

Australian Standard™

**High voltage switchgear and controlgear
Part 102: Alternating current
disconnectors and earthing switches
(IEC 62271-102, Ed.1.0(2003) MOD)**



This Australian Standard was prepared by Committee EL-007, Power Switchgear. It was approved on behalf of the Council of Standards Australia on 20 July 2005.
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Australian British Chamber of Commerce
Australian Electrical and Electronic Manufacturers Association
Energy Networks Association
Engineers Australia
Testing interests (Australia)

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STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 62271.102—2005

High voltage switchgear and controlgear

Part 102: Alternating current disconnectors and earthing switches
(IEC 62271-102, Ed.1.0(2003) MOD)

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Technical Committee EL-007 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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NOTES

Australian Standard™

**High voltage switchgear and controlgear
Part 102: Alternating current
disconnectors and earthing switches
(IEC 62271-102, Ed.1.0(2003) MOD)**

Originated (in part) as AS 1306—1974.
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PREFACE

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear, to supersede AS 1306—1985, *High voltage a.c. switchgear and controlgear—Disconnectors (isolators) and earthing switches* and AS 4298—1995, *Gas-insulated metal-enclosed switchgear for rated voltages 72.5 kV and above—Requirements for switching of bus-charging currents by disconnectors*.

The objective of this Standard is to provide requirements for alternating current disconnectors and earthing switches, designed for indoor and outdoor enclosed and open terminal installations for voltages above 1000 V.

This Standard is an adoption with national modifications and has been reproduced from IEC 62271-102, Ed.1.0 (2003), *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*, and has been varied as indicated to take account of Australian conditions.

Variations to IEC 62271-102, Ed.1.0 (2003) are indicated at the appropriate places throughout this standard. Strikethrough (**example**) identifies IEC text, tables and figures which, for the purposes of this Australia Standard, are deleted. Where text, tables or figures are added, each is set in its proper place and identified by shading (**example**). Added figures are not themselves shaded, but are identified by a shaded border.

This Standard should be read in conjunction with AS 2650 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 AS 2650. Additional subclauses are numbered from 101.

Common numbering of standards falling under the responsibility of EL-007

In accordance with the decision taken by the committee EL-007 a common numbering system will be established in order to align the numbering of Australian Standards falling under the responsibility of EL-007 with IEC standards. All high-voltage switchgear and controlgear Standards will, at their next revision (or as equivalent Standards become available in IEC), become parts of the AS 62271 (High-voltage switchgear and controlgear) series. The table below gives the relationship between future numbering and existing Standard numbers. Standards current at the time of publication of this Standard are marked with an asterisk (*).

AS 62271 Series	High-voltage switchgear and controlgear	Old AS Number
1	Common specifications	*AS 2650
100*	High-voltage alternating current circuit-breakers	AS 2006
102*	Alternating current disconnectors and earthing switches	AS 1306 and AS 4298
103	Switches for rated voltages above 1 kV and less than 52 kV	*AS/NZS 60265.1
104	Switches for rated voltages of 52 kV and above	*AS 60265.2
106	Alternating current contactors and contactor based motor-starters	*AS 2024
110	Inductive load switching	*AS 4372
200*	AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV	AS 2086
201	AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 38 kV	*AS 2264
202	High-voltage/low-voltage prefabricated substations	*AS 61330

AS 62271 Series	High-voltage switchgear and controlgear	Old AS Number
203*	Gas-insulated metal enclosed switchgear for rated voltages above 52 kV	AS 2263
301*	Dimensional standardization of terminals	AS 2395
303	Use and handling of sulphur hexafluoride (SF ₆) in high-voltage switchgear and controlgear	*AS 2791
304	Additional requirements for enclosed switchgear and controlgear from 1 kV to 72,5 kV to be used in severe climatic conditions	*AS 4243
308*	Guide for asymmetrical short-circuit breaking test duty T100a	—

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (b) In the source text 'IEC 62271-102' should read 'AS 62271.102'.
- (c) A full point should be substituted for a comma when referring to a decimal marker.

The terms 'normative' and 'informative' are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

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STANDARDS AUSTRALIA

Australia Standard

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Any table, figure or text of the international standard that is struck through is not part of this standard. Any Australian table, figure or text that is added is part of this standard and is identified by shading.

1 General**1.1 Scope**

This part of IEC 62271 applies to alternating current disconnectors and earthing switches, designed for indoor and outdoor enclosed and open terminal installations for voltages above 1 000 V and for service frequencies up to and including 60 Hz.

It also applies to the operating devices of these disconnectors and earthing switches and their auxiliary equipment.

Additional requirements for disconnectors and earthing switches in enclosed switchgear and controlgear are given in IEC 60298, IEC 60466 and IEC 60517.

NOTE Disconnectors in which the fuse forms an integral part are not covered by this standard.

1.2 Normative references

Subclause 1.2 of IEC 60694 is applicable with the following additions:

References to international standards that are struck through in this clause are replaced by references to Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is identified as such.

