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Alternating current disconnectors and earthing switches

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ALTERNATING CURRENT DISCONNECTORS AND EARTHING SWITCHES

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by Sub-Committee 17A: High-voltage Switchgear and Controlgear, of IEC Technical Committee No. 17: Switchgear and Controlgear.

This third edition replaces the second edition of IEC Publication 129. This standard refers to IEC Publication 694: Common Clauses for High-voltage Switchgear and Controlgear Standards, which is applicable unless otherwise specified in this standard. In order to simplify the indication of corresponding requirements, the same numbering of clauses and sub-clauses is used as in Publication 694. Amendments to these clauses and sub-clauses are given under the same references whilst additional sub-clauses are numbered from 101.

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

Six Months' Rule	Report on Voting
17A(CO)162	17A(CO)166

Further information can be found in the Report on Voting, indicated in the table above.

The following IEC publications are quoted in this standard:

Publications Nos. 50(151) (1978):	International Electrotechnical Vocabulary (IEV), Chapter 151: Electrical and Magnetic Devices.
50(441) (1984):	Chapter 441: Switchgear, Controlgear and Fuses.
60-1 (1973):	High-voltage Test Techniques, Part 1: General Definitions and Test Requirements.
137 (1973):	Bushings for Alternating Voltages above 1 000 V.
265 (1968):	High-voltage Switches.
270 (1981):	Partial Discharge Measurements.
298 (1981):	A.C. Metal-enclosed Switchgear and Controlgear for Rated Voltages above 1 kV and up to and Including 72.5 kV.
466 (1974):	High-voltage Insulation-enclosed Switchgear and Controlgear.
517 (1975):	High-voltage Metal-enclosed Switchgear for Rated Voltages of 72.5 kV and Above.
694 (1980):	Common Clauses for High-voltage Switchgear and Controlgear Standards.

ALTERNATING CURRENT DISCONNECTORS AND EARTHING SWITCHES

1. Scope

This standard applies to alternating current disconnectors and earthing switches, designed for indoor and outdoor installation, for voltages above 1 000 V and for service frequencies up to and including 60 Hz.

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

This standard does not deal with additional requirements for disconnectors and earthing switches in enclosed switchgear and controlgear as these are covered by IEC Publications 298: A.C. Metal-enclosed Switchgear and Controlgear for Rated Voltages Above 1 kV and up to and including 72.5 kV, 466: High-voltage Insulation-enclosed Switchgear and Controlgear and 517: High-voltage Metal-enclosed Switchgear for Rated Voltages of 72.5 kV and Above.

Note. — Disconnectors in which a fuse is an integral part are not covered by this standard.

2. Normal and special service conditions

Clause 2 of IEC Publication 694: Common Clauses for High-voltage Switchgear and Controlgear Standards, is applicable.

3. Definitions

In this clause references are made to definitions in IEC Publication 50(441): International Electrotechnical Vocabulary (IEV), Chapter 441: Switchgear, Controlgear and Fuses, and Publication 50(151), Chapter 151: Electrical and Magnetic Devices, when the relevant definitions exist.

For the purpose of this standard, the following definitions are applicable:

3.101 *General terms*

3.101.1 *Switchgear and controlgear* (441-11-01)

3.101.2 *Indoor switchgear and controlgear* (441-11-04)

3.101.3 *Outdoor switchgear and controlgear* (441-11-05)

3.101.4 *Ambient air temperature* (441-11-13)

3.101.5 *Temperature rise* (of a part of a disconnector or earthing switch)

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

3.102 *Switching devices*

3.102.1 *Disconnector*

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

Note. — "Negligible current" implies currents such as the capacitance currents of bushings, busbars, connections, very short lengths of cables, 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 deemed to be a negligible current for the purpose of this definition; for rated voltages above 420 kV, 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.

3.102.2 *Divided support disconnector* (earthing switch) (441-14-06(07))

3.102.3 *Centre-break disconnector* (441-14-08)

3.102.4 *Double-break disconnector* (441-14-09)

3.102.5 *Earthing switch* (441-14-11)

3.102.6 *Switch-disconnector* (441-14-12)

3.103 *Parts of switching devices*

3.103.1 *Pole* (441-15-01)

3.103.2 *Main circuit* (441-15-02)

3.103.3 *Control circuit* (441-15-03)

3.103.4 *Auxiliary circuit* (441-15-04)

3.103.5 *Contact* (441-15-05)

3.103.6 *Contact piece* (441-15-06)

3.103.7 *Main contact* (441-15-07)

3.103.8 *Auxiliary contact* (441-15-10)

3.103.9 *Control contact* (441-15-09)

3.103.10 *a-contact, make contact* (441-15-12)

3.103.11 *b-contact, break contact* (441-15-13)

3.103.12 *Position indicating device* (441-15-25)

3.103.13 *Position-signalling device*

A part of a disconnector or earthing switch which enables a signal to be given, generally at a location remote from the disconnector or earthing switch, indicating whether the contacts of the main circuit are in the open or closed position.

3.103.14 *Terminal* (151-01-03)

3.103.15 *Contact zone* (for divided support disconnectors and earthing switches)

The spatial region delimiting the various positions the fixed contact may take up for correct engagement with the moving contact.

3.104 *Operation* (of a mechanical switching device)

3.104.1 *Operation* (441-16-01)

3.104.2 *Operating cycle* (441-16-02)

3.104.3 *Closing operation* (441-16-08)

3.104.4 *Opening operation* (441-16-09)

3.104.5 *Dependent manual operation* (441-16-13)

3.104.6 *Dependent power operation* (441-16-14)

3.104.7 *Stored energy operation* (441-16-15)

3.104.8 *Independent manual operation* (441-16-16)

3.104.9 *Closed position* (441-16-22)

3.104.10 *Open position* (441-16-23)

3.104.11 *Interlocking device* (441-16-49)

3.105 *Characteristic quantities*

3.105.1 *Prospective current* (of a circuit and with respect to a disconnector or to an earthing switch) (441-17-01)

3.105.2 *Prospective peak current*

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

Note. — The definition assumes that the current is made by an ideal switching device, i.e. with instantaneous and simultaneous transition of its impedance across the terminals of each pole from infinity to zero. The peak value may differ from one pole to another; it depends on the instant of current initiation relative to the voltage wave across the terminals of each pole.

3.105.3 *Maximum prospective peak current* (of an a.c. circuit) (441-17-04)

3.105.4 *(Peak) making current* (of an earthing switch)

The 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.

Notes 1. — The peak value may differ from one pole to another and from one operation to another as it depends on the instant of current initiation relative to the wave of the applied voltage.

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

3.105.5 *Peak current*

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

3.105.6 *Normal current* (of a disconnector)

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

3.105.7 *Short-time withstand current* (441-17-17)

3.105.8 *Peak withstand current* (441-17-18)

3.105.9 *Rated value* (151-04-03)

3.105.10 *Insulation level* (151-04-14)

3.105.11 *1 min power frequency withstand voltage*

The 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.

3.105.12 *Impulse withstand voltage*

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

Note. — Depending on the shape of the wave, the term may be qualified as switching impulse withstand voltage or lightning impulse withstand voltage.

3.105.13 *External insulation*

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

3.105.14 *Internal insulation*

The internal solid, liquid or gaseous parts of the insulation of equipment which are protected from the effects of atmospheric and other external conditions such as pollution, humidity, vermin, etc.

3.105.15 *Self-restoring insulation*

Insulation which completely recovers its insulating properties after a disruptive discharge caused by the application of a test voltage. Insulation of this kind is generally, but not necessarily, external insulation.

3.105.16 *Non-self-restoring insulation*

Insulation which loses its insulating properties or does not recover them completely after a disruptive discharge caused by the application of a test voltage. Insulation of this kind is generally, but not necessarily, internal insulation.

3.105.17 *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.

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

2. — A disruptive discharge in 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).

3.105.18 *Clearance* (441-17-31)

3.105.19 *Clearance between poles* (441-17-32)

3.105.20 *Clearance to earth* (441-17-33)

3.105.21 *Clearance between open contacts (gap)* (441-17-34)

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.

3.105.22 *Isolating distance* (441-17-35)

3.105.23 *Mechanical terminal load*

The external mechanical load at each terminal equivalent to the combined mechanical forces to which the disconnector or earthing switch may be subjected, not including wind forces acting on the equipment itself.

Notes 1. — A disconnector or earthing switch may be subjected to several mechanical forces different in value, direction and point of action.

2. — Mechanical terminal loads do not include electromagnetic forces of short-circuit currents.

4. Rating

Clause 4 of IEC Publication 694: 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

m) Rated mechanical terminal load

n) Rated values of maximum force required for manual operation (under consideration).

4.1 *Rated voltage*

Sub-clause 4.1 of IEC Publication 694 is applicable.

4.2 *Rated insulation level*

Sub-clause 4.2 of IEC Publication 694 is applicable with the following additions:

For rated voltages 72.5 kV and below, the current practice in the United States of America and Canada is given in Table I.

Disconnectors with rated voltage 300 kV and above are divided into two classes depending upon their rated switching impulse withstand voltage across open poles. Referring to Table IV of IEC Publication 694, the rated values in column 5 apply to Class A disconnectors and those in column 6 apply to Class B disconnectors.

TABLE I

Series II (based upon current practice in the United States of America and Canada. for 60 Hz only)

Rated voltage (kV) (r.m.s.)	Rated lightning impulse withstand voltage (kV) (peak)				Rated power-frequency withstand voltage (kV) (r.m.s.)					
	To earth and between poles		Across the isolating distance		To earth and between poles			Across the isolating distance		
(1)	(2)		(3)		(4)			(5)		
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor		Indoor	Outdoor	
					1 min dry	1 min dry	10 s wet*	1 min dry	1 min dry	10 s wet*
4.76	60	—	70	—	19	—	—	21	—	—
8.25	75	95	80	105	26	35	30	29	39	33
15	95	—	105	—	36	—	—	40	—	—
15.5	110	110	125	125	50	50	45	55	55	50
25.8	125	150	140	165	60	70	60	66	77	66
38	150	200	165	220	80	95	80	88	105	88
48.3	—	250	—	275	—	120	100	—	132	110
72.5	—	350	—	385	—	175	145	—	195	160

* Test requirements are given in IEC Publication 60-1: High-voltage Test Techniques. Part 1: General Definitions and Test Requirements.

4.3 *Rated frequency*

Sub-clause 4.3 of IEC Publication 694 is applicable.

4.4 *Rated normal current and temperature rise*

Sub-clause 4.4 of IEC Publication 694 is applicable. This sub-clause applies only for disconnectors.

4.5 *Rated short-time withstand current*

Sub-clause 4.5 of IEC Publication 694 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*

Sub-clause 4.6 of IEC Publication 694 is applicable with the following addition:

If an earthing switch is combined with a disconnector as a single unit, the 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*

Sub-clause 4.7 of IEC Publication 694 is applicable.

4.8 *Rated supply voltage of closing and opening devices and auxiliary circuits*

Sub-clause 4.8 of IEC Publication 694 is applicable.

4.9 *Rated supply frequency of operating devices and auxiliary circuits*

Sub-clause 4.9 of IEC Publication 694 is applicable.

4.10 *Rated pressure of compressed gas supply for operation*

Sub-clause 4.10 of IEC Publication 694 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*

Divided frame disconnectors and earthing switches shall be able to operate within the limits of their rated contact zone.

The manufacturer shall state the values of maximum and minimum mechanical reaction forces and the method of fixing the "fixed" contact required in case these forces are relevant to the satisfactory operating conditions of the disconnector or earthing switch.

Examples of rated contact zones of disconnectors and earthing switches having "fixed" contact pieces supported by flexible conductors are illustrated in Figures 1 and 2, pages 74 and 75, and given in Table IIA.

TABLE IIA

Examples of rated contact zones for "fixed" contact pieces supported by flexible conductors

Rated voltage (kV)	*L* (m)	*S* (m)	*U* (m)
72.5	0.30	0.20	0.20
100	0.30	0.20	0.20
123	0.35	0.20	0.25
145	0.35	0.20	0.25
170	0.40	0.20	0.30
245	0.50	0.25	0.30
300	0.50	0.25	0.35
362	0.50	0.30	0.35
420	0.50	0.30	0.40
525	0.60	0.40	0.50
550	0.60	0.40	0.50
765	0.70	0.50	0.60

L = horizontal deflection
S = vertical deflection
U = total amplitude of longitudinal movement with respect to supporting conductor

Examples of rated contact zones of disconnectors and earthing switches having "fixed" contacts supported by rigid conductors are given in Table IIB and in Figure 3, page 76.

TABLE IIB

Examples of rated contact zones for "fixed" contact pieces supported by rigid conductors

Rated voltage (kV)	*L* (m)	*S* (m)	*U* (m)
72.5	0.10	0.10	0.10
100	0.10	0.10	0.10
123	0.10	0.10	0.10
145	0.10	0.10	0.10
170	0.15	0.15	0.20
245	0.15	0.15	0.20
300	0.15	0.15	0.20
362	0.15	0.15	0.20
420	0.15	0.15	0.20
525	0.20	0.20	0.25
550	0.20	0.20	0.25
765	0.25	0.25	0.30

L = horizontal deflection
S = vertical deflection
U = total amplitude of longitudinal movement with respect to supporting conductor

4.103 *Rated mechanical terminal load*

Disconnectors and earthing switches should be able to close and open whilst subjected to their rated mechanical terminal loads, where assigned, plus wind loads acting on the equipment itself.

Note. — Wind loads on outdoor equipment and conductors are of a variable nature and are increased by the presence of ice or hoar frost. Methods of proving that wind loads will not endanger the equipment are under consideration.

Rated mechanical terminal loads need not be assigned to disconnectors and earthing switches which are not intended to be subject to substantial mechanical terminal loads.

Some examples of rated mechanical terminal loads (not including wind forces on the equipment itself) are given in Table III and are intended to be used as a guide.

TABLE III

Examples of rated mechanical terminal loads

Rated voltage	Rated normal current	Two- and three-column disconnectors		Divided support disconnectors.	
		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 8, page 81		In Figure 9, page 82	
(kV)	(A)	(N)	(N)	(N)	(N)
72.5	800-1 250	400	130	800	200
100-123-145	1 250	500	170	800	200
245	800-1 250	800	270	1 250	400
	2 000	1 000	330	1 600	500
420	2 000	1 600	530	2 000	800
	4 000	2 000	660	4 000	1 600

4.104 *Rated values of maximum force required for manual operation*

Under consideration.

4.105 *Behaviour when carrying rated peak withstand current and rated short-time withstand current*

a) The rated peak withstand current and the rated short-time withstand current, carried by a disconnector in the closed position during the rated duration of short circuit, shall not cause:

- material mechanical damage to any part of the disconnector;
- separation of the contacts;
- a temperature rise that, added to the maximum temperature obtained when carrying the rated normal current continuously, is likely to damage the insulation.

