



Technical Specification 41-36

Issue 3 2012

SWITCHGEAR FOR SERVICE UP TO 36kV  
(CABLE AND OVERHEAD CONDUCTOR  
CONNECTED)

**© 2012 *Energy Networks Association***

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of Energy Networks Association. Specific enquiries concerning this document should be addressed to:

**Operations Directorate  
Energy Networks Association  
6<sup>th</sup> Floor, Dean Bradley House  
52 Horseferry Rd  
London  
SW1P 2AF**

This document has been prepared for use by members of the Energy Networks Association to take account of the conditions which apply to them. Advice should be taken from an appropriately qualified engineer on the suitability of this document for any other purpose.

## CONTENTS

FOREWORD .....	14
SCOPE .....	14
NORMATIVE REFERENCES .....	15
<b>1 COMMON CLAUSES .....</b>	<b>18</b>
1.1 General .....	18
1.1.101 Quality management.....	18
1.2 Normal and special service conditions.....	18
1.2.1 Normal service conditions.....	18
1.2.1.1 Indoor switchgear and controlgear .....	18
1.2.1.2 Outdoor switchgear and controlgear .....	19
1.3 Terms and definitions .....	19
1.3.201 Dependent manual operation (of a mechanical switching device) IEV 441-16-13 .....	19
1.3.202 Independent manual operation (of a mechanical switching device) IEV 441-16-16.....	19
1.3.203 Independent power operation (of a mechanical switching device).....	19
1.3.204 Anti-pumping device .....	19
1.3.205 Operations .....	19
1.3.205.1 Normal operation .....	19
1.3.205.2 Emergency operation.....	20
1.3.206 Additional definitions for UK network.....	20
1.3.206.1 Primary substation .....	20
1.3.206.2 Secondary substation .....	20
1.3.206.3 Primary switchgear .....	20
1.3.206.4 Secondary switchgear.....	20
1.4 Ratings .....	20
1.4.1 Rated voltage (Ur) .....	20
1.4.2 Rated insulation level.....	20
1.4.2.1 General.....	20
1.4.3 Rated frequency (fr).....	21
1.4.4 Rated normal current and temperature rise.....	21
1.4.4.1 Rated normal current (Ir).....	21
1.4.5 Rated short-time withstand current (Ik) .....	21
1.4.6 Rated peak withstand current (Ip) .....	23
1.4.7 Rated duration of short circuit (tk) .....	23
1.4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (Ua) .....	23
1.4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits .....	24
1.4.10 Rated pressure of compressed gas supply for controlled pressure systems .....	24
1.4.11 Rated filling levels for insulation and/or operation .....	24
1.4.104 Rated values of the bus transfer current switching capability of disconnectors .....	25
1.5 Design and construction .....	26
1.5.0 Design requirements.....	26
1.5.0.1 General.....	26
1.5.0.2 Functions .....	26
1.5.0.2.1 General.....	26
1.5.0.2.2 Single function switching devices (Group A) .....	26
1.5.0.2.3 Dual function switching devices (Group B).....	27

1.5.0.2.4	Combined switching devices (Group C) .....	27
1.5.0.2.5	Auxiliary devices (Group E).....	28
1.5.0.3	Design arrangements for equipment .....	28
1.5.0.3.1	Open terminal equipment - conductor connected.....	28
1.5.0.3.2	Ground mounted equipment - cable connected.....	29
1.5.0.3.2.1	Equipment incorporating fixed switching devices (Groups F & G) .....	29
1.5.0.3.2.2	Equipment incorporating withdrawable switching devices (circuit breakers) .....	33
1.5.0.3.2.3	Gas insulated equipment .....	34
1.5.0.4	Requirements for devices .....	34
1.5.0.4.1	General.....	34
1.5.0.4.2	Facilities for disconnecting the circuit.....	35
1.5.0.4.3	Facilities for earthing circuits and busbars .....	35
1.5.0.4.3.1	Facilities for earthing circuits.....	35
1.5.0.4.3.2	Facilities for earthing busbars .....	37
1.5.0.4.4	Facilities for testing primary circuits and busbars .....	38
1.5.0.4.5	Facilities for checking and testing .....	39
1.5.0.4.5.1	Testing via primary circuits.....	39
1.5.0.4.5.1.1	For fixed equipment .....	39
1.5.0.4.5.1.2	For withdrawable equipment.....	39
1.5.0.4.5.2	Testing via secondary circuits.....	39
1.5.0.4.6	Fault location, voltage withstand and protection testing .....	40
1.5.0.4.7	Facilities for checking voltage and phase identification .....	40
1.5.0.4.8	Facilities for measuring voltage.....	41
1.5.0.5	Operation of equipment - human factors (ergonomics) .....	41
1.5.0.5.1	Height for operation and inspection.....	41
1.5.0.5.2	Force for operation .....	41
1.5.0.5.3	Direction of movement .....	41
1.5.0.5.4	Location of operation .....	41
1.5.1	Requirements for liquids in switchgear and controlgear .....	41
1.5.2	Requirements for gases in switchgear and controlgear.....	42
1.5.3	Earthing of switchgear and controlgear .....	42
1.5.3.101	Frame-earth busbar protection.....	43
1.5.4	Auxiliary and control equipment.....	43
1.5.4.1.3	Degrees of protection.....	43
1.5.4.4.4	Identification .....	44
1.5.4.4.5.1	Cables and wiring .....	44
1.5.4.4.5.2	Terminals and terminations.....	44
1.5.5	Dependent power operation.....	44
1.5.6	Stored energy operation .....	45
1.5.7	Independent manual or power operation (independent unlatched operation) or dependent manual operation .....	46
1.5.7.1	Independent manual or power operation (independent unlatched operation) .....	46
1.5.7.2	Dependent manual operation.....	47
1.5.8	Operation of releases.....	47
1.5.9	Low and high-pressure interlocking and monitoring devices .....	47
1.5.10	Nameplates and labelling.....	48
1.5.10.1	Nameplates .....	48
1.5.10.101	Labelling .....	48
1.5.10.101.1	General.....	48
1.5.10.101.2	Phase identification.....	52
1.5.10.101.3	Circuit labels .....	52
1.5.11	Interlocking devices and padlocking facilities .....	54
1.5.11.101	Interlocking devices .....	54