IEC 60137:1995, *Insulating bushings for alternating voltages above 1 000 V*

~~IEC 60265-1:1998, High-voltage switches — Part 1: Switches for rated voltages above 1 kV and less than 52 kV~~

AS/NZS 60265-1:2001, *High-voltage switches, Part 1: Switches for rated voltages above 1 kV and less than 52 kV*

IEC 60265-2:1988, *High-voltage switches — Part 2: High-voltage switches for rated voltages of 52 kV and above*

IEC 60298:1990, *A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 60466:1987, *A.C. insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV*

IEC 60517:1990, *Gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above*

IEC 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 60865-1:1993, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

ISO 2768-1:1989, *General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

2 Normal and special service conditions

Clause 2 of IEC 60694 is applicable.

3 Definitions

Clause 3 of IEC 60694 is applicable with the following additions:

This clause covers required definitions, most of them by reference to IEC 60050(151), IEC 60050(441) and IEC 60050(604).

3.1 General terms

3.1.101 indoor switchgear and controlgear

[IEV 441-11-04]

3.1.102 outdoor switchgear and controlgear

[IEV 441-11-05]

3.1.103 temperature rise (of a part of a disconnecter or earthing switch)

difference between the temperature of the part and the ambient air temperature

3.1.104 user

person or legal entity using the disconnectors or earthing switches

NOTE This may include the purchaser (for example an electricity supplier), but it may also include the contracting company, the staff responsible for installation, the maintenance or operating staff or anybody else temporarily or permanently responsible for the disconnecter, earthing switch or substation, or even the operation of the switchgear.

3.2 Assemblies of switchgear and controlgear

No particular definitions.

3.3 Parts of assemblies

No particular definitions.

3.4 Switching devices

3.4.101

disconnecter

IEV 441-14-05 is applicable with the following additional notes:

NOTE 1 "Negligible current" implies currents such as the capacitive currents of bushings, busbars, connections, very short lengths of cable, currents of permanently connected grading impedances of circuit-breakers and currents of voltage transformers and dividers. For rated voltages of 420 kV and below, a current not exceeding 0,5 A is a negligible current for the purpose of this definition; for rated voltage above 420 kV and currents exceeding 0,5 A, the manufacturer should be consulted.

"No significant change in voltage" refers to such applications as the by-passing of induction voltage regulators or circuit-breakers.

NOTE 2 For a disconnector having a rated voltage of 52 kV and above, a rated ability of bus-transfer current switching may be assigned.

3.4.101.1

disconnecter class M0

disconnecter having a mechanical endurance of 1 000 operating cycles, suitable for applications in distribution and transmission systems fulfilling the general requirements of this standard

3.4.101.2

disconnecter class M1

disconnecter having an extended mechanical endurance of 2 000 operating cycles, mainly for applications where the disconnector is operated in conjunction with a circuit-breaker of an equal class

3.4.101.3

disconnecter class M2

disconnecter having an extended mechanical endurance of 10 000 operating cycles, mainly for applications where the disconnector is operated in conjunction with a circuit-breaker of an equal class

3.4.102

divided support disconnector (earthing switch)

[IEV 441-14-06(07)]

NOTE Examples are pantograph and semi-pantograph disconnectors.

3.4.103

centre-break disconnector

[IEV 441-14-08]

3.4.104

double-break disconnector

[IEV 441-14-09]

3.4.105**earthing switch**

IEV 441-14-11 is applicable with the following addition:

NOTE An earthing switch having a rated voltage of 52 kV and above may have a rating for switching and carrying induced currents.

Classes E1, E2 and E3 of IEC 60265-1 are based on electrical endurance of switches and switch-disconnectors. These devices may sometimes be operated against a short-circuit as a normal operation duty and the electrical endurance may be the measure of "low maintenance".

3.4.105.1**earthing switch class E0**

earthing switch suitable for applications in distribution and transmission systems fulfilling the general requirements of this standard

3.4.105.2**earthing switch class E1**

earthing switch class E0 with a short-circuit making capability

NOTE This class of earthing switch is able to withstand two making operations at rated making current.

3.4.105.3**earthing switch class E2**

earthing switch of class E1 requiring minimal maintenance, capable of an extended number of short-circuit making operations suitable for applications in systems up to and including 52 kV

NOTE This class of earthing switch proves its reduced maintenance requirements by a number of five making operations at rated making current, but also requires minimal maintenance as lubrication (replenishment of gas and cleaning of external surfaces where applicable).