After the passage of these currents, the disconnector shall be able to carry its rated normal current without its temperature rise exceeding the values specified in Table V, Sub-clause 4.4.2 of IEC Publication 694, and shall be capable of operating under conditions specified therein in Sub-clauses 4.8 to 4.10.

b) The rated peak withstand current and the rated short-time withstand current, carried by an earthing switch in the closed position during the rated duration of short circuit, shall not cause:

- material mechanical damage to any part of the earthing switch;
- separation of the contacts or substantial contact welding;
- a temperature rise likely to damage the insulation.

Note. — Only light welding of contacts is permitted provided the earthing switch can be operated under the conditions given in Sub-clause 6.5.4 of IEC Publication 694.

4.106 *Behaviour of earthing switches when making short-circuit currents*

Earthing switches having a rated short-circuit making current shall, when making short circuit, comply with the following conditions of behaviour:

a) During operation, the earthing switch shall neither show signs of excessive distress nor endanger the operator.

From liquid-filled earthing switches, there shall be no outward emission of flame, and the gases produced, together with the liquid carried with the gases, shall be allowed to escape in such a way as not to cause electrical breakdown.

For other types of earthing switches, flame or metallic particles such as might impair the insulation level of the earthing switch shall not be projected beyond the boundaries specified by the manufacturer.

b) After performing operations corresponding to those specified in Sub-clause 6.101, the mechanical parts and insulators of the earthing switch shall be practically in the same condition as before. The short-circuit making performance may be materially impaired.

c) It is understood that after performing operations corresponding to those specified in Sub-clause 6.101, it may be necessary to carry out inspection of, and maintenance work on, the earthing switch in order to restore it to its original condition specified by the manufacturer before putting it back into service. For example, the following may be necessary:

- repair or replacement of the arc contacts or any other specified renewable parts;
- renewal or filtration of the oil, or of any other liquid insulating medium in liquid-filled earthing switches and the addition of any quantity of the medium necessary to restore its normal level;
- removal from the insulators of deposits caused by the decomposition of the liquid insulating medium.

Note. — Light welding of contacts is permitted, provided the earthing switch can be operated under the conditions given in Sub-clause 6.5.4 of IEC Publication 694 with the 100% rated value of pressure and supply voltage.

4.107 *Co-ordination of rated voltages, rated normal currents, rated short-time withstand currents and rated peak withstand currents*

The co-ordination of the above characteristics is given in Tables IV, VA, VB and VI.

TABLE IV

Co-ordination of rated values for rated voltages, Series I: 3.6 kV to 72.5 kV

Rated voltage (kV)	Rated short-time withstand current (r.m.s.) (kA)	Rated peak withstand current (kA)	Rated normal current (r.m.s.) (A)							
3.6	10	25	400	—	—	—	—	—	—	—
	16	40	—	630	—	1 250	—	—	—	—
	25	63	—	—	—	1 250	1 600	—	2 500	—
	40	100	—	—	—	1 250	1 600	—	2 500	4 000
7.2	8	20	400	—	—	—	—	—	—	—
	12.5	32	400	630	—	1 250	—	—	—	—
	16	40	—	630	—	1 250	1 600	—	—	—
	25	63	—	630	—	1 250	1 600	—	2 500	—
	40	100	—	—	—	1 250	1 600	—	2 500	4 000
12	8	20	400	—	—	—	—	—	—	—
	12.5	32	400	630	—	1 250	—	—	—	—
	16	40	—	630	—	1 250	1 600	—	—	—
	25	63	—	630	—	1 250	1 600	—	2 500	—
	40	100	—	—	—	1 250	1 600	—	2 500	4 000
	50	125	—	—	—	1 250	1 600	—	2 500	4 000
17.5	8	20	400	630	—	1 250	—	—	—	—
	12.5	32	—	630	—	1 250	—	—	—	—
	16	40	—	630	—	1 250	—	—	—	—
	25	63	—	—	—	1 250	—	—	—	—
	40	100	—	—	—	1 250	1 600	—	2 500	—
24	8	20	400	630	—	1 250	—	—	—	—
	12.5	32	—	630	—	1 250	—	—	—	—
	16	40	—	630	—	1 250	—	—	—	—
	25	63	—	—	—	1 250	1 600	—	2 500	—
	40	100	—	—	—	—	1 600	—	2 500	4 000
36	8	20	—	630	—	—	—	—	—	—
	12.5	32	—	630	—	1 250	—	—	—	—
	16	40	—	630	—	1 250	1 600	—	—	—
	25	63	—	—	—	1 250	1 600	—	2 500	—
	40	100	—	—	—	—	1 600	—	2 500	4 000
52	8	20	—	—	800	—	—	—	—	—
	12.5	32	—	—	—	1 250	—	—	—	—
	20	50	—	—	—	1 250	1 600	2 000	—	—
72.5	12.5	32	—	—	800	1 250	—	—	—	—
	16	40	—	—	800	1 250	—	—	—	—
	20	50	—	—	—	1 250	1 600	2 000	—	—
	31.5	80	—	—	—	1 250	1 600	2 000	—	—

Note. — The co-ordination table is intended to be used as a guide for preferred values and is not mandatory. Therefore, a disconnector or earthing switch with another combination of the rated values is not outside this specification. A reduction of the number of preferred combinations of rated values shown in the table is under consideration.

The values given in Table VA show (for information) the present practice in the United States of America and Canada.

TABLE VA *(under consideration)*
Co-ordination of rated values for rated voltages,
Series II: 8.25 kV to 72.5 kV
(Outdoor disconnectors)

Rated voltage (kV)	Rated short-time withstand current (r.m.s.) (kA)*	Rated peak withstand current (kA)*	Rated normal current (r.m.s.) (A)						
8.25	12.5	33.8	400	—	—	—	—	—	—
	25	67.5	—	630	—	—	—	—	—
	38.1	102.9	—	—	1 250	—	—	—	—
	43.8	118.3	—	—	—	—	2 000	—	—
	62.5	168.8	—	—	—	—	2 000	—	—
	75	202.5	—	—	—	—	—	3 150	4 000
15.5	12.5	33.8	400	—	—	—	—	—	—
	25	67.5	—	630	—	—	—	—	—
	38.1	102.9	—	—	1 250	—	—	—	—
	43.8	118.3	—	—	—	—	2 000	—	—
	62.5	168.8	—	—	—	—	2 000	—	—
	75	202.5	—	—	—	—	—	3 150	4 000
25.8	12.5	33.8	400	—	—	—	—	—	—
	25	67.5	—	630	—	—	—	—	—
	38.1	102.9	—	—	1 250	—	—	—	—
	43.8	118.3	—	—	—	—	2 000	—	—
	62.5	168.8	—	—	—	—	2 000	—	—
	75	202.5	—	—	—	—	—	3 150	4 000
38.0	12.5	33.8	400	—	—	—	—	—	—
	25	67.5	—	630	—	—	—	—	—
	38.1	102.9	—	—	1 250	—	—	—	—
	43.8	118.3	—	—	—	—	2 000	—	—
	62.5	168.8	—	—	—	—	2 000	—	—
	75	202.5	—	—	—	—	—	3 150	4 000
48.3	25	67.5	—	630	1 250	—	—	—	—
	38.1	102.9	—	—	1 250	—	—	—	—
	62.5	168.8	—	—	—	—	2 000	—	—
	75	202.5	—	—	—	—	—	3 150	—
72.5	25	67.5	—	630	1 250	—	—	—	—
	38.1	102.9	—	—	1 250	—	—	—	—
	43.8	118.3	—	—	—	1 600	—	—	—
	62.5	168.8	—	—	—	—	2 000	—	—
	75	202.5	—	—	—	—	—	3 150	—

* Values more in line with IEC publications are under consideration.

Note. — The co-ordination table is intended to be used as a guide for preferred values and is not mandatory. Therefore, a disconnector or earthing switch with another combination of the rated values is not outside this specification.

The values given in Table VB show (for information) the present practice in the United States of America and Canada.

TABLE VB *(under consideration)*

Co-ordination of rated values for rated voltages,
Series II: 4.76 kV to 38.0 kV
(Indoor disconnectors)

Rated voltage (kV)	Rated short-time withstand current (r.m.s.) (kA)*	Rated peak withstand current (kA)*	Rated normal current (r.m.s.) (A)								
4.76	12.5	33.8	200	400	—	—	—	—	—	—	—
	25	67.5	—	—	630	—	—	—	—	—	—
	38.1	102.9	—	—	—	1 250	—	—	—	—	—
	50	135	—	—	—	—	2 000	—	—	—	—
	62.5	168.8	—	—	—	—	—	3 150	—	—	—
8.25	12.5	33.8	200	400	—	—	—	—	—	—	—
	25	67.5	—	—	630	—	—	—	—	—	—
	38.1	102.9	—	—	—	1 250	—	—	—	—	—
	50	135	—	—	—	—	2 000	—	—	—	—
	62.5	168.8	—	—	—	—	—	3 150	—	—	—
	75	202.5	—	—	—	—	—	—	4 000	—	—
	100	270	—	—	—	—	—	—	—	5 000	—
	125	337.6	—	—	—	—	—	—	—	—	6 300
15.0 and 15.5	12.5	33.8	200	400	—	—	—	—	—	—	—
	25	67.5	—	—	630	—	—	—	—	—	—
	38.1	102.9	—	—	—	1 250	—	—	—	—	—
	50	135	—	—	—	—	2 000	—	—	—	—
	62.5	168.8	—	—	—	—	—	3 150	—	—	—
	75	202.5	—	—	—	—	—	—	4 000	—	—
	100	270	—	—	—	—	—	—	—	5 000	—
	125	337.6	—	—	—	—	—	—	—	—	6 300
25.8	12.5	33.8	—	400	—	—	—	—	—	—	—
	25	67.5	—	—	630	—	—	—	—	—	—
	38.1	102.9	—	—	—	1 250	—	—	—	—	—
	50	135	—	—	—	—	2 000	—	—	—	—
	62.5	168.8	—	—	—	—	—	3 150	—	—	—
	75	202.5	—	—	—	—	—	—	4 000	—	—
	100	270	—	—	—	—	—	—	—	5 000	—
38.0	12.5	33.8	—	400	—	—	—	—	—	—	—
	25	67.5	—	—	630	—	—	—	—	—	—
	38.1	102.9	—	—	—	1 250	—	—	—	—	—
	50	135	—	—	—	—	2 000	—	—	—	—
	62.5	168.8	—	—	—	—	—	3 150	—	—	—
	75	202.5	—	—	—	—	—	—	4 000	—	—

* Values more in line with IEC publications are under consideration.

Note. — The co-ordination table is intended to be used as a guide for preferred values and is not mandatory. Therefore, a disconnector or earthing switch with another combination of the rated values is not outside this specification.

TABLE VI

Co-ordination of rated values for rated voltages 100 kV to 765 kV

Rated voltage (kV)	Rated short-time withstand current (r.m.s.) (kA)	Rated peak withstand current (kA)	Rated normal current (r.m.s.) (A)					
123	12.5	32	800	1 250	—	—	—	—
	20	50	—	1 250	1 600	2 000	—	—
	25	63	—	1 250	1 600	2 000	—	—
	40	100	—	—	1 600	2 000	—	—
145	12.5	32	800	1 250	—	—	—	—
	20	50	—	1 250	1 600	2 000	—	—
	25	63	—	1 250	1 600	2 000	—	—
	31.5	80	—	1 250	1 600	2 000	3 150	—
	40	100	—	—	1 600	2 000	3 150	—
	50	125	—	—	—	2 000	3 150	—
170	12.5	32	800	1 250	—	—	—	—
	20	50	—	1 250	1 600	2 000	—	—
	31.5	80	—	1 250	1 600	2 000	3 150	—
	40	100	—	—	1 600	2 000	3 150	—
	50	125	—	—	1 600	2 000	3 150	—
245	20	50	—	1 250	1 600	2 000	—	—
	31.5	80	—	1 250	1 600	2 000	—	—
	40	100	—	—	1 600	2 000	3 150	—
	50	125	—	—	—	2 000	3 150	—
300	16	40	—	1 250	1 600	—	—	—
	20	50	—	1 250	1 600	2 000	—	—
	31.5	80	—	1 250	1 600	2 000	3 150	—
	50	125	—	—	1 600	2 000	3 150	—
362	20	50	—	—	—	2 000	—	—
	31.5	80	—	—	—	2 000	—	—
	40	100	—	—	1 600	2 000	3 150	—
420	20	50	—	—	1 600	2 000	—	—
	31.5	80	—	—	1 600	2 000	—	—
	40	100	—	—	1 600	2 000	3 150	—
	50	125	—	—	—	2 000	3 150	4 000
525	40	100	—	—	—	2 000	3 150	—
765	40	100	—	—	—	2 000	3 150	—

Note. — The co-ordination table is intended to be used as a guide for preferred values and is not mandatory. Therefore, a disconnector or earthing switch with another combinaison of the rated values is not outside this specification. A reduction of the number of preferred combinations of rated values shown in the table is under consideration.

5. Design and construction

5.1 *Requirements for liquids in disconnectors and earthing switches*

Sub-clause 5.1 of IEC Publication 694 is applicable.

5.2 *Requirements for gases in disconnectors and earthing switches*

Sub-clause 5.2 of IEC Publication 694 is applicable.

5.3 *Earthing of disconnectors and earthing switches*

Sub-clause 5.3 of IEC Publication 694 is applicable.

5.4 *Auxiliary equipment*

Sub-clause 5.4 of IEC Publication 694 is applicable.

5.5 *Dependent power closing*

Sub-clause 5.5 of IEC Publication 694 is only applicable for earthing switches having a short-circuit making capacity.

5.6 *Stored energy closing*

Sub-clause 5.6 of IEC Publication 694 is only applicable for earthing switches having a short-circuit making capacity.

5.7 *Operation of releases*

Sub-clause 5.7 of IEC Publication 694 is not applicable.

5.8 *Low and high pressure interlocking devices*

Sub-clause 5.8 of IEC Publication 694 is not applicable.

5.9 *Nameplates*

Sub-clause 5.9 of IEC Publication 694 is applicable with the following additions:

- The nameplates of disconnectors, earthing switches and their operating devices shall be marked in accordance with Table VII.
- The nameplate shall be visible in the position of normal service and installation.

TABLE VII

Nameplate information

	Abbreviation	Unit	Disconnector	Earthing switch	Operating device
Manufacturer			×	×	×
Designation of type			×	×	×
Serial number			(×)	(×)	
Rated voltage	U	kV	×	×	
Rated lightning impulse withstand voltage	U_w	kV	(×)*	(×)*	
Rated switching impulse withstand voltage and the class (A or B) of the equipment, for rated voltages 300 kV and above	U_s	kV	×	×	
Rated normal current	I_n	A	×		
Rated short-time withstand current	I_{th}	kA	×	×	
Rated duration of short circuit	t	s	(×)**	(×)**	
Rated pressure of compressed gas	p	MPa	(×)		(×)
Rated auxiliary voltage	U_a	V			(×)
Rated mechanical terminal load	F	N	(×)	(×)	
Mass (including liquid) if more than 300 kg	m	kg	(×)	(×)	(×)

× The marking of these values is mandatory.
(×) The marking of these values is optional.
* Mandatory for $U > 72.5$ kV.
** Mandatory if t different from 1 s.
Note. — The word "rated" need not appear on the nameplate.