1.5.11.101.1	General.....	54
1.5.11.101.2	3-position device.....	54
1.5.11.101.3	Test access .....	55
1.5.11.102	Padlocking facilities .....	55
1.5.11.102.1	Safety padlocking .....	56
1.5.11.102.2	Operational padlocking .....	57
1.5.12	Position indication.....	57
1.5.13	Degrees of protection by enclosures.....	58
1.5.13.1	Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects (IP coding) .....	58
1.5.13.2	Protection against ingress of water (IP coding) .....	58
1.5.13.3	Protection of equipment against mechanical impact under normal service conditions (IK coding) .....	59
1.5.14	Creepage distances for outdoor insulators and environmental considerations.....	59
1.5.15	Gas and vacuum tightness .....	60
1.5.16	Liquid tightness.....	60
1.5.17	Fire hazard (flammability) .....	60
1.5.18	Electromagnetic compatibility (EMC) .....	60
1.5.19	X-ray emission.....	60
1.5.20	Corrosion .....	60
1.5.101	Internal arc fault.....	60
1.5.102	Enclosure.....	62
1.5.102.1	General.....	62
1.5.102.2	Covers and doors .....	62
1.5.102.101	Surface preparation and coatings .....	63
1.5.102.102	Foundation arrangements.....	63
1.5.102.103	Transformer mounting arrangement.....	63
1.5.102.104	Heater.....	64
1.5.103	High-Voltage compartments.....	64
1.5.103.1	General.....	64
1.5.103.1.101	Cable compartments.....	65
1.5.103.2	Fluid filled compartments (gas or liquid).....	66
1.5.103.2.1	General.....	67
1.5.103.2.2	Design .....	67
1.5.103.2.3	Tightness .....	67
1.5.103.2.4	Pressure relief of fluid-filled compartments .....	67
1.5.103.3	Partitions and shutters .....	67
1.5.103.3.1	General.....	67
1.5.105	Provisions for dielectric tests on cables.....	68
1.5.201	Test access covers including shutters.....	68
1.5.202	Test devices .....	69
1.5.203	Busbars and busbar connections.....	69
1.5.204	Clearances for overhead conductor connected equipment .....	70
1.6	Type tests .....	70
1.6.1	General.....	70
1.6.2	Cable connected equipment .....	71
1.6.3	Test facilities.....	72
1.6.201	Solar radiation.....	72
1.6.202	Mechanical operation.....	72
1.6.203	Ageing of composite bushings and insulation .....	73
1.7	Routine tests .....	73
1.8	Guide to the selection of switchgear and controlgear.....	73

1.9	Information to be given with enquiries, tenders and orders .....	73
1.10	Transport, storage, installation, operation, maintenance and disposal .....	73
1.11	Safety .....	74
1.12	Influence of the product on the environment .....	74
2	ADDITIONAL CLAUSES FOR METAL-ENCLOSED CIRCUIT-BREAKERS .....	79
2.1	General .....	79
2.2	Normal service and special service conditions.....	79
2.3	Terms and definitions .....	79
2.4	Ratings .....	79
2.4.101	Rated short-circuit breaking current ( $I_{sc}$ ).....	79
2.4.102	Transient recovery voltage related to the rated short-circuit breaking current .....	80
2.4.103	Rated short-circuit making current .....	80
2.4.104	Rated operating sequence .....	80
2.4.105	Characteristics for short-line faults .....	81
2.4.106	Rated out-of-phase making and breaking currents.....	81
2.4.107	Rated capacitive switching currents .....	81
2.4.108	Inductive load switching .....	81
2.4.109	Rated time quantities .....	82
2.4.110	Number of mechanical operations.....	82
2.4.111	Classification of circuit-breakers as a function of electrical endurance .	82
2.5	Design and construction .....	82
2.5.1	Requirements for liquids in circuit-breakers .....	83
2.5.2	Requirements for gasses in circuit-breakers .....	83
2.5.3	Earthing of circuit-breakers .....	83
2.5.4	Auxiliary equipment .....	83
2.5.5	Dependent power closing .....	84
2.5.6	Stored energy closing .....	84
2.5.7	Independent manual operation .....	84
2.5.8	Operation of releases.....	85
2.5.9	Low and high-pressure interlocking and monitoring devices .....	85
2.5.10	Nameplates and labelling.....	85
2.5.10.1	Nameplates .....	85
2.5.10.101	Labelling .....	86
2.5.10.101.1	GIS motorised disconnectors .....	86
2.5.11	Interlocking devices and padlocking facilities .....	86
2.5.11.101	Interlocking devices .....	86
2.5.11.101.1	Circuit-breakers (except circuit breakers with open-terminal bushings). .....	87
2.5.11.102	Padlocking facilities .....	88
2.5.11.102.1	Safety padlocking .....	88
2.5.12	Position indication.....	88
2.5.13	Degrees of protection by enclosures .....	88
2.5.14	Creepage distances.....	88
2.5.15	Gas and vacuum tightness .....	88
2.5.16	Liquid tightness.....	88
2.5.17	Fire hazard (flammability) .....	88
2.5.18	Electromagnetic compatibility.....	89
2.5.19	X-ray emission .....	89
2.5.20	Corrosion .....	89
2.5.201	Test facilities.....	89
2.5.202	Outdoor open-terminal circuit breaker bushings (not applicable to pole-mounted auto-reclosing circuit-breakers) .....	89