3.5 Parts of switching devices**3.5.101****pole of a switching device**

[IEV 441-15-01]

3.5.102**main circuit (of a switching device)**

[IEV 441-15-02]

3.5.103**contact (of a mechanical switching device)**

[IEV 441-15-05]

3.5.104**main contact**

[IEV 441-15-07]

3.5.105**control contact**

[IEV 441-15-09]

3.5.106**"a" contact****make contact**

[IEV 441-15-12]

3.5.107**“b” contact****break contact**

[IEV 441-15-13]

3.5.108**position signalling device**

part of a disconnecter or earthing switch which uses auxiliary energy to indicate whether the contacts of the main circuit are in the open or closed position

3.5.109**terminal (as a component)**

component provided for the connection of a device to external conductors

[IEV 151-01-03]

3.5.110**contact zone (for divided support disconnectors and earthing switches)**

spatial region of positions the fixed contact may take up for correct engagement with the moving contact

3.6 Operation**3.6.101****operation (of a mechanical switching device)**

[IEV 441-16-01]

3.6.102**operation cycle (of a mechanical switching device)**

[IEV 441-16-02]

3.6.103**closing operation (of a mechanical switching device)**

[IEV 441-16-08]

3.6.104**opening operation (of a mechanical switching device)**

[IEV 441-16-09]

3.6.105**positively driven operation**

[IEV 441-16-12]

3.6.106**dependent manual operation (of a mechanical switching device)**

IEV 441-16-13 is applicable with the following addition:

NOTE Dependent manual operation may be performed by a crank or by a swing lever (horizontal or vertical).

3.6.107**dependent power operation (of a mechanical switching device)**

[IEV 441-16-14]

3.6.108**stored energy operation (of a mechanical switching device)**

[IEV 441-16-15]

3.6.109**independent manual operation (of a mechanical switching device)**

[IEV 441-16-16]

3.6.110**closed position (of a mechanical switching device)**

IEV 441-16-22 is applicable with the following addition:

NOTE Predetermined continuity means that the contacts are fully engaged to carry the rated normal and the rated short-circuit currents, as applicable.

3.6.111**open position (of a mechanical switching device)**

[IEV 441-16-23]

3.6.112**interlocking device**

[IEV 441-16-49]

3.7 Characteristic quantities**3.7.101****peak making current (of an earthing switch)**

peak value of the first major loop of the current in a pole of the earthing switch during the transient period following the initiation of current during a making operation

NOTE Where, for a three-phase circuit, a single value of (peak) making current is referred to, this is, unless otherwise stated, the highest value in any phase.

3.7.102**peak current**

peak value of the first major loop of current during the transient period following initiation

3.7.103**normal current (of a disconnector)**

current which the main circuit of the disconnector is capable of carrying continuously under specified conditions of use and behaviour

3.7.104**short-time withstand current**

[IEV 441-17-17]

3.7.105**peak withstand current**

[IEV 441-17-18]

3.7.106**rated value**

quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment

[IEV 151-04-03]

3.7.107**insulation level**

test voltage, under specified conditions, that the insulation of a device is designed to withstand

[IEV 151-04-14]

3.7.108**one minute power frequency withstand voltage**

r.m.s. value of the sinusoidal alternating voltage at power frequency which the insulation of the disconnector or earthing switch withstands under specified test conditions

(see IEC 60060-1)

3.7.109**impulse withstand voltage**

peak value of the standard impulse voltage wave which the insulation of the disconnector or earthing switch withstands under specified test conditions

(see IEC 60060-1)

NOTE Depending on the shape of the wave, the term may be qualified as switching impulse withstand voltage or lightning impulse withstand voltage. [IEV 604-03-29, IEV 604-03-30].

3.7.110**external insulation**

distances in atmospheric air, and surfaces of solid insulation of disconnectors and earthing switches in contact with the air, which are subject to dielectric stresses and to the effect of atmospheric and other external conditions such as pollution, humidity, vermin, etc.

[IEV 604-03-02, modified]

NOTE External insulation is either weather-protected or non-weather-protected, designed to operate outside or inside closed shelters, respectively

3.7.111**internal insulation**

internal solid, liquid or gaseous parts of the insulation of equipment which are protected from the effects of atmospheric and other external conditions

[IEV 604-03-03]

3.7.112**self-restoring insulation**

insulation which completely recovers its insulating properties after a disruptive discharge

[IEV 604-03-04]

3.7.113**non-self-restoring insulation**

insulation which loses its insulating properties or does not recover them completely after a disruptive discharge

[IEV 604-03-05]

NOTE Definitions 3.7.112 and 3.7.113 apply only when the discharge is caused by the application of a test voltage during a dielectric test. However, discharges occurring in service may cause a self-restoring insulation to lose partially or completely its original insulating properties.

3.7.114**parallel insulation**

insulator arrangement with two insulators in parallel where the distance between the two insulators might influence the dielectric strength

NOTE With open terminal disconnectors and earthing switches, parallel insulation is used when a drive insulator is situated next to a support insulator.

3.7.115**disruptive discharge**

phenomena associated with the failure of insulation under electric stress, in which the discharge completely bridges the insulation under test, reducing the voltage between the electrodes to zero or nearly to zero

NOTE 1 The term applies to discharges in solid, liquid and gaseous dielectrics and to combinations of these.

NOTE 2 A disruptive discharge through a solid dielectric produces permanent loss of dielectric strength (non-self-restoring insulation); in a liquid or gaseous dielectric the loss may be only temporary (self-restoring insulation).