5.101 *Special requirements for earthing switches*

Flexible copper connections between the rotating shaft and the frame shall have a cross-section of at least 50 mm².

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

5.102 *Requirements in respect of the isolating distance of disconnectors*

For reasons of safety, disconnectors should be so designed 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.

Notes 1. — For disconnectors which contain a dielectric other than air at atmospheric pressure, the dielectric conditions to be specified for the isolating distance may form the subject of agreement between manufacturer and user.

2. — Tests to prove the effectiveness of the protection against pollution and the performance of insulation material in respect of leakage currents are under consideration.

5.103 *Mechanical strength*

Disconnectors or earthing switches when installed according to the manufacturer's instructions shall be able to bear on the terminals the total forces (including wind loading and electrodynamic forces on the attached conductors) related to the application and rating without impairing their reliability or current-carrying capacity.

5.104 *Position of the movable contact system and its indicating or signalling devices*

5.104.1 *Securing of position*

Disconnectors and earthing switches, including their operating mechanisms, shall be so constructed that they cannot come out of their open or closed positions by gravity, wind pressure, vibrations, reasonable shocks or accidental touching of the connecting rods of their operating mechanism.

Hand-operated disconnectors and earthing switches shall be so constructed as to permit locking in both the open and closed positions and in these two positions only.

Notes 1. — This applies also to the emergency hand-operated devices of automatically or remotely controlled disconnectors and earthing switches.

2. — These requirements need not be met in the case of disconnectors or earthing switches which are operated by means of a hook-stick.

Automatically or remotely controlled disconnectors and earthing switches may be so constructed as to permit locking both in the open and the closed positions.

5.104.2 *Indication of position*

It shall be possible to know the operating position of the disconnector or earthing switch.

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 position-indicating device.

Notes 1. — Visible moving contacts may serve as the indicating devices.

2. — In the case where all poles of a disconnector or earthing switch are so coupled as to be operable as a single unit, it is permissible to use a common indicating device.

3. — For equipment of which the insulating medium is other than air at atmospheric pressure, special requirements will be a subject for study.

5.104.3 *Auxiliary contacts for signalling*

a) Signalling of the closed position shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, the peak withstand current and the short-time withstand current can be carried safely.

b) Signalling of the open position shall not take place unless the movable contacts have reached a position such that the clearance between contacts is at least 80% of the gap or the isolating distance, or unless it is certain that the movable contacts will reach their fully open position.

c) A common signalling device for all poles of a disconnector or earthing switch shall be arranged in such a way that the signal is given only in the case of all poles of the disconnector or earthing switch having a position in accordance with *a)* or *b)*.

Notes 1. — In the case where all poles of a disconnector or earthing switch are so coupled as to be operable as a single unit, it is permissible to use a common position-signalling device.

2. — Upon special request, signalling of the open position of a disconnector shall not take place until all the movable contacts have reached a stable open condition as defined in the first paragraph of Sub-clause 5.104.1.

6. Type tests

Clause 6 of IEC Publication 694 is applicable with the following additions to the list of type tests:

- tests to prove the short-circuit making capacity of earthing switches (Sub-clause 6.101);
- tests to prove satisfactory operation and mechanical endurance (Sub-clause 6.102);
- tests to prove satisfactory operation under ice conditions (only on special request by the user, Sub-clause 6.103);
- tests to prove satisfactory operation at minimum and maximum ambient air temperatures (Sub-clause 6.104).

Type tests carried out on one type of disconnector may be used to prove the performance of another type of different current or voltage rating but with similar components.

6.1 *Dielectric tests*

6.1.1 *Ambient air conditions during tests*

Sub-clause 6.1.1 of IEC Publication 694 is applicable.

6.1.2 *Wet test procedure*

Sub-clause 6.1.2 of IEC Publication 694 is applicable.

6.1.3 *Conditions of disconnectors or earthing switches during dielectric tests*

Sub-clause 6.1.3 of IEC Publication 694 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 compatible with the locking arrangements specified in Sub-clause 5.104.

6.1.4 *Application of test voltage and test conditions*

Sub-clause 6.1.4 of IEC Publication 694 is applicable for disconnectors.

For earthing switches in the open position, the test voltage shall be applied between the insulated terminals and between each insulated terminal and the earthed base.

6.1.5 *Test voltages*

Sub-clause 6.1.5 of IEC Publication 694 is applicable.

6.1.6 *Lightning and switching impulse voltage tests*

Sub-clause 6.1.6 of IEC Publication 694 is applicable with the following additions:

6.1.6.1 *Lightning impulse voltage tests*

With the disconnector closed or the earthing switch open, the test voltage equal to the rated withstand voltage to earth shall be applied for each test condition in Sub-clause 6.1.4.

With the disconnector open and in the case of disconnectors having a rated voltage lower than 300 kV, two test series shall be performed:

- the first test series with a test voltage equal to the rated withstand voltage to earth for each test condition of Table VIII of IEC Publication 694;
- the second test series with a test voltage equal to the rated withstand voltage across isolating distance for each test condition of Table VIII of IEC Publication 694. The opposite terminal shall be earthed. The terminals of the other poles and the base shall be insulated in such a way as to prevent disruptive discharge to earth.

With the disconnector open and in the case of disconnectors having rated voltage 300 kV and above, for each test condition of Table X of IEC Publication 694, one terminal shall be energized with a test voltage equal to the rated lightning impulse and the opposite terminal energized at the power-frequency voltage $0.7 \times U/\sqrt{3}$ (r.m.s. value).

Note. — Subject to agreement of the manufacturer, the tests with the disconnector open, having a rated voltage 300 kV and above, can be performed avoiding the use of the power frequency voltage source. In this case, two test series should be performed:

- The first test series consists of the application of 15 consecutive impulses to each terminal in turn at a voltage equal to the sum of the rated withstand voltage U_w and the value $0.7 \times U\sqrt{2}/\sqrt{3}$ (peak value). The opposite terminal should be earthed and the other terminals, the base and the terminal to which the voltage is to be applied, insulated in such a way as to prevent disruptive discharges to earth. The disconnector should be considered to have passed this first test series successfully if the number of the disruptive discharges across the isolating distance or between poles on self-restoring insulation does not exceed two for each test condition, and if no disruptive discharge on non-self-restoring insulation occurs;

- The second test series consists of the application to each terminal in turn of 15 consecutive impulses at the rated withstand voltage U_w. The other terminals and the base shall be earthed. The disconnector should be considered to have passed this second test series successfully if the number of disruptive discharges to earth or between poles on self-restoring insulation does not exceed two and if no disruptive discharge across the isolating distance and on non-self-restoring insulation occurs.

For rated voltages above 420 kV this test procedure may not be appropriate. For these voltages other test methods are under consideration.

6.1.6.2 *Switching impulse voltage tests*

For rated voltage 300 kV and above, disconnectors shall have two classes, Class A and Class B, which depend on the service conditions foreseen for the disconnector and result in different switching impulse voltage test procedures applied.

With the disconnector closed or the earthing switch open, a test voltage equal to the rated withstand voltage to earth, shall be applied for each test condition in Sub-clause 6.1.4.

With the disconnector open, two test series shall be performed:

- the first test series with a test voltage equal to the rated withstand voltage to earth for each test condition in Table VIII of IEC Publication 694;
- the second test series with a test procedure depending upon whether the disconnector is of Class A or Class B.

a) Class A

The second test series with a test voltage equal to the rated switching impulse withstand voltage across the isolating distance (see IEC Publication 694, Table IV, column 5) for each test condition in Table VIII of IEC Publication 694. Since in this case the applied voltage may be higher than the rated withstand voltage to earth, it is permitted to insulate the terminals of the other poles and the base in order to prevent disruptive discharge to earth.

Note. — For rated voltages above 420 kV this test procedure may not be appropriate. For these voltages other test methods are under consideration.

b) Class B

In the second test series, for each test condition in Table X of IEC Publication 694, one terminal shall be energized with the switching impulse voltage across the isolating distance (see IEC Publication 694, Table IV, column 6) and the opposite terminal energized at the power-frequency voltage $U/\sqrt{3}$ (r.m.s.).

Note. — For Class B equipment, subject to agreement of the manufacturer, the second test series with the disconnector open may be performed avoiding the use of the power-frequency voltage source. In this case, the second test series consists of the application of 15 consecutive impulses to each terminal in turn at a voltage equal to the sum of the switching impulse voltage and the value $U\sqrt{2}/\sqrt{3}$ (peak value), from column 6 of Table IV of IEC Publication 694. The opposite terminal shall be earthed. The other terminals, the terminal to which the voltage is applied and the base shall be insulated in such a way as to prevent disruptive discharges to earth.

For rated voltages above 420 kV this procedure may not be appropriate. For these voltages other test methods are under consideration.
It is emphasized that this test is not mandatory but is an alternative method available to the manufacturer and it is not intended to introduce a third class of disconnectors.

6.1.7 *Power-frequency voltage withstand tests*

Sub-clause 6.1.7 of IEC Publication 694 is applicable with the following additions:

For disconnectors and earthing switches having a rated voltage lower than 300 kV, the tests with the disconnector open shall be performed using two different voltage sources in out-of-phase conditions, in order to obtain the rated withstand voltages across open gap as specified in Sub-clauses 4.2.1 and 4.2.2 of IEC Publication 694. Neither of the two voltage values applied to the two terminals shall be higher than two-thirds of the rated withstand voltage to earth.

Note. — Subject to agreement of the manufacturer, the tests with the disconnector open may be performed using one single voltage source. In this case, the test voltage should be applied to each terminal in turn, the opposite terminal being earthed and the other terminals, the base and the terminal to which the voltage is to be applied being insulated in such a way as to prevent disruptive discharges to earth.
This test is more severe than the standard test prescribed earlier.

For disconnectors and earthing switches having a rated voltage of 300 kV and above, the tests with the disconnector open shall be performed using two different voltage sources in out-of-phase conditions in order to obtain the rated withstand voltages across open gap as specified in Sub-clause 4.2.3 of IEC Publication 694. Neither of the two voltage values applied to the two terminals shall be higher than the rated voltage of the disconnector.

6.1.8 *Artificial pollution tests*

Sub-clause 6.1.8 of IEC Publication 694 is applicable.

6.1.9 *Partial discharge tests*

Sub-clause 6.1.9 of IEC Publication 694 is replaced by the following:

No partial discharge tests are required to be performed on the complete disconnector or earthing switch. However, in the case of disconnectors or earthing switches using components for which a relevant IEC publication exists, including partial discharge measurements (e.g. bushings, see IEC Publication 137: Bushings for Alternating Voltages above 1 000 V) evidence shall be produced by the manufacturer showing that those components have passed the partial discharge tests as foreseen by the relevant IEC publication. For partial discharge measurement, see IEC Publication 270: Partial Discharge Measurements.

6.1.10 *Test on auxiliary and control circuits*

Sub-clause 6.1.10 of IEC Publication 694 is applicable.

6.2 *Radio interference voltage (r.i.v.) tests*

Sub-clause 6.2 of IEC Publication 694 is applicable. These tests shall be subject to special agreement between manufacturer and user.

6.3 *Temperature-rise tests*

Sub-clause 6.3 of IEC Publication 694 is applicable. The temperature-rise tests of the main circuit are only applicable for disconnectors.

6.4 *Measurement of the resistance of the main circuit*

Sub-clause 6.4 of IEC Publication 694 is applicable. The measurements are only applicable for disconnectors.

6.5 *Short-time and peak withstand current tests*

Sub-clause 6.5 of IEC Publication 694 is applicable with the following addition:

6.5.1 *Arrangement of the mechanical switching device and of the test circuit*

6.5.1.1 *General*

Disconnectors and earthing switches shall be subjected to a test to prove their ability to carry the rated peak withstand current and the rated short-time withstand current. The test shall be made with the disconnector or earthing switch in the closed position at any suitable voltage and starting at any convenient temperature.

Each test shall be preceded by a no-load operation of the disconnector or earthing switch.

For test, the disconnector or earthing switch shall be mounted on its own support or an equivalent support and installed with its own operating mechanism as far as necessary to make the test representative.

The test connections to and from the disconnector or earthing switch shall be arranged in such a way that the result of the tests shall be comparable and valid for installation in service.

For tests on a disconnector or on an earthing switch not associated with a disconnector, the arrangement shall be representative of the least favourable conditions of electromagnetic forces tending to open the disconnector or earthing switch for which it is intended in service.

The tests on an earthing switch associated with a disconnector shall be made with test connections adopted for the disconnector test. The electromagnetic forces shall tend to open the earthing switch, provided current flow resulting in this effect is not prevented by an interlocking device between earthing switch and disconnector.

The test may be made single-phase or three-phase. In the case of single-phase tests, the following shall apply:

On a three-pole disconnector or earthing switch, having a common frame, the tests shall be made on two adjacent poles.

In the case of separate poles, the tests shall be made either on two adjacent poles assembled with the minimum recommended pole centres, or a single pole with a return conductor.

The return conductor shall be parallel to the blade in the case of a two-column or three-column disconnector and at the same elevation above the base if its plane is parallel to the blade. The centre line of the return conductor shall be spaced from the centre line of the blade at minimum recommended pole centres. The length of the return conductor shall be at least equal to the distance between the input terminal of the connection to the supply and the output terminal of the disconnector.

When an earthing switch is not associated with a disconnector, the single-phase test shall be made with the test connection and the return conductor parallel to each other and representative of the earth fault condition in normal installation. The test connection shall be unsupported for a distance at least equal to the gap of the open earthing switch.

For a divided support disconnector, the position of the contact in the contact zone should be chosen so as to represent the most unfavourable condition.

Note. — No other forces need to be applied if they are slight compared with the electrodynamic forces.

6.5.1.2 *Disconnectors and earthing switches with rated voltages up to and including 52 kV*

A three-pole disconnector or earthing switch should preferably be tested three-phase.

The test arrangement given in Figure 4, page 76, may be used as an example for disconnectors and earthing switches having a rated peak withstand current not exceeding 100 kA. The distance x between the input terminals of the disconnector and the nearest support of the test connections is equal to three times the distance y between pole centres. The distances u and v are as small as possible but not smaller than y.

Figure 4 may, in principle, also be used as an example for single-phase tests. Other configurations of return conductors resulting in equivalent forces on the disconnector may be used.