2.5.203	Outdoor open-terminal circuit breaker control facilities (not applicable to pole-mounted auto-reclosing circuit-breakers) .....	89
2.5.204	Outdoor open-terminal circuit breaker mechanism cabinet (not applicable to pole-mounted auto-reclosing circuit-breakers).....	89
2.5.205	Transformer mounting arrangements (not applicable to pole-mounted auto-reclosing circuit-breakers).....	90
2.6	Type tests .....	90
2.7	Routine tests .....	91
2.8	Guide to the selection of circuit-breakers for service.....	91
2.9	Information to be given with enquiries, tenders and orders .....	91
2.10	Rules for transport, storage, installation, operation and maintenance .....	91
2.11	Safety .....	91
2.12	Influence of the product on the environment .....	91
3	ADDITIONAL CLAUSES FOR METAL-ENCLOSED SWITCHES .....	96
3.1.	General .....	96
3.2	Normal service and special service conditions.....	96
3.3	Terms and definitions .....	96
3.4	Ratings .....	96
3.4.101	Rated mainly active load-breaking current ( $I_{load}$ ) .....	96
3.4.102	Rated closed-loop breaking current ( $I_{loop}$ ).....	96
3.4.104	Rated cable-charging breaking current ( $I_{cc}$ ).....	97
3.4.105	Rated line-charging breaking current ( $I_{lc}$ ) .....	97
3.4.111	Rated short-circuit making current ( $I_{ma}$ ).....	97
3.4.116	Type and classes for a general purpose switch.....	97
3.4.201	Rated mechanical endurance of switches .....	97
3.5	Design and construction .....	97
3.5.1	Requirements for liquids in switchgear and controlgear .....	98
3.5.2	Requirements for gases in switchgear and controlgear .....	98
3.5.3	Earthing of switchgear and controlgear .....	98
3.5.4	Auxiliary and control equipment .....	98
3.5.5	Dependent power operation.....	98
3.5.6	Stored energy operation .....	98
3.5.7	Independent manual or power operation (independent unlatched operation) .....	98
3.5.8	Operation of releases.....	98
3.5.9	Low- and high-pressure interlocking and monitoring devices .....	98
3.5.10	Nameplates and labelling.....	98
3.5.11	Interlocking devices and padlocking facilities .....	99
3.5.12	Position indication.....	99
3.5.13	Degrees of protection provided by enclosures .....	99
3.5.14	Creepage distances for outdoor insulators.....	99
3.5.15	Gas and vacuum tightness .....	100
3.5.16	Liquid tightness.....	100
3.5.17	Fire hazard (flammability) .....	100
3.5.18	Electromagnetic compatibility (EMC) .....	100
3.5.19	X-ray emission .....	100
3.5.20	Corrosion .....	100
3.5.201	Test facilities.....	100
3.5.202	Transformer mounting arrangements.....	100
3.6	Type tests .....	100
3.7	Routine tests .....	101
3.8	Guide to the selection of switchgear and controlgear.....	101
3.9	Information to be given with enquiries, tenders and orders .....	101
3.10	Transport, storage, installation, operation and maintenance .....	101

3.11	Safety .....	101
3.12	Influence of the product on the environment .....	102
4	ADDITIONAL CLAUSES FOR METAL-ENCLOSED SWITCH-FUSE COMBINATIONS	107
4.1	General .....	107
4.2	Normal service and special service conditions.....	107
4.3	Definitions .....	107
4.4	Ratings .....	107
4.4.101	Rated short-circuit breaking current .....	107
4.4.102	Rated transient recovery voltage .....	107
4.4.103	Rated short-circuit making current .....	107
4.4.104	Rated transfer current (striker operation) .....	107
4.4.105	Rated take-over current for release-operated combinations.....	108
4.5	Design and construction .....	108
4.5.1	Requirements for liquids in switch-fuse combinations .....	108
4.5.2	Requirements for gasses in switch-fuse combinations .....	108
4.5.3	Earthing of switch-fuse combinations.....	108
4.5.4	Auxiliary and control equipment .....	108
4.5.5	Dependent power closing .....	108
4.5.6	Stored energy closing .....	108
4.5.7	Independent manual operation .....	108
4.5.8	Operation of releases.....	109
4.5.9	Low and high-pressure interlocking and monitoring devices .....	109
4.5.10	Nameplates and labelling.....	109
4.5.11	Interlocking devices and padlocking facilities .....	109
4.5.12	Position indication.....	110
4.5.13	Degrees of protection by enclosures.....	110
4.5.14	Creepage distances.....	110
4.5.15	Gas and vacuum tightness .....	110
4.5.16	Liquid tightness.....	111
4.5.17	Flammability .....	111
4.5.18	Electromagnetic compatibility.....	111
4.5.20	Corrosion .....	111
4.5.201	Test facilities .....	111
4.5.202	Transformer mounting arrangements.....	111
4.5.203	Fuse-link arrangement.....	111
4.6	Type tests .....	111
4.7	Routine tests .....	112
4.8	Guide for the selection of switch-fuse combinations for transformer protection	112
4.8.1	HV fuse-links .....	112
4.8.2	Rated normal current .....	113
4.9	Information to be given with enquiries, tenders and orders .....	113
4.10	Rules for transport, storage, erection, operation and maintenance .....	113
4.11	Safety .....	113
4.12	Influence of the product on the environment .....	113
5	ADDITIONAL CLAUSES FOR METAL ENCLOSED RING MAIN EQUIPMENT .....	119
5.1	General .....	119
5.2	Normal service and special service conditions.....	119
5.3	Definitions .....	119
5.3.1	Ring main equipment with switch-fuse tee-off.....	119
5.3.2	Ring main equipment with circuit-breaker tee-off .....	119
5.4	Ratings .....	119
5.4.1	Rated operating sequence.....	119



