards Board.
- 3) IEC/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/IEEE Publications is accurate, IEC or IEEE cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications (including IEC/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC and IEEE are not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or IEEE or their directors, employees, servants or agents including individual experts and members of technical committees and IEC National Committees, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board, for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC/IEEE Publication or any other IEC or IEEE Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that implementation of this IEC/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

IEC/IEEE 62271-37-013 was prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear, in cooperation with the Switchgear Committee of the IEEE Power and Energy Society¹, under the IEC/IEEE Dual Logo Agreement between IEC and IEEE. It is an International Standard.

This document is published as an IEC/IEEE Dual Logo standard.

The IEEE Std C37.013™-1997 (R2008) was revised and converted into the first edition of the IEC/IEEE Dual Logo International Standard IEC/IEEE 62271-37-013 published in 2015.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

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

- a) content has been added to address the requirements of the other components of the generator circuit breaker system;
- b) requirements for the application of generator circuit-breakers in power plants with multiple generators connected to one step-up transformer have been added;
- c) requirements for testing and application of Tee-OFF generator circuit-breakers have been added;
- d) requirements for application of generator circuit-breakers in power plants with doubly-fed induction machines, pumped-storage power plants, and wind farms have been added;
- e) the clause numbering has been aligned with the numbering in IEC 62271-1:2017;
- f) the topic of reference mechanical characteristics has been revised to improve clarity;
- g) the modifying effects of capacitors on the prospective TRVs for out-of-phase and load current switching has been addressed in Annex M and in Annex N with use of the tool named "GenCB TRV calculator". This tool provides the values of K_{E2} , $RRRV_0$, K_{RRRV-U} , K_{RRRV-I} , t_{d0} , K_{td-U} , K_{td-I} , as well as the values of the parameters of the prospective TRV modified by the capacitors of the generator circuit-breaker.

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

FDIS	Report on voting
17A/1318/FDIS	17A/1327/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 the rules given in the ISO/IEC Directives, Part 2, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

¹ A list of IEEE participants can be found at the following address:
http://standards.ieee.org/downloads/62271/62271-37-013-2015/62271-37-013-2015_wg-participants.pdf.

This document is to be read in conjunction with IEC 62271-1, to which it refers and which is applicable unless otherwise specified. 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 numbering, while additional subclauses are numbered from 101.

This document contains attached files in the form of Excel spreadsheets ("GenCB TRV calculator"). These files are intended to be used as a complement and do not form an integral part of the document.

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

The IEC Technical Committee and IEEE Technical Committee have 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,
- replaced by a revised edition, or
- amended.

<p>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.</p>
--

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 37-013: Alternating current generator circuit-breakers

1 Scope

This part of IEC 62271 is applicable to three-phase AC high-voltage generator circuit-breakers, hereafter called generator circuit-breakers, designed for indoor or outdoor installation and for operation at frequencies of 50 Hz and 60 Hz on systems having voltages above 1 kV and up to 38 kV.

It is applicable to generator circuit-breakers that are installed between the generator and the transformer terminals. Requirements relative to generator circuit-breakers intended for use with generators and transformers rated 10 MVA or more are covered specifically. Generator circuits rated less than 10 MVA and pumped-storage installations are considered special applications, and their requirements are not completely covered by this document.

This document is also applicable to the operating mechanisms of generator circuit-breakers and to their auxiliary equipment.

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.

If not otherwise specified throughout this document, the relevant IEC or IEEE standards for the particular components or functions of a generator circuit-breaker system apply.

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

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

IEC 60071-1:2019, *Insulation co-ordination – Part 1: Definition, principles and rules*

IEC 60071-2:2018, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60296, *Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment*

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

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

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

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

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

IEC IEEE 62271-37-082, *High-voltage switchgear and controlgear – Part 37-082: Standard practice for the measurement of sound pressure levels on alternating current circuit-breakers*

IEC 62271-100:2021, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*

IEC 62271-101:2021, *High-voltage switchgear and controlgear – Part 101: Synthetic testing*

IEC 62271-102:2018, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC TR 62271-306, *High-voltage switchgear and controlgear – Part 306: Guide to IEC 62271-100, IEC 62271-1 and other IEC standards related to alternating current circuit-breakers*

IEEE Std C37.011TM, *IEEE Guide for the Application of Transient Recovery Voltage for AC High-Voltage Circuit Breakers with Rated Maximum Voltage above 1000 V²*

IEEE Std C37.59TM, *IEEE Standard Requirements for Conversion of Power Switchgear Equipment*

² The IEEE standards or products referred to in this clause are trademarks of the Institute of Electrical and Electronics Engineers, Inc.