6.5.1.3 *Disconnectors and earthing switches with rated voltages exceeding 52 kV*

The single-phase test arrangements given in Figures 5 and 6, pages 77 and 79, may be used as examples for disconnectors for connection by flexible conductors. Disconnectors with a horizontal isolating distance intended to be used in installations with rigid conductors may be tested in the same arrangement as given in Figure 5 but with rigid conductors and x_1 is equal to $1.2\,y$, x_2 remaining unchanged. Disconnectors with a vertical isolating distance to be used in installations with rigid conductors may be tested in the test arrangement given in Figure 7, page 80.

6.101 *Tests to prove the short-circuit making performance of earthing switches*

Earthing switches which have a rated short-circuit making current shall be subjected to a making test series in accordance with IEC Publication 265: High-voltage Switches.

6.102 *Operating and mechanical endurance tests*

6.102.1 *General test conditions*

Unless otherwise specified, the tests shall be made at the ambient temperature of the test room.

The supply voltage of the operating devices shall be measured at the terminals with full current flowing. Auxiliary equipment forming part of the operating device shall be included. However, no intentional addition to the impedance (e.g. for regulation of the voltage) between the voltage source and the terminals of the devices is permitted.

6.102.2 *Contact zone test*

This test shall be made in order to prove satisfactory operation of divided support disconnectors (according to Figure 1, page 74), in the various positions of the fixed contact within the limits of the rated contact zone according to Sub-clause 4.102.

With the device in the open position, the fixed contact shall be placed in the following positions (according to Figures 1 and 2, page 75), h being the normal height of the fixed contact above the mounting plane:

a) at a height of h on the vertical axis of the assembly;

b) at a height of $h-S$ on the same axis;

c) at a height equal to h and displaced from the axis horizontally by $+L/2$;

d) at a height equal to h and displaced from the axis horizontally by $-L/2$.

With the device in the open position, the fixed contact shall be placed in the following positions (see Figure 2), U being the total amplitude of movement of the fixed contacts:

e) at a distance equal to $+U/2$

f) at a distance equal to $-U/2$

In each position, the device shall close and open correctly.

6.102.3 *Mechanical endurance test*

The mechanical endurance test shall consist of 1 000 operating cycles without voltage on, without current in the main circuit and without the mechanical terminal load applied.

The test shall be made on disconnectors and earthing switches equipped with their own operating devices.

On a disconnector or earthing switch having a power-operated mechanism:

- 900 close-open operating cycles shall be made at rated supply voltage and/or rated pressure of compressed gas supply;
- 50 close-open operating cycles at the specified minimum supply voltage and/or minimum pressure of compressed gas supply;
- 50 close-open operating cycles at the specified maximum supply voltage and/or maximum pressure of compressed gas supply.

These operations shall be made at a rate such that the temperatures of the energized electrical components do not exceed the values given in Table V of IEC Publication 694. During the tests, lubrication in accordance with the manufacturer's instructions is permitted, but no mechanical adjustment.

For manually operated disconnectors and earthing switches, the handle may, for convenience of testing, be replaced by an external power-operated device. In this case, it is not necessary to vary the supply voltage.

The closed and open positions shall be attained during each operating cycle.

In the case of a dependent manual operating mechanism, the values of the operating torques measured after the test shall not be increased by more than 20% from the torque values noted before the test.

During the test, satisfactory operation of the control and auxiliary contacts and position-indicating devices (if any) shall be verified.

After the test, all parts, including contacts, shall be in good condition and shall not show undue wear; see also Note 5 of Table V of IEC Publication 694.

6.102.4 *Verification of operation during application of rated mechanical terminal loads*

Twenty-five operating cycles shall be made with the rated mechanical terminal loads, according to Sub-clause 4.103 applied in four directions in turn spaced at 90°, including the wind forces where assigned acting on the equipment.

After these tests, the following verifications are made:

- for electrically operated equipment, that the power consumed by the motor during an operating cycle is not materially increased, and
- for manually operated equipment, that the value of the forces measured during a switching cycle does not differ from the value measured under the same conditions before the tests by more than 20%.

Examples of the application of rated mechanical terminal loads are given in Figures 8 and 9, pages 81 and 82.

Note. – Unless otherwise specified, the rated mechanical terminal load should only be tested in direction F_{a1} for disconnectors with horizontal isolating distance.

6.103 *Operation under severe ice conditions*

6.103.1 *Introduction*

Formation of ice may produce difficulties in the operation of electric power systems. Under certain atmospheric conditions, a deposit of ice can build up to a thickness which sometimes makes the operation of outdoor switching equipment difficult.

Nature produces ice coatings which may be divided into two general categories:

a) clear ice generally resulting from rain falling through air somewhat below the freezing point of water, and

b) rime ice, characterized by a white appearance, formed for example from atmospheric moisture condensing on cold surfaces.

6.103.2 *Applicability*

The tests defined in this sub-clause are to be made only if the manufacturer claims suitability of disconnectors and earthing switches for operation under severe conditions of ice formation.

A procedure is described for producing clear ice coatings which compare with those encountered in nature so that reproducible tests can be made. A choice is provided between two classes of ice thickness: 10 mm and 20 mm.

6.103.3 *Test arrangement*

a) All parts of the disconnector or earthing switch to be tested shall be assembled, together with their operating mechanism, in a room which can be cooled to a temperature of about –10 °C, or outdoors if it is desired to perform the tests in conditions of natural frost.

The energizing of heating elements of the control mechanism is permitted during the test.

Operating members may be shortened in the assembly to suit the test facilities available, provided the angle of rotation of the parts affected remains unchanged.

Note. — In choosing the refrigeration capacity required, the heat content of the water with which the apparatus under test is sprayed has to be taken into account.

b) Single poles of three-pole apparatus may be tested if each pole has a separate operating mechanism. In the case of three-pole apparatus having an operating mechanism common to the three poles, the complete three-pole device shall be tested, except that tests of a single pole operated by the common mechanism may become necessary for apparatus with rated voltage exceeding 72.5 kV, as the majority of testing laboratories cannot accommodate complete standard three-pole apparatus of these voltages. However, it is recommended that mounting structures or spacings should be modified, where this is possible, in order to enable three-pole tests to be made.

c) The disconnector or earthing switch shall be tested for operation from both the open position and the closed position, unless otherwise specified by the user.

d) Any excess oil or grease shall be removed from all outside surfaces as thin films of oil or grease prevent ice from adhering and greatly change the results of tests.

e) To facilitate measurement of ice thickness, a copper bar or tube 30 mm in diameter and 1 m in length shall be mounted in a horizontal position in a place where it will receive the same general rainfall as the apparatus under test. If the specific thermal capacities per unit surface area of test bar and apparatus under test differ considerably, even identical spraying conditions may produce very different ice coatings. These differences in thickness may be minimized by short periods of spraying alternating with longer periods of cooling.

f) The arrangement shall allow the entire apparatus to be sprayed with artificial rain falling from above at various angles from the vertical to 45°. The water used in the spray should be cooled to a temperature between 0 °C and 3 °C and should reach the test object in the liquid state.

Note. — As a guide, it has been observed that between 20 litres and 80 litres per hour per square metre of area sprayed will be required to cause ice to be deposited at a rate of approximately 6 mm per hour.

6.103.4 *Test procedure*

6.103.4.1 *Formation of ice deposit*

A coating of solid clear ice of the required thickness, 10 mm or 20 mm, shall be produced. A typical test procedure for the formation of ice is:

a) With the test disconnector in the open or closed position, lower the air temperature to 2 °C and start the spray of pre-cooled water. Continue this spray for a minimum of 1 h while holding the air temperature in the range of 0.5 °C to 3 °C.

b) Following step *a)*, lower the room temperature to the range of –7 °C to –3 °C while continuing the water spray. The rate of temperature change is not critical and may be whatever is obtainable with available refrigeration apparatus.

c) Hold the room temperature in the range of –7 °C to –3 °C and continue to spray until the specified thickness of ice can be measured on the top surface of the test bar. The amount of water should be controlled to cause ice to build up over the entire disconnector at the rate of approximately 6 mm per hour.

d) Discontinue the spray and maintain the room temperature in the range of –7 °C to –3 °C for a period of at least 4 h. This ensures that all parts of the disconnector and the ice coating have assumed a constant temperature.

Following this ageing period, the satisfactory operation of the disconnector, including its auxiliary equipment, shall be checked.

6.103.4.2 *Checking of operation*

If the disconnector or earthing switch is manually operated, the test may be considered as satisfactorily completed if the apparatus can be operated manually, and if it does not sustain damage which may later interfere with its mechanical or electrical performance.

If the disconnector or earthing switch is electrically, pneumatically or hydraulically operated, the test may be considered as satisfactorily completed if the apparatus can be operated fully by the operating device supplied at its rated voltage or pressure, and if it does not sustain damage which may later interfere with its mechanical or electrical performance.

After completion of the test and with the temperature restored to normal ambient, it shall be demonstrated that there has been no significant change in the contact condition, for example by measurement of contact resistance.

6.104 *Operation at the temperature limits*

These tests apply only to outdoor disconnectors and earthing switches and shall be performed on special request of the user.

The tests shall be carried out with the rated values of voltage and supply pressure.

Single poles of three-pole apparatus may be tested if each pole has a separate operating mechanism. In the case of three-pole apparatus having an operating mechanism common to the three poles, the complete three-pole device shall be tested, except that tests of a single pole operated by the common mechanism may become necessary for apparatus with rated voltage exceeding 72.5 kV, as the majority of testing laboratories cannot accommodate complete standard three-pole apparatus of these voltages. However, it is recommended that mounting structures or spacings should be modified, where this is possible, in order to enable three-pole tests to be made.

6.104.1 *Operation at minimum ambient air temperature*

The disconnector or earthing switch in the closed position, together with its operating devices and auxiliary equipment, shall be placed in a test chamber. The temperature shall be lowered to and maintained at the minimum ambient temperature appropriate to the class of the apparatus (see Sub-clause 2.1 of IEC Publication 694) for a period long enough to reach temperature balance. The apparatus shall then complete 10 operating cycles satisfactorily.

The energizing of heating elements of the control mechanism is permitted during the test.

6.104.2 *Operation at maximum ambient air temperature*

The disconnector or earthing switch in the closed position, together with its operating devices and auxiliary equipment, shall be placed in a test chamber. The temperature shall be raised to and maintained at the maximum ambient temperature of 40 °C (see Sub-clause 2.1 of IEC Publication 694) for a period long enough to reach temperature balance. The apparatus shall then complete 10 operating cycles satisfactorily.

7. Routine tests

Clause 7 of IEC Publication 694 is applicable with the following addition to the list of routine tests:

d) mechanical operating tests.

7.1 *Power-frequency voltage withstand dry tests on the main circuit*

Sub-clause 7.1 of IEC Publication 694 is applicable with the following additions:

The test conditions when testing disconnectors shall be in accordance with Table VIII.

TABLE VIII

Power-frequency voltage tests

Test condition No.	Disconnector position	Voltage applied to	Earth connected to
1*	Closed	AaCc	BbF
2*	Closed	Bb	AaCcF
3	Open	ABC	abcF
4	Open	abc	ABCF

* If the insulation between poles is air at atmospheric pressure, test conditions Nos. 1 and 2 may be combined, the test voltage being applied between all parts of the main circuit connected together and the base.

When testing earthing switches, the test voltage shall be raised to the withstand value specified and maintained for 1 min. The voltage shall be applied between the insulated terminals and between all the insulated terminals connected together and the base earthed, with the earthing switch open.

7.2 *Voltage withstand tests on auxiliary and control circuits*

Sub-clause 7.2 of IEC Publication 694 is applicable.

7.3 *Measurement of the resistance of the main circuit*

Sub-clause 7.3 of IEC Publication 694 is applicable.

7.101 *Mechanical operating tests*

Operating tests are made to ensure that the disconnectors or earthing switches comply with the prescribed operating conditions within the specified voltage and supply pressure limits of their operating devices.

During these tests, which are performed without voltage on, or current in, the main circuit, it shall be verified, in particular, that the disconnectors or earthing switches open and close correctly when their operating devices are energized or under pressure. It shall also be verified that operation will not cause any damage to the disconnectors or earthing switches.

The tests shall comprise:

a) at rated supply voltage and/or rated pressure of compressed gas supply and for hand-operated disconnectors or earthing switches: 50 operating cycles;

b) at specified maximum supply voltage and/or maximum pressure of compressed gas supply: 10 operating cycles;

c) at specified minimum supply voltage and/or minimum pressure of compressed gas supply: 10 operating cycles.

During these tests, no adjustment shall be made and the operation shall be faultless. The closed and open positions shall be attained during each operating cycle.

After these tests, no parts of the disconnector or earthing switch shall have been damaged.

8. Guide to the selection of switching devices for service

8.101 *General*

A disconnector or earthing switch suitable for a given duty in service is best selected by considering the individual rated values required by load conditions and fault conditions.

Co-ordination tables of rated values for disconnectors and earthing switches are given in Sub-clause 4.107.

It is desirable that the rated values of a disconnector or earthing switch should be chosen from these tables according to the characteristics of the system as well as to its anticipated developments.

The complete list of rated characteristics is given in Clause 4.

Other parameters to be considered when selecting a disconnector or earthing switch are, for example:

- local atmospheric and climatic conditions;
- use at high altitude.

The duty imposed by the fault conditions with which a disconnector or earthing switch is required to deal should be determined by calculating the fault currents at the place where the disconnector or earthing switch is to be located in the system, in accordance with some recognized method of calculation.

When selecting a disconnector or earthing switch, due allowance should be made for the likely future development of the system as a whole, so that the disconnector or earthing switch may be suitable not merely for immediate needs but also for the requirements of the future.

8.102 *Selection of rated values for normal service conditions*

8.102.1 *Selection of rated voltage*

The rated voltage of the disconnector or earthing switch should be chosen so as to be at least equal to the highest voltage of the system at the point where the disconnector or earthing switch is to be installed.

The rated voltage of a disconnector or earthing switch should be selected from the standard values given in Sub-clause 4.1 of IEC Publication 694.

Preferred combinations of rated voltage, rated short-time withstand current, rated peak withstand current and rated normal current are given in the co-ordination tables in Sub-clause 4.107.

The insulation level tables in Sub-clause 4.2 should also be taken into account in the selection of the rated voltage.

The rated voltages given in the above-mentioned tables are voltages between lines.

8.102.2 *Insulation co-ordination*

The rated insulation level of a disconnector or earthing switch shall be selected from Tables I to IV of IEC Publication 694. Current practice in the United States of America and Canada is given in Table I of this standard.

Where a disconnector or earthing switch is required for a position necessitating a higher insulation level, this shall be specified in the enquiry (see Sub-clause 9.101).

8.102.3 *Selection of rated normal current*

The rated normal current of a disconnector should be selected from the R10 series (see Sub-clause 4.4.1 of IEC Publication 694).

Preferred combinations of rated normal current, rated voltage, rated short-time withstand current and rated peak withstand currents are given in the co-ordination tables in Sub-clause 4.107.