3.7.116**clearance**

[IEV 441-17-31]

3.7.117**clearance between poles**

[IEV 441-17-32]

3.7.118**clearance to earth**

[IEV 441-17-33]

3.7.119**clearance between open contacts**

IEV 441-17-34 is applicable with the following additional note:

NOTE When determining the total clearance, the sum of the distances should be taken into consideration.

3.7.120**isolating distance (of a pole of a mechanical switching device)**

[IEV 441-17-35]

3.7.121**mechanical terminal load**

external load acting on each terminal

NOTE 1 The external load is the result of the combined mechanical forces to which the disconnector or earthing switch may be subjected. Wind forces acting on the equipment itself are not included as they do not contribute to the external load.

NOTE 2 A disconnector or earthing switch may be subjected to several mechanical forces different in value, direction and point of action.

NOTE 3 The terminal loads as defined here do not usually apply to enclosed switchgear.

3.7.121.1**static mechanical terminal load**

static mechanical terminal load at each terminal equivalent to the mechanical force to which this terminal of the disconnector or earthing switch is subjected by the flexible or rigid conductor connected to this terminal

3.7.121.2**dynamic mechanical terminal load**

combination of the static mechanical load and the electromagnetic forces under short-circuit conditions

3.7.122**bus-transfer current switching**

opening and closing of disconnectors under load when this load is not interrupted, but transferred from one bus to another

3.7.123**induced current switching**

breaking or making of an earthing switch of inductive or capacitive currents that are induced in an earthed or unearthed system by a parallel high-voltage system

NOTE When two or more transmission lines are mounted together on line towers or where two or more lines mounted on different towers are located close by, energy will be induced electrostatically and electromagnetically from a live system into a de-energized system resulting in capacitive or inductive currents flowing in this system, depending whether it is earthed at one or at both ends.

4 Ratings

Clause 4 of IEC 60694 is applicable with the following additions to the list of ratings:

- k) rated short-circuit making current (for earthing switches only);
- l) rated contact zone (for divided support disconnectors only);
- m) rated mechanical terminal load;

and for rated voltages 52 kV and above:

- n) rated values of the bus-transfer current switching capability of disconnectors;
- o) rated values of the induced current switching capability of earthing switches.

4.1 Rated voltage (U_r)

Subclause 4.1 of IEC 60694 is applicable.

4.2 Rated insulation level

Subclause 4.2 of IEC 60694 is applicable with the following addition:

For disconnectors having an isolating distance in parallel to the base of the disconnector and having integral earthing switches, the safety requirements are fulfilled during the temporary approach of the earthing blade to the opposite live parts, if the 1 min power frequency withstand voltage for the smallest gap is not lower than that specified in 6.2.5.

NOTE 1 The temporary reduction of dielectric strength is not a general problem of safety requirements, except during the short period of operation of an earthing switch having a manual operating mechanism only. For this reason, and because no ageing is taken into consideration, the reduced dielectric strength is acceptable. An impulse voltage test is not required because of the very low probability of a lightning or switching impulse during the earthing procedure.

NOTE 2 If national safety regulations specify higher withstand values for earthing switches which have manual operating mechanisms only, this has to be agreed upon between user and manufacturer.

NOTE 3 If the minimum temporary clearance is larger than the clearances given in IEC 60071-2, no test is required.

4.3 Rated frequency (f_r)

Subclause 4.3 of IEC 60694 is applicable.

4.4 Rated normal current and temperature rise

Subclause 4.4 of IEC 60694 is applicable. This subclause generally applies only to disconnectors.

NOTE Consideration should be given to the skin effect depending on the shape, construction and material of the main current path of a disconnector operated with 60 Hz, because with rectangular-shaped conductors deviations of more than 5 % compared with 50 Hz have been experienced.

4.5 Rated short-time withstand current (I_k)

Subclause 4.5 of IEC 60694 is applicable with the following addition:

If an earthing switch is combined with a disconnector as a single unit, the rated short-time withstand current of the earthing switch shall, unless otherwise specified, be at least equal to that assigned to the disconnector.

4.6 Rated peak withstand current (I_p)

Subclause 4.6 of IEC 60694 is applicable with the following addition:

If an earthing switch is combined with a disconnector as a single unit, the rated peak withstand current of the earthing switch shall, unless otherwise specified, be at least equal to that assigned to the disconnector.

4.7 Rated duration of short-circuit (t_k)

Subclause 4.7 of IEC 60694 is applicable with the following addition:

If an earthing switch is combined with a disconnector as a single unit, the rated duration of the short-time withstand current of the earthing switch shall, unless otherwise specified, be at least equal to that assigned to the disconnector.

4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)

Subclause 4.8 of IEC 60694 is applicable.

4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits

Subclause 4.9 of IEC 60694 is applicable.

4.10 Rated pressure of compressed gas supply for insulation and/or operation

Subclause 4.10 of IEC 60694 is applicable.

4.101 Rated short-circuit making current

Earthing switches to which a rated short-circuit making current has been assigned 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.