5.5	Design and construction .....	119
5.6	Type tests .....	120
5.7	Routine tests .....	120
5.8	Guide to the selection of ring main equipment .....	120
5.9	Information to be given with enquiries, tenders and orders .....	120
5.10	Rules for transport, storage, erection, operation and maintenance .....	120
5.11	Safety .....	121
5.12	Influence of the product on the environment .....	121
<b>6</b>	<b>ADDITIONAL CLAUSES FOR OVERHEAD CONDUCTOR CONNECTED AIR-BREAK SWITCH-DISCONNECTORS, DISCONNECTORS AND EARTHING SWITCHES .....</b>	<b>128</b>
6.1	General .....	128
6.2	Normal service and special service conditions.....	128
6.3	Definitions .....	128
6.3.1	Switch-disconnector (IEV 441-14-12).....	128
6.3.2	Switch-disconnector (Category A).....	128
6.3.3	Switch-disconnector (Category B).....	129
6.4	Ratings .....	129
6.4.101	Rated mainly active load-breaking current ( $I_{load}$ ) .....	129
6.4.102	Rated closed-loop breaking current ( $I_{loop}$ ).....	129
6.4.104	Rated cable-charging breaking current ( $I_{cc}$ ).....	129
6.4.105	Rated line-charging breaking current ( $I_{lc}$ ) .....	129
6.4.106	Rated values of mechanical endurance for disconnectors .....	130
6.4.112	Rated short-circuit making current ( $I_{ma}$ ).....	130
6.4.113	Rated breaking and making currents for a general purpose switch ...	130
6.5	Design and construction .....	130
6.5.1	Requirements for liquids in disconnectors and earthing switches.....	130
6.5.2	Requirements for gasses in disconnectors and earthing switches.....	130
6.5.3	Earthing of disconnectors and earthing switches .....	130
6.5.4	Auxiliary and control equipment .....	131
6.5.5	Dependent power operation and dependent manual operation .....	131
6.5.5.1	General.....	131
6.5.5.1.1	Manual low level actuation .....	131
6.5.5.1.2	Manual high level actuation.....	132
6.5.6	Stored energy operation .....	132
6.5.7	Independent manual operation .....	132
6.5.8	Operation of releases.....	133
6.5.9	Low and high-pressure interlocking and monitoring devices .....	133
6.5.10	Nameplates and labelling.....	133
6.5.11	Interlocking devices and padlocking facilities .....	133
6.5.12	Position indication.....	133
6.5.13	Degrees of protection by enclosures .....	134
6.5.14	Creepage distances.....	134
6.5.15	Gas and vacuum tightness .....	134
6.5.16	Liquid tightness.....	134
6.5.17	Flammability .....	134
6.5.18	Electromagnetic compatibility.....	134
6.5.201	Flexible leads and connections .....	134
6.5.202	Surface preparation and coatings .....	134
6.5.203	Mounting arrangements .....	135
6.5.204	Support insulators.....	135
6.5.205	Contacts .....	135
6.6	Type tests .....	135
6.7	Routine tests .....	136

6.8	Guide to the selection of disconnectors, switch-disconnectors and earthing switches .....	136
6.9	Information to be given with enquiries, tenders and orders .....	136
6.10	Rules for transport, storage, erection, operation and maintenance .....	136
6.11	Safety .....	136
6.12	Influence of the product on the environment .....	136
<b>7</b>	<b>ADDITIONAL CLAUSES FOR POLE-MOUNTED ENCLOSED SWITCHGEAR.....</b>	<b>140</b>
7.1	General .....	140
7.1.1	Ratings .....	140
7.1.2	Mounting arrangements .....	140
7.1.3	Means of operation .....	140
7.1.3.1	Manual.....	140
7.1.3.2	Power .....	141
7.1.3.3	Operations counter .....	141
7.1.4	Auxiliary power supplies to control box .....	141
7.1.5	Auxiliary transformer .....	142
7.1.6	Telecontrol.....	142
7.1.7	Earthing .....	142
7.1.8	Terminals.....	142
7.1.9	Lightning protection .....	142
7.2	Auto-reclosing circuit-breakers .....	143
7.2.1	General.....	143
7.2.2	Control and indication .....	143
7.2.3	Number of trips to lock-out.....	144
7.2.4	Loss of source voltage .....	144
7.2.6	Type tests .....	144
7.2.7	Routine tests.....	144
7.2.8	Guide to the selection of pole-mounted auto-reclosing circuit-breakers .....	144
7.2.9	Information to be given with enquiries, tenders and orders .....	144
7.2.10	Rules for transport, storage, erection, operation and maintenance ....	144
7.2.11	Safety .....	145
7.2.12	Influence of the product on the environment .....	145
7.3	Switches and switch-disconnectors .....	149
7.3.1	General.....	149
7.3.2	Control and indication .....	149
7.3.6	Type tests .....	149
7.2.7	Routine tests.....	149
7.3.8	Guide to the selection of pole-mounted enclosed switches and switch-disconnectors.....	150
7.3.9	Information to be given with enquiries, tenders and orders .....	150
7.3.10	Rules for transport, storage, erection, operation and maintenance ....	150
7.3.11	Safety .....	150
7.3.12	Influence of the product on the environment .....	150
7.4	Sectionalisers .....	155
7.4.1	General.....	155
7.4.2	Operation.....	155
<b>8</b>	<b>ADDITIONAL CLAUSES FOR OVERHEAD CONDUCTOR CONNECTED EXPULSION FUSES, SOLID LINKS AND AUTOMATIC SECTIONALISING LINKS .....</b>	<b>156</b>
8.1.	General .....	156
8.2	Normal service and special service conditions.....	156
8.3	Definitions .....	156