It should be noted that disconnectors have no specified continuous overcurrent capability. When selecting a disconnector, therefore, the rated normal current should be such as to make it suitable for any load current that may occur in service. Where intermittent overcurrents are expected to be frequent and severe, the manufacturer should be consulted.

Note. — It is understood that the rated normal current is the current that a disconnector can carry continuously except for uncommon conditions of use. Such conditions may be met, for example for generator disconnectors which may be in the closed position for a very long time at a current near the rated normal current without being operated, and in a high ambient temperature. In such cases, the manufacturer should be consulted.

8.102.4 *Local atmospheric and climatic conditions*

The normal atmospheric and climatic conditions for disconnectors and earthing switches are given in Sub-clause 2.1 of IEC Publication 694.

A distinction is made between classes "minus 5 indoor", "minus 25 indoor", "minus 25 outdoor" and "minus 40 outdoor" disconnectors and earthing switches, these being suitable for differing minimum ambient air temperatures. Where the lower values are required, it is necessary to state so clearly. The manufacturer should be consulted if an apparatus is to be located where the ambient air temperature may fall below – 25 °C for an indoor apparatus and below – 40 °C for an outdoor apparatus, or where the temperature may exceed 40 °C (or if the 24 h average exceeds 35 °C).

For outdoor disconnectors and earthing switches, the atmospheric conditions in certain areas are unfavourable on account of smoke, chemical fumes, salt-laden spray and the like. Where such adverse conditions are known to exist, special consideration should be given to the design of those parts of the disconnector or earthing switch, especially the insulators normally exposed to the atmosphere.

The performance of an insulator in such atmospheres also depends on the frequency with which artificial washing or natural cleaning is carried out. Since the performance of an insulator under such conditions is dependent on so many factors, it is not possible to give precise definitions of normal and heavily polluted atmospheres. Experience in the area where the insulator is to be used is the best guide.

The manufacturer should be consulted when the disconnector or earthing switch is to be located where the wind pressure exceeds 700 Pa. If a disconnector or earthing switch is to be located where an ice-coating with a thickness exceeding 1 mm is expected, agreement should be reached between manufacturer and user as to the ability of the disconnector or earthing switch to perform correctly under such conditions (for operation tests under severe ice conditions, see Sub-clause 6.103). Agreement should also be reached between manufacturer and user in cases where earth tremors can be expected.

For indoor installations, in coastal areas where salt pollution is a problem, it is recommended to use outdoor equipment.

8.102.5 *Use at high altitudes*

The normal service conditions in Sub-clause 2.1 of IEC Publication 694 provide for disconnectors and earthing switches intended for use at altitudes not exceeding 1 000 m.

For installations at altitudes above 1 000 m, the manufacturer should be consulted.

8.102.6 *Selection of rated short-time withstand current and of rated duration of short circuit*

The rated short-time withstand current should be selected from the R10 series (see Sub-clause 4.5 of IEC Publication 694).

Preferred combinations of rated short-time withstand current, rated peak withstand current, rated voltage and rated normal current are given in the co-ordination tables in Sub-clause 4.107.

The standard value of rated duration of short-circuit current given in Sub-clause 4.7 of IEC Publication 694 is 1 s.

If, however, a higher duration is necessary, the value of 3 s should be selected.

For short-circuit durations greater than the rated value, the relation between current and time, unless otherwise stated by the manufacturer, is in accordance with the formula:

$$I^2 \times t = \text{constant}$$

8.102.7 *Selection of rated peak withstand current and of rated short-circuit making current for earthing switches*

The selected disconnector or earthing switch shall have a rated peak withstand current not less than the highest peak value of the fault current.

Unless otherwise stated, the rated peak withstand current is 2.5 times (i.e. approximately 1.8 $\sqrt{2}$ times) the rated short-time withstand current.

In some cases, for example when induction motors are electrically close, the maximum peak value of the fault current may be more than 2.5 times the rated short-time withstand current. In such cases, a special design should be avoided and a standard disconnector or earthing switch having a suitable rated peak withstand current should be selected.

These considerations also apply to the rated short-circuit making current, where required, of an earthing switch.

9. Information to be given with enquiries, tenders and orders

9.101 *Information to be given with enquiries and orders*

When enquiring for or ordering a disconnector or earthing switch, the following particulars should be supplied by the enquirer:

1. Particulars of system, i.e. nominal and highest voltages, frequency, number of phases and details of neutral earthing.

2. Service conditions including minimum and maximum ambient air temperatures, the latter, if greater than the normal values; altitude if over 1 000 m; and any special conditions likely to exist or arise, for example unusual exposure to steam or vapour, moisture, fumes, explosive gases, excessive dust or salt air (see Sub-clauses 8.102.4 and 8.102.5).

3. Characteristics of a disconnector or earthing switch. The following information should be given:

   a) number of poles;

   b) class: indoor or outdoor;

   c) rated voltage;

   d) rated insulation level where a choice exists between different insulation levels corresponding to a given rated voltage or, if other than standard, desired insulation level;

   e) rated frequency;

   f) rated normal current (for disconnectors only);

   g) rated short-time withstand current;

   h) rated short-circuit making current if any (for earthing switches only);

   i) if other than standard, specified value of duration of short circuit;

   j) mechanical terminal load;

   k) mounting conditions and connections of the disconnector and earthing switch;

   l) the type tests specified on special request (artificial pollution and radio interference);

   m) for disconnectors of rated voltage $\geqslant$ 300 kV, Class A or Class B rated switching impulse withstand voltage.

4. Characteristics of the operating mechanism and associated equipment, in particular:

   a) method of operation, whether manual or power;

   b) number and type of spare auxiliary switches;

   c) rated supply voltage and rated supply frequency.

5. Requirements concerning the use of compressed gas and requirements for design and tests of pressure vessels.

Note. — The enquirer should give information of any special conditions not included above that might influence the tender or the order.

9.102 *Information to be given with tenders*

When the enquirer requests technical particulars of a disconnector or earthing switch, the following information, where applicable, should be given by the manufacturer with the descriptive matter and drawings:

9.102.1 *Rated values and characteristics*

a) number of poles;

b) class: indoor or outdoor;

c) rated voltage;

d) rated insulation level;

e) rated frequency;

f) rated normal current (for disconnectors only);

g) rated short-time withstand current;

h) rated short-circuit making current (for earthing switches only);

i) the type tests specified on special request (artificial pollution and radio interference);

j) for disconnectors of rated voltage $\geqslant$300 kV, Class A or Class B rated switching impulse withstand voltage.

9.102.2 *Type tests*

Certificate or report on request.

9.102.3 *Constructional features*

a) mass of complete disconnector or earthing switch;

b) pressure and limits of pressure between which the disconnector or earthing switch will operate correctly (if operated by pneumatic or hydraulic device);

c) minimum clearances in air:
- between poles,
- to earth,
- for isolating distance (for disconnectors only);

d) for divided frame assemblies, how to achieve and adjust the isolating distance or gap.

9.102.4 *Operating mechanism of a disconnector or earthing switch and associated equipment*

a) type of operating mechanism;

b) rated supply voltage and/or pressure of operating mechanism;

c) current required at rated supply voltage to operate the disconnector or earthing switch;

d) quantity of free gas required to operate the disconnector or earthing switch at the rated supply pressure;

e) number and type of auxiliary switches;

f) design of the device or description of means for securing the position;

g) design of indicating or signalling device.

9.102.5 *Overall dimensions and other information*

The manufacturer should give the necessary information as regards the overall dimensions of the disconnector or earthing switch in the open and closed positions and details necessary for the design of the foundation. General information regarding maintenance should also be given (see Sub-clause 10.3 of IEC Publication 694).

10. Rules for transport, storage, erection and maintenance

Clause 10 of IEC Publication 694 is applicable.

10.1 *Conditions during transport, storage and erection*

Sub-clause 10.1 of IEC Publication 694 is applicable.

10.2 *Erection*

Sub-clause 10.2 of IEC Publication 694 is applicable.

10.3 *Maintenance*

Sub-clause 10.3 of IEC Publication 694 is applicable.

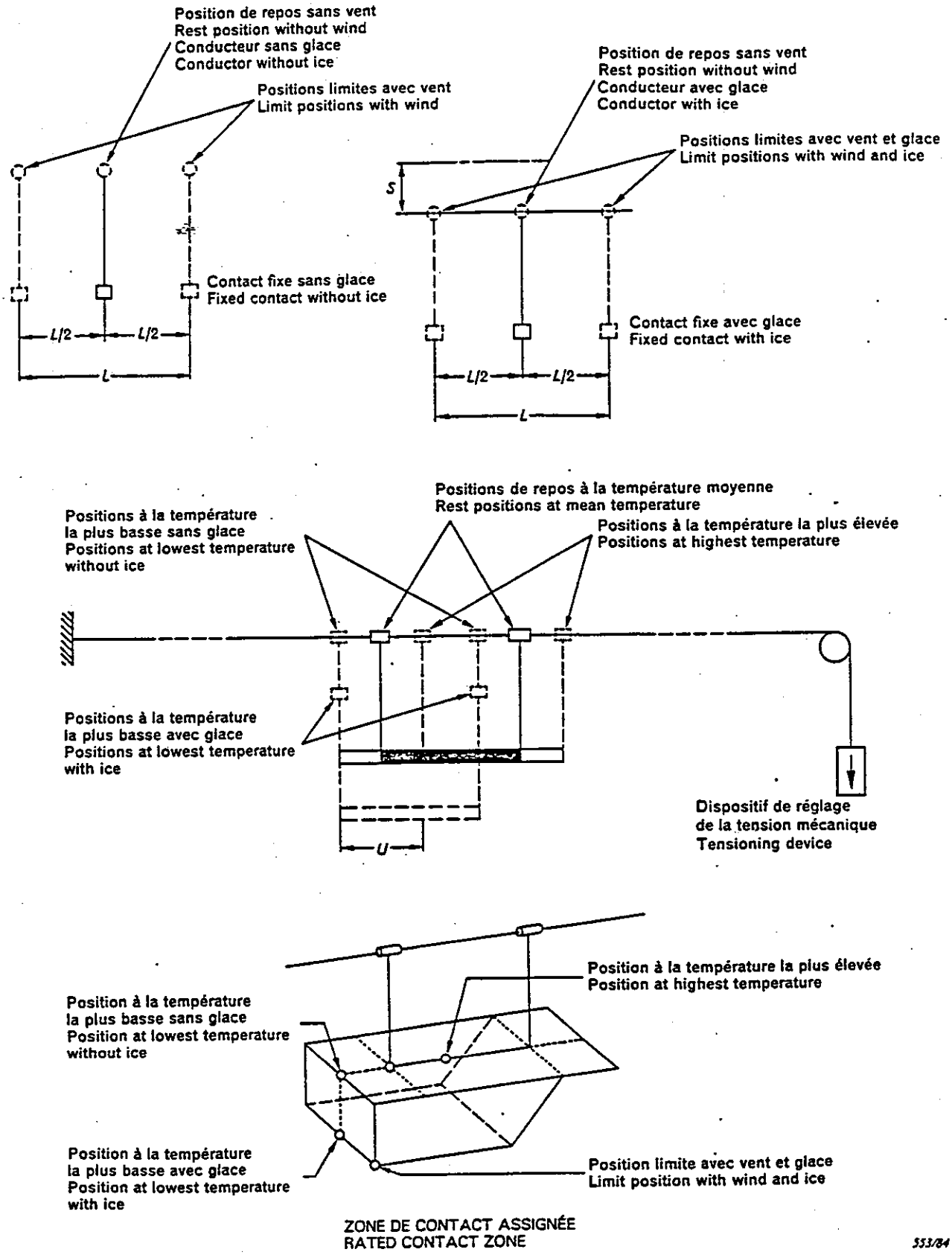


FIG. 1. — Pièce de contact fixe parallèle au conducteur support.
Fixed contact piece parallel to the supporting conductor.

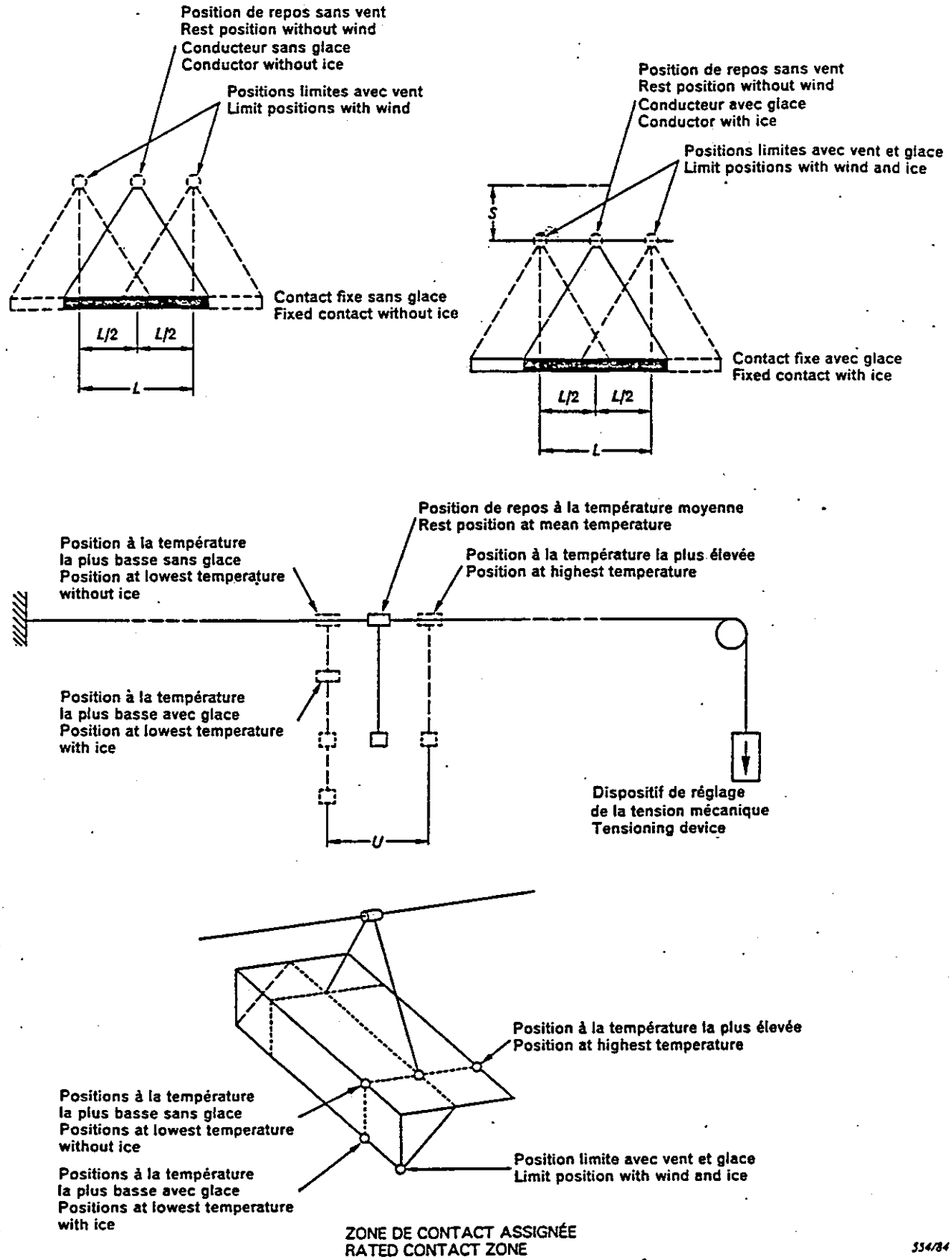


FIG. 2. — Pièce de contact fixe perpendiculaire au conducteur support.
Fixed contact piece perpendicular to the supporting conductor.