If an earthing switch has a rated short-circuit making current, this shall be equal to the rated peak withstand current.

4.102 Rated contact zone

The manufacturer shall state the rated values of contact zone (indicated by x_r , y_r and z_r). The values in tables 1 and 2 are for reference only. The rated values shall be obtained from the manufacturer. This refers also to a tolerable angular displacement of the fixed contact.

For proper function of the disconnector or earthing switch, the user shall ensure that the fixed contact stays within these limits by considering the service conditions when specifying the substation design and the cantilever strength of insulators (see 8.102.3).

Table 1 – Recommended contact zones for “fixed” contacts supported by flexible conductors

Rated voltage (U_r) kV	x mm	y mm	$z1$ mm	$z2$ mm
72,5 – 100	100	300	200	300
123 – 145	100	350	200	300
170	200	400	200	300
245	200	500	250	450
300	200	500	250	450
362	200	500	300	450
420	200	500	300	500
550	200	600	400	500
x = total amplitude of longitudinal movement of the supporting conductor (temperature). y = total horizontal deflection (perpendicular to supporting conductor) (wind). z = vertical deflection (temperature and ice).				
NOTE $z1$ are values for short-span, $z2$ are values for long-span of the flexible conductors to which the fixed contacts are mounted.				

Table 2 – Recommended contact zones for “fixed” contacts supported by rigid conductors

Rated voltage (U_r) kV	x mm	y mm	z mm
72,5 – 100 – 123 – 145	100	100	100
170 – 245 – 300 – 362 – 420	150	150	150
550	175	175	175
800	200	200	200
x = total amplitude of longitudinal movement of the supporting conductor (temperature). y = total horizontal deflection (perpendicular to supporting conductor) (wind). z = vertical deflection (ice).			

4.103 Rated mechanical terminal load

The rated mechanical terminal load shall be stated by the manufacturer.

Disconnectors and earthing switches shall be able to close and open while subjected to their rated static mechanical terminal loads.

The maximum static mechanical terminal load to which the terminal of a disconnector or earthing switch is allowed to be subjected under the most disadvantageous conditions is the rated static mechanical terminal load of this disconnector.

Recommended rated static mechanical terminal loads are given in table 3 and are intended to be used as a guide.

The maximum external dynamic mechanical load to which the terminal of a disconnector or earthing switch is allowed to be subjected is the rated dynamic mechanical load of this disconnector.

Disconnectors and earthing switches shall be able to withstand their rated dynamic mechanical terminal load under short-circuit.

The rating of the disconnector or earthing switch for terminal loads depends not only on the design, but also on the strength of the insulators used.

The required cantilever strength of an insulator shall be calculated taking into consideration the height of the terminal above the top of the insulator as well as additional forces acting on the insulator (see 3.7.122 and 8.102.3).

Table 3 – Recommended static mechanical terminal loads

Rated voltage (U_r) kV	Rated normal current A	Two- and three-column disconnectors		Divided support disconnectors		Vertical Force F_c^a N
		Straight load F_{a1} and F_{a2}	Cross-load F_{b1} and F_{b2}	Straight load F_{a1} and F_{a2}	Cross-load F_{b1} and F_{b2}	
		In figure 7		In figure 8		
		N	N	N	N	
52 – 72,5	800 – 1 250	400	130	800	200	500
100-123-145	1 250	500	170	800	200	1 000
170	1 250	600	200	1 000	300	
	2 000	800	250	1 250	400	
245	800 – 1 250	800	270	1 250	400	
	2 000	1 000	330	1 600	500	
300 – 362	2 000	1 000	400	1 600	500	1 500
	3 150	1 500	500	1 800	600	
420	2 000	1 600	530	2 000	800	
	4 000	2 000	660	4 000	1 600	
550	2 000	1 600	530	2 000	800	1 500
	4 000	2 000	660	4 000	1 600	
800	2 000	1 600	530	2 000	800	1 500
	4 000	2 000	660	4 000	1 600	

^a F_c simulates the downward forces caused by the weight of the connecting conductors. With flexible conductors the weight is included in the longitudinal or perpendicular forces.

^a F_c simulates the downward forces caused by the weight of the connecting conductors. With flexible conductors the weight is included in the longitudinal or perpendicular forces.

4.104 Rated values of the bus-transfer current switching capability of disconnectors

The rated values are given together with all other details in annex B.

This subclause is applicable to disconnectors rated 52 kV and above.

4.105 Rated values of the induced current switching capability of earthing switches

The rated values are given together with all other details in annex C.

This subclause is applicable to earthing switches rated 52 kV and above.