8.3.1	Drop-out expulsion fuse .....	156
8.3.2	Solid link .....	156
8.3.3	Drop-out automatic sectionalising link .....	156
8.3.4	Minimum actuating current .....	157
8.3.5	Reclaim time .....	157
8.3.6	Hold-off current .....	157
8.3.7	Actuator .....	157
8.4	Ratings .....	157
8.4.1	Rated voltage .....	157
8.4.2	Rated insulation level .....	157
8.4.3	Rated frequency .....	157
8.4.4	Rated current/ minimum actuating current .....	157
8.4.5	Rated short-time withstand current .....	157
8.4.6	Rated peak withstand current .....	157
8.4.7	Rated duration of short-circuit .....	158
8.4.8	Breaking capacity .....	158
8.4.9	Reclaim time (of an automatic sectionalising link) .....	158
8.5	Design and construction .....	158
8.5.1	General .....	158
8.5.2	Mounting arrangement .....	159
8.5.3	Terminals .....	159
8.5.4	Drop-out automatic sectionalising links .....	159
8.5.5	Marking of voltage rating of drop-out automatic sectionalising links ...	159
8.5.6	Labelling of automatic sectionalising links .....	159
8.6	Type tests .....	160
8.6.1	General .....	160
8.6.2	Tensile test on expulsion fuse-links .....	160
8.6.3	Type test for automatic sectionalising links .....	160
8.6.3.1	Operational test for automatic sectionalising links .....	160
8.6.3.2	Short-time withstand current test .....	161
8.6.3.3	Special tests .....	161
8.6.3.4	Performance characteristics .....	161
8.7	Routine tests .....	161
8.9	Information to be given with enquiries, tenders and orders .....	161
8.10	Rules for transport, storage, erection, operation and maintenance .....	162
8.11	Safety .....	162
8.12	Influence of the product on the environment .....	162
9	ADDITIONAL CLAUSES FOR 36kV FAULT-THROWING SWITCHES .....	164
9.1	General .....	164
9.2	Normal service and special service conditions .....	164
9.3	Definitions .....	164
9.3.1	Fault-throwing switch .....	164
9.4	Ratings .....	164
9.5	Design and construction .....	164
9.5.1	Operating mechanism .....	164
9.5.2	Position indication .....	165
9.5.3	Interlocking devices .....	165
9.5.4	Supporting structure .....	165
9.5.5	Terminations, conductors and fittings .....	165
9.5.6	Cable connection .....	165
9.5.7	Release circuit monitoring .....	165
9.6	Type tests .....	166
9.7	Routine tests .....	166
9.8	Guide to the selection of fault-throwing switches for service .....	166

9.9	Information to be given with enquiries, tenders and orders .....	166
9.10	Rules for transport, storage, erection, operation and maintenance .....	166
9.11	Safety .....	166
9.12	Influence of the product on the environment .....	166
<b>10</b>	<b>ADDITIONAL CLAUSES FOR MISCELLANEOUS EQUIPMENT</b>	
	(CTs, VTs, protection, instrumentation and metering equipment ) .....	169
10.1	General .....	169
10.2	Current transformers.....	169
10.2.1	General.....	169
10.2.2	Performance characteristics.....	170
10.2.3	Type tests .....	170
10.3	Voltage transformers .....	170
10.3.1	General.....	170
10.3.2	Performance characteristics.....	170
10.3.3	Voltage transformer connections.....	170
10.3.3.1	General.....	170
10.3.3.2	‘Star point’ connection.....	171
10.3.4	Padlocking facilities .....	171
10.3.4.1	Safety padlocking .....	171
10.4	Metering equipment.....	172
10.4.1	Self contained metering unit .....	172
10.5	Instruments .....	173
10.6	Protection .....	173
10.7	Fault passage indication .....	173
10.7.1	Local fault indication .....	173
10.7.2	Remote fault indication .....	173
<b>ANNEX A</b>	<b>EXPLANATORY NOTES.....</b>	<b>174</b>
A1	Test devices .....	174
A2	Small inductive breaking current.....	174
A2.1	Circuit-breakers .....	174
Section 2:	Transformer magnetising currents .....	175
2.1	General.....	175
2.2	Transformer magnetising current for circuit-breakers with rated voltage of 100kV and above.....	175
2.3	Transformer magnetising current for circuit-breakers with rated voltage below 100kV.....	175
A2.2	Switches .....	175
A3	Air-break switch disconnectors - making and breaking duty.....	176
A4	Mimic diagrams and symbols.....	176
<b>ANNEX B</b>	<b>FUSE-SWITCH TRIP TESTING DEVICE .....</b>	<b>178</b>
B1	Scope .....	178
B2	Description .....	178
B3	Time delay .....	178
B4	Tripping pin energy .....	178
B5	Voltage withstand .....	179
B6	Labelling .....	179
B7	Storage .....	179
<b>ANNEX C</b>	<b>SYMBOLS FOR MIMIC DIAGRAMS .....</b>	<b>180</b>
C1	Position indication.....	180