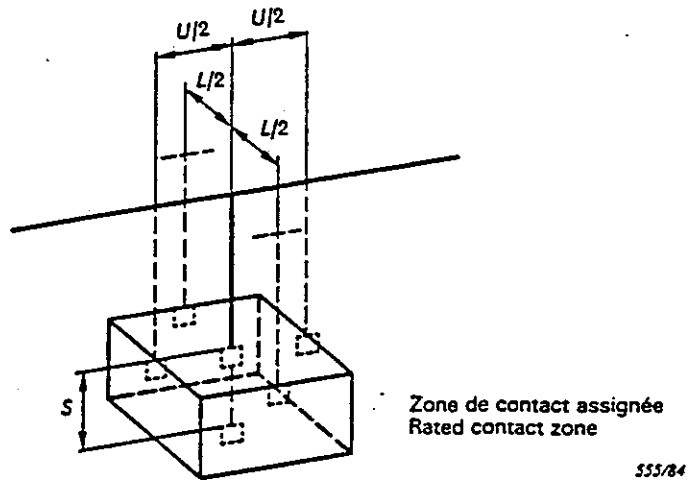
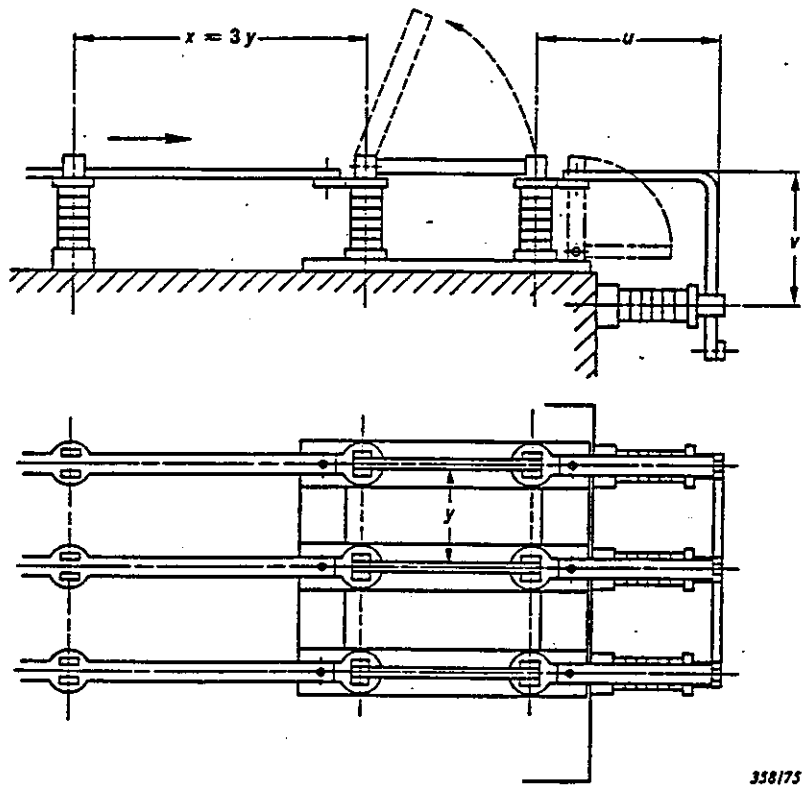


FIG. 3. — Cas des conducteurs rigides.
Case of rigid conductors

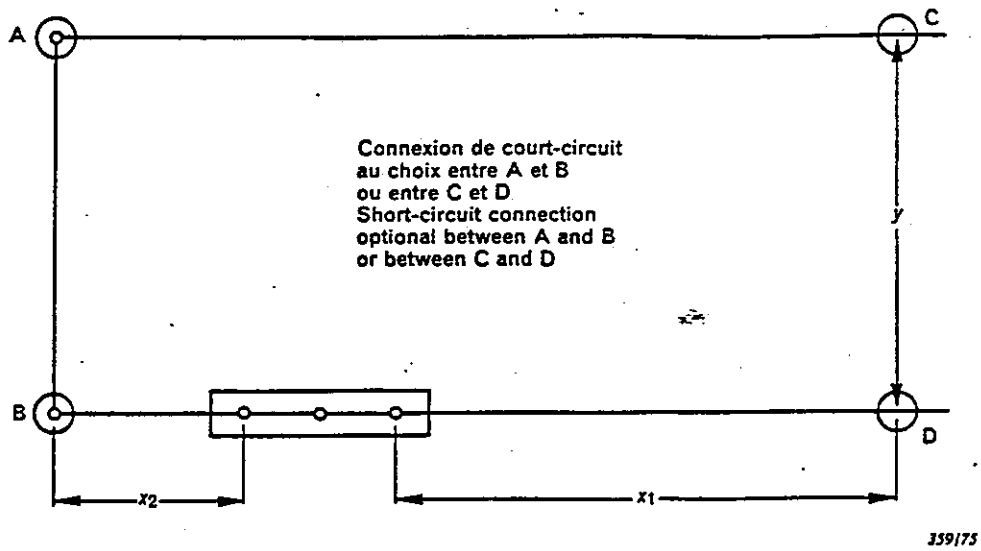


Note. — Il convient de s'assurer que des efforts non représentatifs des conditions de service ne sont pas introduits par les connexions à la source d'alimentation.

Note. — Care should be taken that forces not representative of service conditions are not introduced by the connections to the supply.

FIG. 4. — Exemple d'une disposition d'essai triphasé pour des sectionneurs de tension inférieure ou égale à 52 kV et dont la valeur de crête du courant admissible assigné ne dépasse pas 100 kA.

Example of a three-phase test arrangement for disconnectors up to and including 52 kV and rated peak withstand currents not exceeding 100 kA.



Sauf spécification contraire, pour les sectionneurs avec des efforts longitudinaux sur les bornes négligeables et raccordés par des conducteurs souples:

$$x_1 = 2\,y$$
$$x_2 = 0.5\,y$$

y = distance minimale entre axes de pôles voisins, indiquée par le constructeur

Notes 1. — La tension, la flèche, le nombre d'entretoises, etc., des conducteurs souples sont à l'étude et, par conséquent, définis par accord entre constructeur et utilisateur.

2. — Il convient de s'assurer que des efforts non représentatifs des conditions de service ne sont pas introduits par les connexions à la source d'alimentation.

3. — En principe, la figure 5 s'applique également à l'essai des sectionneurs de terre, le sectionneur de terre étant disposé de façon appropriée.

4. — Les sectionneurs destinés à être utilisés dans des installations équipées de conducteurs rigides peuvent être essayés avec la même disposition mais avec des conducteurs rigides et $x_1 = 1.2\,y$; $x_2 = 0.5\,y$.

Disconnectors connected by flexible conductors with negligible longitudinal terminal loads unless otherwise stated:

$$x_1 = 2\,y$$
$$x_2 = 0.5\,y$$

y = minimum centre-to-centre distance between adjacent poles, as stated by the manufacturer

Notes 1. — Tension, sag, number of spacers, etc., of flexible conductors are under consideration and, therefore, subject to agreement between manufacturer and user.

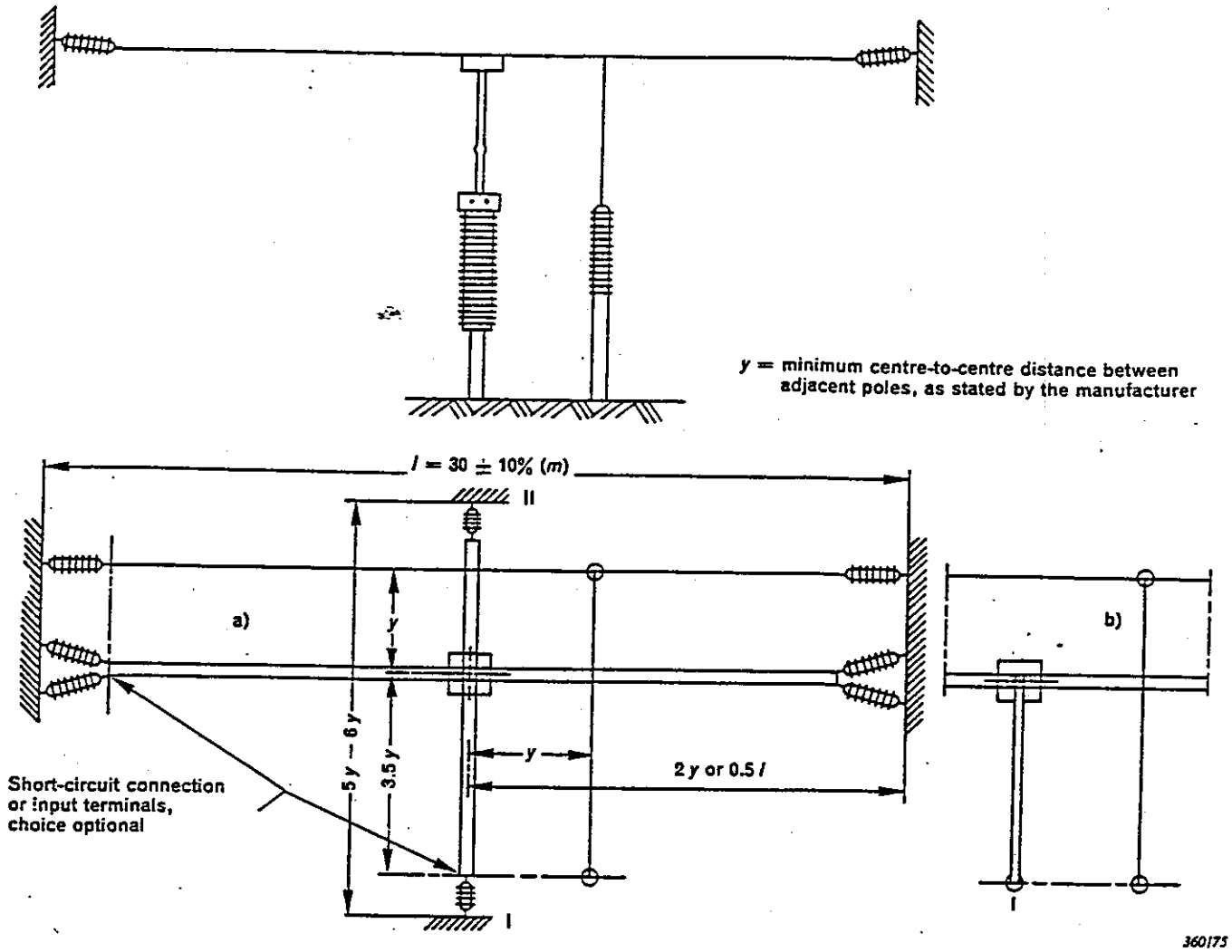
2. — Care should be taken that forces not representative of service conditions are not introduced by the connections to the supply.

3. — In principle, Figure 5 is also applicable for testing earthing switches with the appropriate arrangement of earth conductor.

4. — Disconnectors intended to be used in plants with rigid conductors may be tested in the same arrangement but with rigid conductors and $x_1 = 1.2\,y$; $x_2 = 0.5\,y$.

FIG. 5. — Exemple d'une disposition d'essai monophasé pour sectionneurs comportant une distance de sectionnement horizontale et de tensions assignées supérieures à 52 kV.

Example of a single-phase test arrangement for disconnectors with a horizontal isolating distance with rated voltages exceeding 52 kV.



Disconnector with small rated mechanical terminal load

Test arrangement a)

Single or bundled flexible conductors anchored at points I and II and supported on the disconnector without longitudinal terminal load.

Alternative test arrangement b)

Rigid conductor supported on the disconnector and at point I.

Disconnector with heavy rated mechanical terminal load

Test arrangement b)

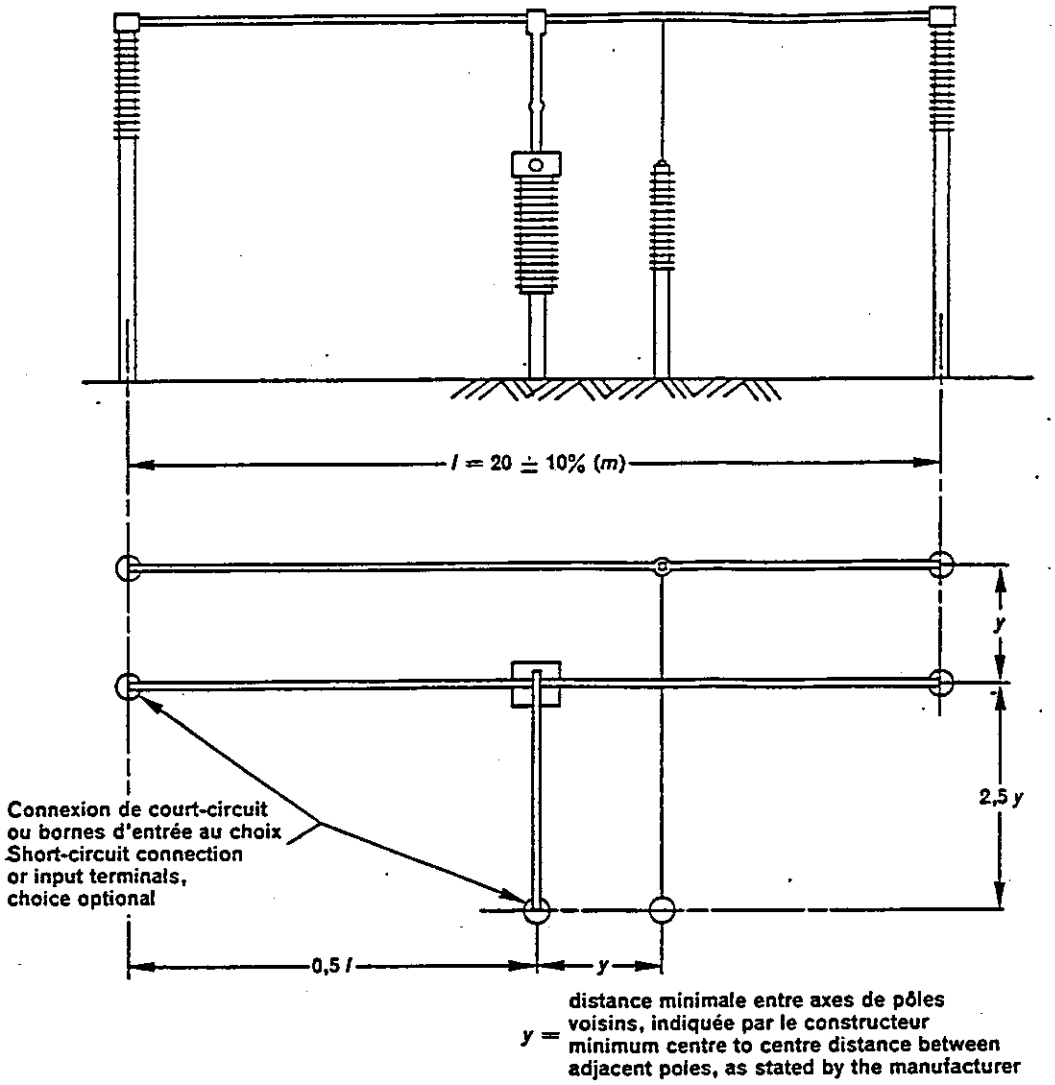
Single or bundled flexible conductors anchored at pantograph disconnector and at point I. Rated mechanical terminal load in accordance with Sub-clause 4.103.