4.106 Rated values of mechanical endurance for disconnectors

A disconnector shall be able to perform the following number of operations taking into account the programme of maintenance specified by the manufacturer:

Table 3a – Classification of disconnectors for mechanical endurance

Class	Type of disconnector	Number of operating cycles
M0	Standard disconnector (normal mechanical endurance)	1 000
M1	Disconnector intended for use with a circuit-breaker of equal class (extended mechanical endurance)	2 000
M2	Disconnector intended for use with a circuit-breaker of equal class (extended mechanical endurance)	10 000

4.107 Rated values of electrical endurance for earthing switches

Earthing switches have three classes of electrical endurance:

- earthing switches with no making capability = class E0;
- earthing switches with short-circuit making capability = class E1 (these earthing switches have the making capability of two making operations);
- earthing switches with a short-circuit making capability of five making operations = class E2.

5 Design and construction

5.1 Requirements for liquids in disconnectors and earthing switches

Subclause 5.1 of IEC 60694 is applicable.

5.2 Requirements for gases in disconnectors and earthing switches

Subclause 5.2 of IEC 60694 is applicable.

5.3 Earthing of disconnectors and earthing switches

Subclause 5.3 of IEC 60694 is applicable with the following addition.

Metallic enclosures and operating mechanisms not mounted together with and not electrically connected to the metallic frame of the disconnector or earthing switch, shall be provided with an earthing terminal marked with the protective earth symbol.

5.4 Auxiliary and control equipment

Subclause 5.4 of IEC 60694 is applicable with reference to 5.104 of this standard.

5.5 Dependent power operation

Subclause 5.5 of IEC 60694 is applicable with the following additions.

This requirement applies also to disconnectors and earthing switches with dependent power operation having a rated switching and/or making current.

Disconnectors and earthing switches having a pneumatic or hydraulic operating device shall be capable of closing and opening when the supply pressure is between 85 % and 110 % of the rated value. For operation of releases see 5.8.

5.6 Stored energy operation

Subclause 5.6 of IEC 60694 is applicable.

5.7 Independent manual operation

Subclause 5.7 of IEC 60694 is applicable.

5.8 Operation of releases

Subclause 5.8 of IEC 60694 is applicable.

5.9 Low- and high-pressure interlocking and monitoring devices

Subclause 5.9 of IEC 60694 is applicable.

5.10 Nameplates

Subclause 5.10 of IEC 60694 is applicable with the following additions:

- the nameplates of disconnectors and earthing switches (and their operating devices) shall be marked in accordance with table 4;
- the nameplate shall be visible in the position of normal service and installation.

Table 4 – Nameplate information

	Abbreviation	Unit	Disconnecter	Earthing switch ^b	Operating device
Manufacturer			x	x	x
Designation of type			x	x	x
Serial number			x	x	x
Year of manufacture			x	x	x
Rated voltage	U_r	kV	x	x	
Rated lightning impulse withstand voltage	U_p	kV	x	x	
Rated switching impulse withstand voltage for rated voltages 300 kV and above	U_s	kV	x	x	
Rated normal current	I_r	A	x		
Rated short-time withstand current	I_k	kA	x	x	
Rated duration of short-circuit	t_k	s	(x) ^a	(x) ^a	
Rated filling pressure for insulation and/or operation	P_{re}	MPa	x	x	x
Rated supply voltage of auxiliary circuits	U_a	V			x
Rated static mechanical terminal load	F	N	(x)	(x)	
Mechanical endurance class of disconnecters	M_r		(x) ^c		
Electrical endurance class of earthing switches	E_r			(x) ^c	
Mass (including liquid)	m	kg	(x)	(x)	(x)
NOTE 1 The marking of values indicated by x is mandatory.					
NOTE 2 The marking of values indicated by (x) is optional.					
NOTE 3 The word “rated” does not need to appear on the nameplate.					
^a Mandatory if t different from 1 s.					
^b An earthing switch combined with a disconnector as a single unit does not require a separate nameplate unless it has a short-circuit rating different from the disconnector.					
^c The class marking is mandatory if different from M0 or E0. It may be included into the type designation to avoid additional space requirement.					

5.11 Interlocking devices

Subclause 5.11 of IEC 60694 is applicable.

5.12 Position indication

Subclause 5.12 of IEC 60694 is applicable (see also 5.104).

5.13 Degree of protection by enclosures

Subclause 5.13 of IEC 60694 is applicable with the following addition for the cubicles of secondary equipment.

The degree of protection provided by cubicles for outdoor installation shall be a minimum of IP3XDW.

For indoor installations the degree of protection shall be not less than IP2X.

In addition, generally no protection of persons against inadvertent contact with hazardous parts is required after the enclosure has been opened (see clause 11 of IEC 60694).

5.14 Creepage distances

Subclause 5.14 of IEC 60694 is applicable with the following addition:

Although the creepage distance may correspond to 5.14 of IEC 60694, with parallel insulation the distance between the two parallel insulators has to be taken into consideration.

5.15 Gas and vacuum tightness

Subclause 5.15 of IEC 60694 is applicable.

5.16 Liquid tightness

Subclause 5.16 of IEC 60694 is applicable.

5.17 Flammability

Subclause 5.17 of IEC 60694 is applicable.

5.18 Electromagnetic compatibility (EMC)

Subclause 5.18 of IEC 60694 is applicable.