C.1.1	Position indication for circuit-breaker, disconnector and earthing switch .....	180
C.1.2	Position indication for switch-disconnector / earthing switch .....	181
C.1.3	Position indication of earthing switch when integral earth star point is removed for testing purposes.....	181
C2	Graphical symbols for equipment.....	182
C.2.1	VT symbol - IEC 60617-6 symbol No. 06-13-01A.....	182
C.2.2	VT with VT HV disconnector - IEC 60617-7 symbol no. 07-13-06 .....	182
C.2.3	Primary test point.....	182
C.2.4	Capacitively coupled test point.....	182
C.3	Typical pictogram for busbar earthing.....	183
ANNEX D	STANDARD LABELS ANNEX E What has changed between Issues 2 and 3 and reasons for change .....	184
ANNEX E	What has changed between Issues 2 and 3 and reasons for change .....	185
NOTE	ANNEX D1 to D10 is no longer included with this technical specification, but may be obtained from the ENA office.	
Fig. 1.1	Group A single function devices .....	27
Fig. 1.2	Group B dual function devices .....	27
Fig. 1.3	Group C combined switching devices .....	27
Fig. 1.4	Group D 2 or 3 position switching devices .....	28
Fig. 1.5	Group E Auxiliary functions.....	28
Fig. 1.6	Group G Combination of devices .....	32
Fig. 1.7	Fixed circuit breaker examples chosen from Group G combinations of devices.	33
Fig. 1.8	Withdrawable circuit breaker examples chosen from Group G devices.....	34
Fig. 1.9	Circuit label for front and rear of equipment .....	53
Fig. 1.10	Circuit label for removable portion of equipment .....	53
Fig. 1.11	11kV Switchgear Circuit Flange and Connections for Direct Transformer Mounting .....	76
Fig. 2.1	Distribution transformer protection by time fuse links.....	84
Fig. 3.1	Typical switch and earthing switch identification and operating handle movement labels .....	102
Fig. 4.1	Typical switch-fuse combination and earthing switch designation and operating handle movement labels .....	114
Fig. 6.1	Universal Drilling in 33kV Disconnector Base .....	137
Table 1.1	Normal rated insulation levels.....	21
Table 1.2	Alternative rated insulation levels for pole-mounted equipment where preferred	21
Table 1.3	Rated normal current and rated short-time withstand current.....	22
Table 1.4	Rated short-time withstand currents required to cover majority of applications ..	24
Table 1.5	Rated supply voltage .....	24
Table 1.6	Group F Fixed switching devices .....	29
Table 1.7	a.c. and d.c. withstand voltages for test facilities.....	40
Table 1.8	Standard label requirements.....	51
Table 1.9	Degree of protection for ground mounted equipment.....	59
Table 1.10	Ring Main Units - Maximum number of single core cables per phase and maximum size of cable.....	66
Table 1.11	12 / 24 / 36kV switchgear - Maximum number of single core cables per phase and maximum size of cable .....	66
Table 1.12	Additional power frequency withstand voltage type test values.....	71
Table 2.1	Values of rated short-circuit breaking current.....	80
Table 2.2	Relationship between rated short-circuit breaking currents at 45ms & 120ms ...	81

Table 2.3	Values of rated line-charging breaking current and rated cable-charging breaking current .....	81
Table 2.4	Additional operating sequences for 16kA circuit-breakers.....	82
Table 2.5	Type tests for feeder or bus-section circuit-breaker including enclosure, disconnecter, VT, CTs and earthing switch as appropriate .....	92
Table 3.1	values of rated cable-charging breaking currents and line-charging breaking currents .....	97
Table 3.2	Type tests for switch-disconnector including enclosure and earthing switch ....	103
Table 4.1	Type tests for switch-fuse including enclosure and earthing switch.....	115
Table 5.1	Type tests for ring main equipment (RME) with switch-fuse tee-off.....	122
Table 5.2	Type tests for ring main equipment (RME) with circuit-breaker tee-off .....	124
Table 6.1	Values of rated breaking currents for air-break switch disconnectors.....	129
Table 6.2	Values of rated short-circuit making current for air-break switch disconnectors	130
Table 6.3	Type tests for overhead conductor connected air-break switch-disconnector, disconnecter or earthing switch .....	138
Table 7.1	Type tests for pole mounted auto-reclosing circuit-breakers .....	146
Table 7.2	Type tests for pole mounted enclosed switches and switch-disconnectors .....	151
Table 8.1	Rated current, rated short-time withstand current, rated peak withstand current, rated duration of short-circuit and breaking capacity.....	158
Table 8.2	Type tests for overhead conductor connected expulsion fuses, solid links and automatic sectionalising links .....	162
Table 9.1	Type tests for fault-throwing switches .....	167
Schedule 2.1	Summary declaration of technical parameters for feeder or bus-section circuit-breaker .....	94
Schedule 3.1	Summary declaration of technical parameters for switch-disconnector .....	105
Schedule 4.1	Summary declaration of technical parameters for switch-fuse combinations....	117
Schedule 5.1	Summary declaration of technical parameters for ring main equipment (RME)	126
Schedule 6.1	Summary declaration of technical parameters for overhead conductor connected air-break switch-disconnector, disconnecter or earthing switch .....	139
Schedule 7.1	Summary declaration of technical parameters for pole mounted auto-reclosing circuit-breakers.....	146
Schedule 7.2	Summary declaration of technical parameters for pole mounted enclosed switches and switch-disconnectors.....	153
Schedule 8.1	Summary declaration of technical parameters for overhead conductor connected expulsion fuses, solid links and automatic sectionalising links.....	163
Schedule 9.1	Summary declaration of technical parameters for fault-throwing switches .....	168

## **SWITCHGEAR FOR SERVICE UP TO 36kV (CABLE AND OVERHEAD CONDUCTOR CONNECTED)**

### **FOREWORD**

This technical specification has been prepared by the Energy Networks Association.

The Electricity at Work Regulations 1989 made under the Health and Safety at Work etc. Act 1974, apply to switchgear whenever manufactured, purchased or installed. Appendix 2 of the Memorandum of guidance on the Regulations lists Standards, Codes of Practice and other publications which contain guidance relevant to the Regulations and electrical safety.

This technical specification lists International and British Standards, including the aforementioned, relevant to switchgear.