Notes 1. — Tension, sag, number of spacers, etc., of flexible conductors are under consideration and therefore subject to agreement between manufacturer and user.

2. — Care should be taken that forces not representative of service conditions are not introduced by the connections to the supply.

3. — In principle, Figure 6 is also applicable for testing earthing switches with the appropriate arrangement of earth conductor.

FIG. 6. — Examples of single-phase test arrangements for disconnectors with a vertical isolating distance with rated voltages exceeding 52 kV.



Notes 1. — La définition complète de la disposition d'essai est à l'étude et, par conséquent, il est actuellement recommandé qu'elle fasse l'objet d'un accord entre constructeur et utilisateur.

2. — Limite inférieure pour la distance Z entre les conducteurs parallèles: $Z = 0{,}5$ fois la distance minimale entre pôles, indiquée par le constructeur.

Notes 1. — The complete definition of the test arrangement is under consideration and therefore, at the present time, it should be subject to agreement between manufacturer and user.

2. — Lower limit for the distance Z of parallel conductors: $Z = 0.5$ times minimum distance between poles as indicated by the manufacturer.

FIG. 7. — Exemple d'une disposition d'essai monophasé pour sectionneurs comportant une distance de sectionnement verticale, de tensions assignées supérieures à 52 kV et prévus pour être utilisés avec des conducteurs rigides.

Example of a single-phase test arrangement for disconnectors with a vertical isolating distance with rated voltages exceeding 52 kV to be used with rigid conductors.

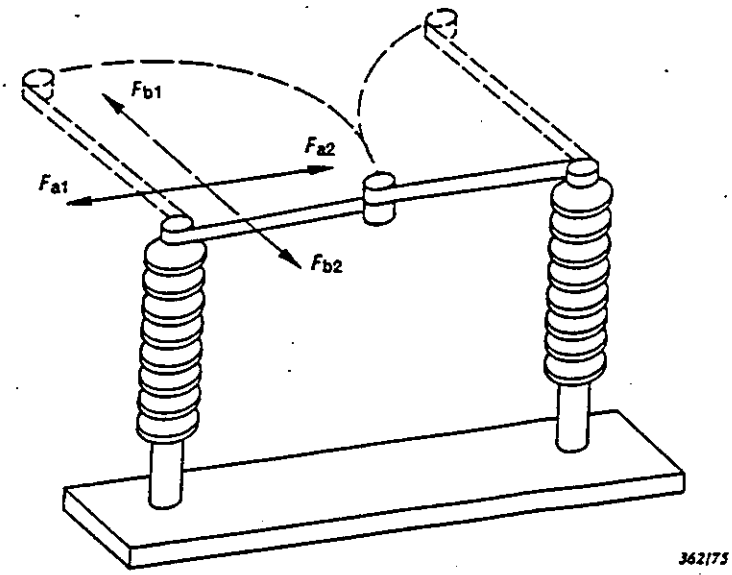


FIG. 8. — Exemple d'application des efforts mécaniques assignés sur les bornes d'un sectionneur à deux colonnes.

Example of the application of rated mechanical terminal loads to a two-column disconnector.

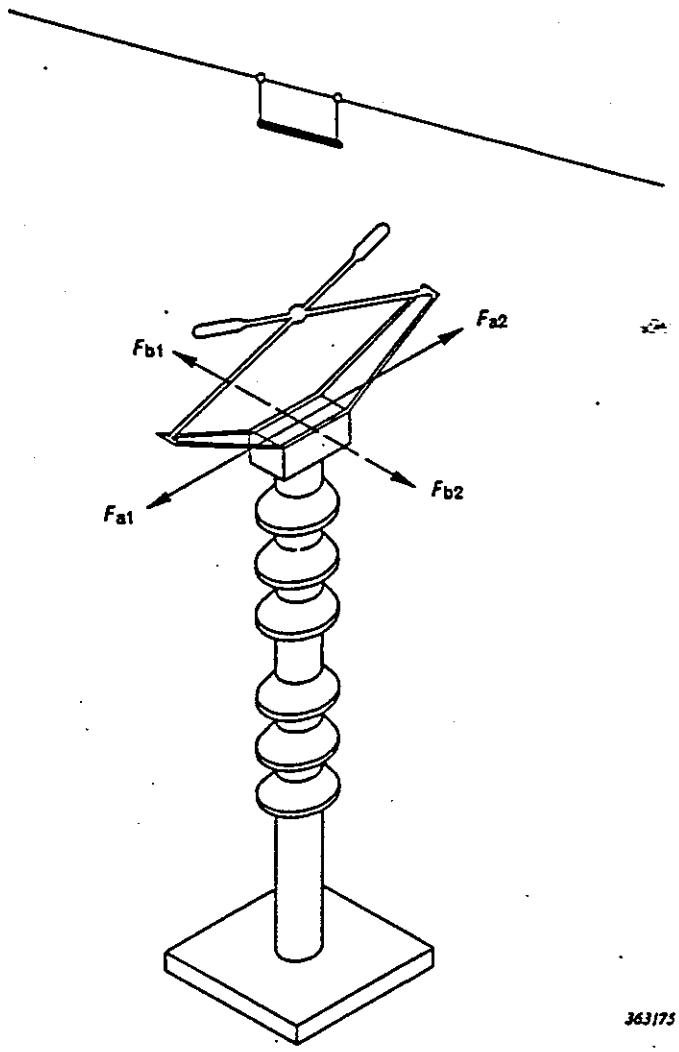


FIG. 9. — Exemple d'application des efforts mécaniques assignés sur les bornes d'un sectionneur pantographe.

Example of the application of rated mechanical terminal loads to a pantograph disconnector.

Publications de la CEI préparées par le Comité d'Etudes n° 17

54 (1936)[1]	Recommandations de la CEI concernant la normalisation du sens de mouvement des organes de manœuvre et les lampes indicatrices de disjoncteurs.
277 (1968)	Définitions relatives à l'appareillage.
277A (1971)	Premier complément.
470 (1974)	Contacteurs haute tension à courant alternatif. Modification n° 1 (1975).
632: — Démarreurs de moteurs à haute tension.	
632-1 (1978)	Première partie: Démarreurs directs (sous pleine tension) en courant alternatif.

Publications de la CEI préparées par le Sous-Comité 17A

56: — Disjoncteurs à courant alternatif à haute tension.

56-1 (1971)	Première partie: Généralités et définitions (Troisième édition comprenant les Modifications n° 1 et n° 2).
56-2 (1971)	Deuxième partie: Caractéristiques nominales. (Troisième édition comprenant les Modifications n° 1, n° 2 et n° 3.) Modification n° 4 (1981).
56-3 (1971)	Troisième partie: Conception et construction. (Troisième édition comprenant la Modification n° 1.)
56-4 (1972)	Quatrième partie: Essais de type et essais individuels. (Troisième édition comprenant les Modifications n° 1 et n° 2.) Modification n° 3 (1981).
56-4A (1974)	Premier complément: Annexe E: Méthodes de détermination des ondes de la tension transitoire de rétablissement présumée.
56-5 (1971)	Cinquième partie: Règles pour le choix des disjoncteurs selon le service. (Troisième édition comprenant la Modification n° 1.) Modification n° 2 (1981).
56-6 (1971)	Sixième partie: Renseignements à donner dans les appels d'offres, les soumissions et les commandes et les règles pour le transport, l'installation et l'entretien. (Troisième édition comprenant la Modification n° 1.) Modification n° 2 (1981).
129 (1984)	Sectionneurs et sectionneurs de terre à courant alternatif.
265 (1968)	Interrupteurs à haute tension. Modification n° 1 (1975). Modification n° 2 (1976).
265A (1969)	Premier complément: Essais de mise en et hors circuit d'une batterie unique de condensateurs.
265B (1969)	Deuxième complément.
265C (1970)	Troisième complément: Essais pour la vérification du pouvoir de coupure de lignes à vide et de câbles à vide.
265-1 (1983)	Première partie: interrupteurs à haute tension pour tensions assignées supérieures à 1 kV et inférieures à 52 kV[2]. Modification N° 1 (1984).
267 (1968)	Guide pour l'essai des disjoncteurs en ce qui concerne la mise en et hors circuit lors d'une discordance de phases.
420 (1973)	Combinés interrupteurs-fusibles et combinés disjoncteurs-fusibles à haute tension pour courant alternatif. Modification n° 1 (1975). Modification n° 2 (1977). Modification n° 3 (1978).
427 (1973)	Rapport sur les essais synthétiques des disjoncteurs à courant alternatif à haute tension.
518 (1975)	Normalisation dimensionnelle des bornes de l'appareillage à haute tension.
694 (1980)	Clauses communes pour les normes de l'appareillage à haute tension.

Publications de la CEI préparées par le Sous-Comité 17C

298 (1981)	Appareillage sous enveloppe métallique pour courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 72,5 kV.
466 (1974)	Appareillage à haute tension sous enveloppe isolante. Modification n° 1 (1977). Modification n° 2 (1978). Modification n° 3 (1979).
517 (1975)	Appareillage à haute tension sous enveloppe métallique de tensions nominales égales ou supérieures à 72,5 kV. Modification n° 1 (1977). Modification n° 2 (1982). Modification n° 3 (1983).

[1] Cette publication est remplacée par la Publication 447 en ce qui concerne les sens de mouvement.

[2] Cette publication remplace la publication 265 (1968), Modification n° 1 (1975), Modification n° 2 (1976), Complément 265A (1969), 265B (1969) et 265C (1970), pour tension inférieure à 52 kV.

IEC publications prepared by Technical Committee No. 17

54 (1936)[1]	IEC recommendations for standard direction of motion of operating devices and for indicating lamps for circuit-breakers.
277 (1968)	Definitions for switchgear and controlgear.
277A (1971)	First supplement.
470 (1974)	High-voltage alternating current contactors. Amendment No. 1 (1975).
632: — High-voltage motor starters.	
632-1 (1978)	Part 1: Direct-on-line (full voltage) a.c. starters.

IEC publications prepared by Sub-Committee 17A

56: — High-voltage alternating-current circuit breakers.

56-1 (1971)	Part 1: General and definitions (Third edition incorporating Amendments No. 1 and No. 2).
56-2 (1971)	Part 2: Rating. (Third edition incorporating Amendments No. 1, No. 2 and No. 3.) Amendment No. 4 (1981).
56-3 (1971)	Part 3: Design and construction. (Third edition incorporating Amendment No. 1.)
56-4 (1972)	Part 4: Type tests and routine tests. (Third edition incorporating Amendment No. 1 and No. 2.) Amendment No. 3 (1981).
56-4A (1974)	First supplement: Appendix E: Methods of determining prospective transient recovery voltage waves.
56-5 (1971)	Part 5: Rules for the selection of circuit-breakers for service. (Third edition incorporating Amendment No. 1.) Amendment No. 2 (1981)
56-6 (1971)	Part 6: Information to be given with enquiries, tenders and orders and rules for transport, erection and maintenance. (Third edition incorporating Amendment No. 1.) Amendment No. 2 (1981).
129 (1984)	Alternating current disconnectors and earthing switches.
265 (1968)	High-voltage switches. Amendment No. 1 (1975). Amendment No. 2 (1976).
265A (1969)	First supplement: Tests for single capacitor bank switching.
265B (1969)	Second supplement.
265C (1970)	Third supplement: Test for line and cable switching.
265-1 (1983)	Part 1: High-voltage switches for rated voltages above 1 kV and less than 52 kV[2]. Amendment No. 1 (1984).
267 (1968)	Guide to the testing of circuit-breakers with respect to out-of-phase switching.
420 (1973)	High-voltage alternating current fuse-switch combinations and fuse-circuit-breaker combinations. Amendment No. 1 (1975). Amendment No. 2 (1977). Amendment No. 3 (1978).
427 (1973)	Report on synthetic testing of high-voltage alternating current circuit-breakers.
518 (1975)	Dimensional standardization of terminals for high-voltage switchgear and controlgear.
694 (1980)	Common clauses for high-voltage switchgear and controlgear standards.

IEC publications prepared by Sub-Committee 17C

298 (1981)	A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 72.5 kV.
466 (1974)	High-voltage insulation-enclosed switchgear and controlgear. Amendment No. 1 (1977). Amendment No. 2 (1978). Amendment No. 3 (1979).
517 (1975)	High-voltage metal-enclosed switchgear for rated voltages of 72.5 kV and above. Amendment No. 1 (1977). Amendment No. 2 (1982). Amendment No. 3 (1983).

[1] This publication is replaced by Publication 447 wherever direction of motion is concerned.

[2] This publication supersedes Publication 265 (1968), Amendment No. 1 (1975) Amendment No. 2 (1976), Supplement 265A (1969), 265B (1969) and 265C (1970), for voltages less than 52 kV.

NORME INTERNATIONALE
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CEI
IEC
129

1984

AMENDEMENT 1
AMENDMENT 1

1992-12

Amendement 1

Sectionneurs et sectionneurs de terre à courant alternatif

Amendment 1

Alternating current disconnectors and earthing switches

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE C

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For price, see current catalogue

FOREWORD

This amendment has been prepared by sub-committee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The text of this amendment is based on the following documents:

DIS	Reports on Voting
17A(CO)196 17A(CO)225	17A(CO)202 17A(CO)238

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

Page 21

4.102 *Rated contact zone*

Replace the last paragraph by the following:

Examples of rated contact zones of pantograph and semi-pantograph disconnectors and earthing switches having "fixed" contacts supported by flexible conductors are illustrated in figures 1 and 2, pages 74 and 75, and given in table IIA, page 23.