5.101 Special requirements for earthing switches

Flexible copper connections between movable parts of an earthing switch and its frame shall have a cross-section of at least 50 mm².

This minimum value of the cross-sectional area of copper connections is given to ensure mechanical strength and resistance to corrosion.

Where the flexible connection is used to carry the short-circuit current, it shall be designed accordingly. If another material is used, a suitable equivalent of cross-section shall be provided.

5.102 Requirements in respect of the isolating distance of disconnectors

For reasons of safety, disconnectors shall be designed in such a way that no dangerous leakage currents can pass from the terminals of one side to any of the terminals of the other side of the disconnector.

This safety requirement is met when any leakage current is led away to earth by a reliable earth connection or when the insulation involved is effectively protected against pollution in service.

NOTE It is usual that the isolating gap of a disconnector is longer than the phase-to-ground insulating distance since IEC 60694 specifies higher withstand test levels across the isolating distance than for the phase-to-ground insulation.

Where a long creepage distance is required, the phase-to-ground insulation distance should become longer than the isolating gap. For such cases, to maintain low probability of disruptive discharge across the isolating gap, the use of protective devices such as surge arresters or rod gaps may be necessary.

5.103 Mechanical strength

Disconnectors and earthing switches having a rated static mechanical terminal load when installed according to the manufacturer's instructions shall be able to withstand their rated static and dynamic mechanical terminal load without impairing their reliability or current-carrying capacity.

5.104 Operation of disconnectors and earthing switches – Position of the movable contact system and its indicating and signalling devices

5.104.1 Securing of position

Disconnectors and earthing switches, including their operating mechanisms, shall be designed in such a way that they cannot come out of their open or closed position by gravity, wind pressure, vibrations, reasonable shocks or accidental touching of the connecting rods of their operating system.

Disconnectors and earthing switches shall permit temporary mechanical locking in both the open and closed position for safety purposes (for example maintenance).

NOTE This last requirement need not be met in the case of disconnectors or earthing switches that are operated by means of a hook-stick.

5.104.2 Additional requirements for power-operated mechanisms

Power operated mechanisms shall also provide a manual operating facility. Connecting a hand-operating device (for instance a hand crank) to the power-operated mechanism shall ensure safe interruption of the control energy to the power-operated mechanism.

5.104.3 Indication and signalling of position

Indication and signalling of the closed and open position shall not take place unless the movable contacts have reached their closed or open position, respectively, and the first paragraph of 5.104.1 is fulfilled.

NOTE For the definition of “closed” and “open” see 3.6.110 and 3.6.111.

5.104.3.1 Indication of position

It shall be possible to know the operating position of the disconnector or earthing switch. For the open position this requirement is met if one of the following conditions is fulfilled:

- the isolating distance or gap is visible;
- the position of each movable contact ensuring the isolating distance or gap is indicated by a reliable visual position indicating device.

NOTE In some countries the design of the disconnector is such that the isolating distance is visible.

The kinematic chain between the movable contacts and the position indicating device shall be designed with sufficient mechanical strength to meet the requirements of the specified tests (annex A). The position indicating kinematic chain shall be a continuous mechanical connection to ensure a positively driven operation. The position indicating device may be marked directly on a mechanical part of the power kinematic chain by suitable means. The strain-limiting device, if any, shall not be part of the position indicating kinematic chain.

Where all poles of a disconnector or earthing switch are mechanically coupled so as to be operable as a single unit, it is permissible to use a common position indicating device.

5.104.3.2 Electrical position signalling by auxiliary contacts

A common signal for all poles of a disconnector or earthing switch shall be given only if all poles of the disconnector or earthing switch have a position in accordance with 5.104.3.

Where all poles of a disconnector or earthing switch are mechanically coupled so as to be operable as a single unit, it is permissible to use a common position indicating device.

5.105 Maximum force required for manual operation

The values given below also apply to maintenance hand operation of normally motor-operated disconnectors and earthing switches.

NOTE These values include ice-breaking, if applicable.

The operating height above servicing level should be agreed between manufacturer and user.

5.105.1 Operation requiring more than one revolution

The force needed to operate a disconnector or earthing switch requiring more than one revolution (hand crank for example) shall not be higher than 60 N with a possible peak of 120 N during a maximum of 10 % of the total required revolutions.

5.105.2 Operation requiring up to one revolution

The force needed to operate a disconnector or earthing switch requiring up to one revolution (swing lever for example) should not exceed 250 N (refer to 5.6.3 of IEC 60694). A peak value of 450 N is accepted during a rotation of 15° maximum.

5.106 Dimensional tolerances

For the mounting dimensions and the dimensions of high-voltage connections as well as the earthing connections of disconnectors and earthing switches, the tolerances given in ISO 2768-1 shall apply for linear and angular dimensions.

6 Type tests

Clause 6 of IEC 60694 is applicable with the following additions:

6.1 General

Subclause 6.1 of IEC 60694 is applicable.