Switchgear covered by this technical specification shall comply with the International and British Standards listed. This document is intended to amplify and/or clarify the requirements of those Standards, where alternative arrangements are permitted by those Standards and further information is required.

This technical specification should be read in conjunction with the relevant International and British Standards, and to assist in cross-reference, the document follows the format of the major International Standards. Where possible, the international standards' clause numbers have been used, preceded with the number of the relevant part of this technical specification.

Part 1 of the document covers all common clause requirements of switchgear, as defined. Clauses specific to particular equipments are covered in the subsequent Parts of the document.

Annex D of the document includes 'Self Certification Conformance Declaration' sheets and 'Type Test Conformance Declaration' tables to enable manufacturers to declare conformance or otherwise, clause by clause, with the relevant parts of the document.

### **SCOPE**

This technical specification defines technical requirements for switchgear rated at voltages within the range 7.2kV to 36kV, for use on 6.6kV, 11kV, 20kV and 33kV systems and supersedes Energy Networks Association technical specification, ENA TS 41-36 Issue 2.

It applies to alternating current switchgear, designed for indoor or outdoor installation, cable or overhead conductor connected, and for operation at service frequency of 50Hz on systems having voltages above 1000V as detailed above.

It covers the requirements of ground or transformer-mounted, pole or structure mounted, metal-enclosed switchgear and pole or structure mounted non-enclosed switchgear, as defined.

Equipment covered by this technical specification is for use on systems with the neutral point earthed solidly, or through a resistor or reactor.

## NORMATIVE REFERENCES

This technical specification makes reference to the following documents and it is important that users of all standards and technical specifications ensure that they are applying the most recent editions together with any amendments.

The Construction Design and Management Regulations 2007  
The Electricity Safety, Quality and Continuity Regulations 2002  
The Electricity at Work Regulations 1989  
The Health and Safety at Work etc. Act 1974,

IEC 60044-1	-	Instrument transformers – Part 1 : Current transformers
IEC 60044-2	-	Instrument transformers – Part 2 : Voltage transformers
IEC 60050-441	-	International electro technical vocabulary switchgear, controlgear and fuses
IEC 60073	-	Basic and safety principles for man-machine interface, marking and identification-Coding principles for indication devices and actuators
IEC 60376	-	Specification of technical grade sulphur hexafluoride (SF <sub>6</sub> ) for use in electrical equipment
IEC 60417	-	Graphical symbols for use on equipment
IEC 60445	-	Basic and safety principles for man-machine interface, marking and identification -_Identification of equipment terminals and of terminations certain designated conductors, including general rules for an alphanumeric system
IEC 60480	-	Guidelines for checking and treatment of sulphur hexafluoride (SF <sub>6</sub> ) taken from electrical equipment and specification for its re-use
IEC 60446	-	Basic and safety principles for man-machine interface, marking and identification -_Identification of conductors by colours or numerals
IEC 60466	-	Insulation-Enclosed Switchgear and Controlgear for Rated Voltages Above 1 kV and up to and Including 38 kV
IEC 60529	-	Degrees of protection provided by enclosures (IP code)
IEC 60617	-	Graphical symbols for diagrams
IEC 60815	-	Guide for the selection of insulators in respect of polluted conditions
IEC 61109	-	Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1000 V - Definitions, test methods and acceptance criteria
IEC 61243	-	Live working - Voltage detectors
IEC 61958	-	Voltage presence indicating systems
IEC 62262	-	Degrees of protection provided by enclosures for electrical equipment of switchgear and controlgear
IEC 62271-1	-	High-voltage switchgear and controlgear – Part 1: Common specifications
IEC 62271-100	-	High-voltage alternating current circuit-breakers
IEC 62271-103	-	High-voltage switchgear and controlgear –



		Part 103: Switches for rated voltages above 1kV and up to and including 52kV
IEC 62271-102	-	High-voltage alternating current disconnectors and earthing switches
IEC 62271-105	-	High-voltage alternating current switch-fuse combinations
IEC 62271-200	-	A.C. metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV
IEC 62271-202	-	High voltage / low voltage prefabricated substations
IEC 62271-303	-	High-voltage switchgear and controlgear – Part 303: Use and handling of sulphur hexafluoride (SF <sub>6</sub> )
ISO 9001	-	Management and quality assurance standards
ISO 12732-1	-	Ergonomics of thermal environment – Methods for assessment of human responses to contact with surfaces Part 1 Hot surfaces
BS EN 60168	-	Post insulators of ceramic material or glass for nominal voltages greater than 1000V (Associated Standards, IEC 60273)
BS 148	-	Specification for unused and reclaimed mineral insulating oil for transformers and switchgear (Associated Standards IEC 296)
BS 381C	-	Specification for colours for identification, coding and special purposes
BS 2562	-	Specification for cable boxes for transformers and reactors
BS 2692	-	Fuses for voltages exceeding 1000V ac (Associated Standard IEC 60282)
BS 2874	-	Specification for copper and copper alloy rods and sections (other than forging stock)
BS 4608	-	Specification for copper for electrical purposes (rolled strip, sheet and foil)
BS 4781	-	Specification for pressure sensitive adhesive plastic labels for permanent use
BS 5207	-	Specification for sulphur hexafluoride for electrical equipment (Associated standard IEC 60376)
BS 5499 Parts 1, 5 and 6	-	Safety Signs and Colours
BS 6121	-	Mechanical cable glands - Specification for metallic glands
BS 6553	-	Guide for selection of fuse-links of high-voltage fuses for transformer circuit applications (Associated Standard IEC 60787)
BS 6626	-	Code of practice for maintenance of electrical switchgear and controlgear for voltages above 1000V and up to and including 36kV
BS 7198	-	Hydraulic fluid power quick-action couplings (Associated Standard ISO 7241)
BS 7354	-	Design of high-voltage open-terminal substations
BS IEC 60076-7	-	Loading guide for oil-immersed transformers
ANSI/IEEE C37.60	-	American National Standard requirements for overhead, pad-mounted, dry-vault and submersible automatic circuit reclosers and fault interrupters for a.c. systems
ENA TS 12-6	-	Time Fuse-Links
ENA TS 12-8	-	The application of fuse-links to 11kV/415V and 6.6kV/415V underground distribution networks

- ENA TS 12-11 - Dry cable terminations in HV switchgear for service at rated voltages 12, 24 and 36kV
- ENA TS 35-1 - Distribution transformers (from 16kVA to 1000kVA)
- ENA TS 41-16 - Apparatus terminations, conductor sizes and associated fittings (copper) used in outdoor and indoor substations with outdoor equipment
- ENA TS 41-18 - Partial discharge testing of bushings, capacitors, instrument transformers and switchgear of rated voltage 7.2kV-420kV inclusive
- ENA TS 41-24 - Guidelines for the design, installation, testing and maintenance of main earthing systems in substations
- ENA TS 43-92 - Conductor fittings for overhead lines
- ENA TS 43-95 - Steelwork for overhead lines
- ENA TS 50-18 - Design and application of ancillary electrical equipment
- ENA TS 98-1 - Surface preparation and coating systems for new plant and equipment
- ENA TS 50-19 - Specification for standard numbering for small wiring for switchgear and transformers together with their associated relay and control panels
- ENA ER G18 - Operation of air break isolating switches
- ENA ER G79 - Guide to the assessment of power system plant & products\* for use by the Energy Networks Association member companies  
\* Part 2a covers switchgear
- ENA ER G89 - Specification of D.C. time constants for switchgear
- ENA ER S15 - Standard schematic diagrams

## **1 COMMON CLAUSES**

### **1.1 General**

International Standard IEC 62271-1 “High-voltage Switchgear and Controlgear Part 1: Common Specifications”, shall apply except where modified by the following common clauses.

The requirements for metal enclosed switchgear and controlgear are specified in International Standard IEC 62271-200 “A.C. Metal-enclosed Switchgear and Controlgear for Rated Voltages Above 1kV and up to and Including 52kV”. Where necessary, reference is made to the relevant clauses of IEC 62271-200 in this Part 1.

This Part 1 of this technical specification amplifies and/or clarifies the requirements of IEC 62271-1 and IEC 62271-200 where alternative arrangements are permitted by IEC 62271-1 and IEC 62271-200 and further information is necessary to meet UK Distribution Network Operator’s (DNOs) requirements.

Parts 2 to 10 of this technical specification in cover additional requirements specific to individual equipment, which are not included in Part 1.

NOTES: The numbering of sub-clauses generally follows that of the ruling standard for the equipment. Where this document introduces requirements not covered by the standard, the numbering starts at X.201, where X is replaced by the Part number for the specific equipment

The sub-clause numbering in later parts follows the numbering sequence in Part 1, except ‘1’ is replaced by the Part number for the specific equipment (e.g. ‘2’ for circuit breakers)

The requirements of this Part 1 of this technical specification shall also apply to withdrawable retrofit circuit breakers where indicated by an ‘R’ in the associated Self Certification Conformance Declarations (‘Retrofit’ column).

#### **1.1.101 Quality management**

Quality assurance schemes shall be in place and in accordance with ISO 9001 and shall cover all aspects of design and manufacture of the complete equipment up to the final delivery stage and shall apply to all locations at which these activities take place.

### **1.2 Normal and special service conditions**

Clause 2 of IEC 62271-1 and, for metal-enclosed switchgear, Clause 2 of IEC 62271-200 are applicable with the following limitations.

#### **1.2.1 Normal service conditions**

##### **1.2.1.1 Indoor switchgear and controlgear**

The ambient air temperature does not exceed 40°C and its average value, measured over a period of 24 hrs, does not exceed 35°C.

The minimum ambient air temperature is -5°C (class minus 5 indoor).

Manufacturers shall clearly state in the conformance declarations, any environmental conditions specified in 2.1.1 of IEC 62271-1 that the switchgear cannot tolerate without environmental control, and as such what environmental controls/ conditions are required.

### **1.2.1.2 Outdoor switchgear and controlgear**

The ambient air temperature does not exceed 40°C and its average value, measured over a period of 24 h, does not exceed 35°C.

The minimum ambient air temperature is -25°C (class minus 25 outdoor).

The ice coating does not exceed 10mm for class 10.

The pollution level of insulation shall be Class III (heavy) of IEC 60815.

Account shall be taken of the influence of solar radiation up to a level of 1000 W/m<sup>2</sup> (on a clear day at noon) and supporting evidence provided.

## **1.3 Terms and definitions**

Clause 3 of IEC 62271-1 and, for metal-enclosed switchgear, Clause 3 of IEC 62271-200 are applicable with the following additions:

### **1.3.201 Dependent manual operation (of a mechanical switching device) IEV 441-16-13**

An 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.

### **1.3.202 Independent manual operation (of a mechanical switching device) IEV 441-16-16**

A stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator.

### **1.3.203 Independent power operation (of a mechanical switching device)**

A stored energy operation where the energy originates from power other than manual, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the power source.

NOTE: This kind of operation may be by an actuator fitted to an independent manual mechanism.

### **1.3.204 Anti-pumping device**

A device which prevents reclosing after a close-open operation as long as the device initiating closing is maintained in the position for closing.

### **1.3.205 Operations**

#### **1.3.205.1 Normal operation**

When equipment is operated as intended using the manual handle (as supplied by the manufacturer), control switches, and interlock keys.

NOTE: Normal operations includes switching, cable testing, LV isolation, but excludes maintenance.