6.1.1 Grouping of tests

Subclause 6.1.1 of IEC 60694 is applicable with the following additions to the mandatory type tests given in IEC 60694:

Mandatory type tests:

- tests to prove satisfactory operation and mechanical endurance (6.102) (M);

Optional type tests:

- tests to prove the short-circuit making performance of earthing switches (6.101);
- tests to prove satisfactory operation under severe ice conditions (6.103);
- tests to prove satisfactory operation at temperature limits (6.104);
- tests to verify the proper function of position indicating devices (6.105 and annex A);

- tests to prove the bus-transfer current switching capability of disconnectors (6.106 and annex B);
- tests to prove the induced current-switching capability of earthing switches (6.107 and annex C);
- tests to prove the bus-charging current switching ability of disconnectors used in metal enclosed switchgear (6.108 and annex F).

For the mandatory tests, not more than four samples shall be used; for optional tests, additional test samples are accepted.

6.1.2 Information for identification of specimens

Subclause 6.1.2 of IEC 60694 is applicable.

6.1.3 Information to be included in type-test reports

Refer to 6.1.3 of IEC 60694 with the following addition (where applicable):

The following details concerning insulators used during the type tests are of particular importance and shall be given in the relevant test reports:

- rated cantilever strength;
- rated torsional strength of support insulators (and operating insulators, where applicable);
- height and number of elements;
- creepage length and shed-profile.

In the case of dielectric tests, information shall be included regarding the smallest gap at which the indicating or signalling device can signal the position OPEN. The minimum size of the gap and the height above ground used for the test shall be stated (see 6.2.3). Also the distance of the lowest part of insulation to ground shall be given.

In the case of short-circuit tests, the following information shall be included:

- details of the mechanical and electrical connection of the tested switchgear to the other parts of the test circuit including the static terminal load and the dimensions of the conductor;
- information on the mounting arrangements used;
- details of the mounting of the fixed contact to the upper conductor with divided support disconnectors;
- arrangement of the operating mechanism of disconnector or earthing switch having one mechanism for three phases;
- the contact resistance before and after the short-circuit test;
- where access is possible, the contact force before and after tests.

6.2 Dielectric tests

Subclause 6.2 of IEC 60694 is applicable.

6.2.1 Ambient air conditions during tests

Subclause 6.2.1 of IEC 60694 is applicable.

6.2.2 Wet test procedure

Subclause 6.2.2 of IEC 60694 is applicable.

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6.2.3 Conditions of disconnectors and earthing switches during dielectric tests

Subclause 6.2.3 of IEC 60694 is applicable with the following addition:

Dielectric tests on disconnectors or earthing switches when in the OPEN position shall be carried out with the minimum isolating distance for the disconnector or gap for the earthing switch at which the indicating or signalling device can signal the position OPEN or the minimum isolating distance compatible with the locking arrangements specified in 5.104, whichever is the smallest.

This requirement does not apply to independent operated indoor disconnectors and earthing switches.

6.2.4 Criteria to pass the test

Subclause 6.2.4 of IEC 60694 is applicable with the following addition.

The disconnector or earthing switch shall be considered to have passed the impulse tests if the following conditions are fulfilled:

- a) the number of disruptive discharges shall not exceed two for each series of 15 impulses;
- b) no disruptive discharges on non-self-restoring insulation shall occur.

This is verified by at least five impulses without disruptive discharge following that impulse out of the series of 15 impulses, which caused the last disruptive discharge. If this impulse is one of the last five out of the series of 15 impulses, additional impulses shall be applied.

If disruptive discharges occur and, for any reason, evidence cannot be given during testing that the disruptive discharges were on self-restoring insulation, after the completion of the dielectric tests the disconnector or earthing switch shall be dismantled and inspected. If punctures of non-self-restoring insulation are observed, the disconnector or earthing switch shall be considered to have failed the test.

NOTE 1 If the atmospheric correction factor K_1 is less than 1,00 but greater than 0,95, it is permissible to follow the criteria stated in 6.2.4 of IEC 60694 if the correction factor is not applied during the tests. Then, if one or two disruptive discharges out of 15 impulses occur in the external insulation, the particular test series showing flashover(s) is repeated with the appropriate correction factor so that no external disruptive discharge occurs.

NOTE 2 For GIS disconnectors or earthing switches tested with test bushings which are not part of the disconnector or earthing switch, flashover across the test bushings should be disregarded and should not be counted.

NOTE 3 The determination of the location of the observed disruptive discharges should be carried out by the laboratory using sufficient detection means, for example, photographs, video recordings, internal inspection, etc.

Where applicable, the requirements of IEC 60298 and IEC 60517 shall be considered.

6.2.5 Application of the test voltage and test conditions

Subclause 6.2.5 of IEC 60694 is applicable with the following addition.

Disconnectors having an isolating distance in parallel to the base of the disconnector and having integrated earthing switches, shall be tested in the most unfavourable position of the earthing blade with the power frequency test voltage given in table 5 (see 4.2).

These tests are not required for disconnectors that can only be operated with both terminals de-energized.