Replace the paragraph on page 23, between tables IIA and IIB, by the following:

Examples of rated contact zones of pantograph and semi-pantograph disconnectors and earthing switches having "fixed" contacts supported by rigid conductors are given in table IIB and in figure 3, page 76.

Add the following paragraph after table IIB:

The rated contact zones of other types of divided support disconnectors and earthing switches, for example suspended disconnectors, are determined by agreement between manufacturer and user.

7.1 *Power-frequency voltage withstand dry tests on the main circuit*

Add the following new paragraphs:

When the insulation of disconnectors and earthing switches is provided only by solid core insulators and air at ambient air-pressure, the power-frequency voltage withstand test may be omitted if the dimensions between the conductive parts – between poles, between open contacts and between conductive parts and the frame – are checked by measurements.

Bases for the checking of dimensions are the dimensional (outline) drawings, which are part of the type test report (or are referred to in it) of the particular disconnector or earthing switch. Therefore, in these drawings all information necessary for dimensional checking including the permissible tolerances shall be given.

Publications de la CEI préparées par le Comité d'Etudes n° 17

56 (1987) Disjoncteurs à courant alternatif à haute tension.
Amendement 1 (1992).

129 (1984) Sectionneurs et sectionneurs de terre à courant alternatif.
Amendement 1 (1992).

158: – Appareillage de commande à basse tension.

158-2 (1982) Deuxième partie: Contacteurs à semiconducteurs (contacteurs statiques).

158-3 (1985) Troisième partie: Prescriptions complémentaires pour conducteurs sujets à certification.

265: – Interrupteurs à haute tension.

265-1 (1983) Première partie: Interrupteurs à haute tension pour tensions assignées supérieures à 1 kV et inférieures à 52 kV.
Modification n° 1 (1984).

265-2 (1988) Deuxième partie: Interrupteurs à haute tension de tension assignée égale ou supérieure à 52 kV.

298 (1990) Appareillage sous enveloppe métallique pour courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV.

420 (1990) Combinés interrupteurs-fusibles à haute tension pour courant alternatif.

427 (1989) Essais synthétiques des disjoncteurs à courant alternatif à haute tension.
Amendement 1 (1992).

439: – Ensembles d'appareillages à basse tension.

439-1 (1992) Première partie: Ensembles de série et ensembles dérivés de série.

439-2 (1987) Deuxième partie: Règles particulières pour les canalisations préfabriquées.
Amendement n° 1 (1991).

439-3 (1990) Troisième partie: Règles particulières pour ensembles d'appareillage BT destinés à être installés en des lieux accessibles à des personnes non qualifiées pendant leur utilisation - Tableaux de répartition.

439-4 (1990) Quatrième partie: Règles particulières pour ensembles de chantier (EC).

466 (1987) Appareillage sous enveloppe isolante pour courant alternatif de tension assignée supérieure à 1 kV et inférieure ou égale à 38 kV.

470 (1974) Contacteurs haute tension à courant alternatif.
Modification n° 1 (1975).

517 (1990) Appareillage sous enveloppe métallique à isolation gazeuse de tension assignée égale ou supérieure à 72,5 kV.

518 (1975) Normalisation dimensionnelle des bornes de l'appareillage à haute tension.

632: – Démarreurs de moteurs à haute tension.

632-1 (1978) Première partie: Démareurs directs (sous pleine tension) en courant alternatif.

694 (1980) Clauses communes pour les normes de l'appareillage à haute tension.
Modification n° 1 (1985).

715 (1981) Dimensions de l'appareillage à basse tension. Montage normalisé sur profilés-supports pour le support mécanique des appareils électriques dans les installations d'appareillage à basse tension.

859 (1986) Raccordement de câbles pour appareillage sous enveloppe métallique à isolation gazeuse pour tension assignée égale ou supérieure à 72,5 kV.

(Suite)

IEC publications prepared by Technical Committee No. 17

56 (1987) High-voltage alternating-current circuit breakers.
Amendment 1 (1992).

129 (1984) Alternating current disconnectors (isolators) and earthing switches.
Amendment 1 (1992).

158: – Low-voltage controlgear.

158-2 (1982) Part 2: Semiconductor contactors (solid state contactors).

158-3 (1985) Part 3: Additional requirements for contactors subject to certification.

265: – High-voltage switches.

265-1 (1983) Part 1: High-voltage switches for rated voltages above 1 kV and less than 52 kV.
Amendment No. 1 (1984).

265-2 (1988) Part 2: High-voltage switches for rated voltages of 52 kV and above.

298 (1990) A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.

420 (1990) High-voltage alternating current switch-fuse combinations.

427 (1989) Synthetic testing of high-voltage alternating current circuit-breakers.
Amendment 1 /1992).

439: – Low-voltage switchgear and controlgear assemblies.

439-1 (1992) Part 1: Type-tested and partially type-tested assemblies.

439-2 (1987) Part 2: Particular requirements for busbar trunking systems (busways).
Amendment No. 1 (1991).

439-3 (1990) Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards.

439-4 (1990) Part 4: Particular requirements for assemblies for construction sites (ACS).

466 (1987) A.C. insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV.

470 (1974) High-voltage alternating current contactors.
Amendment No. 1 (1975)

517 (1990) Gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above.

518 (1975) Dimensional standardization of terminals for high-voltage switchgear and controlgear.

632: – High-voltage motor starters.

632-1 (1978) Part 1: Direct-on-line (full voltage) a.c. starters.

694 (1980) Common clauses for high-voltage switchgear and controlgear standards.
Amendment No. 1 (1985).

715 (1981) Dimensions of low-voltage switchgear and controlgear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and controlgear installations.

859 (1986) Cable connections for gas-insulated metal-enclosed switchgear for rated voltages of 72.5 kV and above.

(Continued)

Publications de la CEI préparées par le Comité d'Etudes n° 17 *(suite)*

890 (1987) Méthode de détermination par extrapolation des échauffements pour les ensembles d'appareillage à basse tension dérivés de série (EDS).

932 (1988) Spécifications complémentaires pour l'appareillage sous enveloppe de 1 kV à 72,5 kV destiné à être utilisé dans des conditions climatiques sévères.

947: – Appareillage à basse tension.

947-1 (1988) Première partie: Règles générales.

947-2 (1989) Deuxième partie: Disjoncteurs.
Amendement n° 1 (1992).

947-3 (1990) Troisième partie: Interrupteurs, sectionneurs, interrupteurs-sectionneurs et combinés-fusibles.

947-4-1 (1990) Quatrième partie: Contacteurs et démarreurs de moteurs – Section un: Contacteurs et démarreurs électromécaniques.

947-5-1 (1990) Cinquième partie: Appareils et éléments de commutation pour circuits de commande – Section un: Appareils électromécaniques pour circuits de commande.

947-5-2 (1992) Partie 5: Appareils et éléments de commutation pour circuits de commande – Section 2: Détecteurs de proximité.

947-6-1 (1989) Sixième partie: Matériels à fonctions multiples – Section un: Matériels de connexion de transfert automatique.

947-6-2 (1992) Section deux: Appareils (ou matériel) de connexion de commande de protection (ACP).

947-7-1 (1989) Septième partie: Matériels accessoires – Section un: Blocs de jonction pour conducteurs en cuivre.

1095 (1992) Contacteurs électromécaniques pour usages domestiques et analogues.

1117 (1992) Méthode pour déterminer la tenue aux courts-circuits des ensembles d'appareillage dérivés de série (EDS).

1128 (1992) Sectionneurs à courant alternatif. Transfert de barres par les sectionneurs.

1129 (1992) Sectionneurs de terre à courant alternatif: Etablissement et coupure de courants induits.

1208 (1993) Disjoncteurs à courant alternatif à haute tension – Guide pour la maintenance

IEC publications prepared by Technical Committee No. 17 *(continued)*

890 (1987) A method of temperature-rise assessment by extrapolation for partially type-tested assemblies (PTTA) of low-voltage switchgear and controlgear.

932 (1988) Additional requirements for enclosed switchgear and controlgear from 1 kV to 72.5 kV to be used in severe climatic conditions.

947: – Low-voltage switchgear and controlgear.

947-1 (1988) Part 1: General rules.

947-2 (1989) Part 2: Circuit-breakers.
Amendment No. 1 (1992).

947-3 (1990) Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units.

947-4-1 (1990) Part 4: Contactors and motor-starters – Section One: Electromechanical contactors and motor-starters.

947-5-1 (1990) Part 5: Control circuit devices and switching elements – Section One: Electromechanical control circuit devices.

947-5-2 (1992) Part 5: Control circuit devices and switching elements – Section 2: Proximity switches.

947-6-1 (1989) Part 6: Multiple function equipment – Section One: Automatic transfer switching equipment.

947-6-2 (1992) Section Two: Control and protective switching devices (or equipment) (CPS).

947-7-1 (1989) Part 7: Ancillary equipment – Section One: Terminal blocks for copper conductors.

1095 (1992) Electromechanical contactors for household and similar purposes.

1117 (1992) A method for assessing the short-circuit withstand strength of partially type-tested assemblies (PTTA).

1128 (1992) Alternating current disconnectors. Bus-transfer current switching.

1129 (1992) Alternating current earthing switches. Induced current switching.

1208 (1993) High-voltage alternating current circuit-breakers – Guide for maintenance.

Publication 129

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AMENDEMENT 2
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1996-07

Amendement 2

Sectionneurs et sectionneurs de terre à courant alternatif

Amendment 2

Alternating current disconnectors and earthing switches

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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FOREWORD

This amendment has been prepared by sub-committee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The text of this amendment is based on the following documents:

FDIS	Report on voting
17A/468/FDIS	17A/483/RVD

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

Page 7

Preface

Add to the list of IEC publications, the following publication:

529 (1989): Degrees of protection provided by enclosures (IP Code).

Page 9

1 Scope

Add the following new paragraphs at the end of this clause:

When a position indicating device is used as alternative to the visible isolating distance or gap and is connected to the movable contacts of disconnectors or earthing switches by a mechanical connection the following instructions shall be applied.

NOTE – The IEC standards (IEC 129 subclause 5.104.2, IEC 298 subclause 5.105, IEC 265-1 subclause 5.104.2, IEC 265-2 subclause 5.103.2 and IEC 517 subclause 5.106) accept as an alternative to a visible isolating distance or gap that the moving contact position is shown by a reliable indicating device. In this standard, additional design and testing requirements are given and they have to be implemented in order that the indicating device can be considered reliable.

Page 9

3 Definitions

After 3.102.5, page 11, insert the following new definitions:

3.102.5.1 *Earthing switch class A*

An earthing switch not falling into the category of class B as defined in 3.102.5.2.

3.102.5.2 *Earthing switch class B*

An earthing switch designed so as not to require maintenance of the main contacts during the expected operating life of the earthing switch, and only minimal maintenance of its other parts.

NOTES

1 Minimal maintenance may include lubrication, replenishment of gas and cleaning of external surfaces, where applicable.

2 This definition is limited to earthing switches having a rated voltage less than 52 kV.

3 There are two choices: use an earthing switch requiring maintenance of its main contacts and maintain as needed during its expected working life, or use a class B earthing switch but expect a more onerous testing regime to check its capability.

Add the following new definitions after 3.103.15:

3.103.16 *Power kinematic chain*

The mechanical connecting system from and including the operating mechanism up to and including the moving contacts (refer to figure 10).

3.103.17 *Position indicating kinematic chain*

The mechanical connecting system from and including the moving contacts up to and including the indicating device.

3.103.18 *Connecting point*

The most upstream point of the common part of the kinematic chains (power and indicating).

3.103.19 *Opening point*

The nearest accessible point upstream of the connecting point where the power kinematic chain may be opened.

3.103.20 *Test positions*

- for disconnectors: the closed position with moving contact locked;
- for earthing switches: the open position with moving contact locked.

In the case of a multipolar switching device, only the moving contact of the pole with the greatest length of the power kinematic chain is locked.

Page 37

5 Design and construction

Add, page 41, the following paragraph to 5.104.2:

The kinematic chain of the position indicating device shall be designed with sufficient mechanical strength such that it meets the requirements of the specified tests (according to 6.105). 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.

Page 43

6 Type tests

Replace, page 53, 6.101 by the following:

6.101 *Tests to prove the short-circuit making performance of earthing switches*

Earthing switches which have a rated short-circuit making current shall be subjected to a making test series in accordance with IEC 265-1 or IEC 265-2 depending on their rated voltage.

Earthing switches class B for rated voltages less than 52 kV, and which have a rated short-circuit making current, shall be subjected to a making test series in accordance with test duty 5 of 6.101.9 of IEC 265-1, except that the number of making operations shall be increased to five.

Add, page 55, the following new subclause 6.102.5:

6.102.5 *Extended mechanical endurance tests on disconnectors for special service requirements*

NOTE – These tests do not apply to manual-only operated disconnectors.

Special service requirements in the case of disconnectors frequently operating in conjunction with opening of the circuit-breakers in series, extended mechanical endurance tests may be carried out as follows:

a) The extended mechanical endurance tests programme shall consist of a number of close-open operations carried out in accordance with 6.102.1 and 6.102.3.

According to the service requirements, one of the following number of operating cycles shall be performed:

- 2 000 (for disconnectors in conjunction with general-purpose circuit-breakers);
- 10 000 (for disconnectors in conjunction with circuit-breakers for special service requirements).

Between the test series specified, some maintenance such as lubrication and mechanical adjustment is allowed and shall be performed in accordance with the manufacturer's instructions. Change of contacts is not permitted.

The programme of maintenance during the tests shall be defined by the manufacturer before the tests and recorded in the test report.

b) Before and after the total test programme, the following operations shall be performed:

- five close-open operating cycles at the rated supply voltage and/or pressure;
- five close-open operating cycles at the minimum supply voltage and/or pressure;
- five close-open operating cycles at the maximum supply voltage and/or pressure;
- five close-open manual operations.

During these operating cycles, operating characteristics shall be recorded or evaluated if applicable such as operating times, consumption of the control circuit, maximum forces for manual operation; satisfactory operation of control and auxiliary contacts, and position indicating devices (if any) shall be verified. It is not necessary to publish all the oscillograms recorded.

In addition a measurement of the resistance of the main circuit shall be performed.

The variation between the mean values of each parameter measured before and after the extended mechanical endurance tests shall be within the tolerance given by the manufacturer.

The following tests shall also be performed:

- contact zone test (6.102.2), if applicable;
- verification of operation during application of rated mechanical terminal loads (6.102.4), if applicable.

c) After each series of 1 000 operating cycles or at maintenance intervals, some significant operating characteristics should be recorded or evaluated.

d) In addition, after the total test programme, checks and tests shall be performed as follows:

- verification of the satisfactory operation with the minimum duration of the operating signal given by the manufacturer;
- verification of the satisfactory condition of the mechanical travel limit stops;
- verification of operation of the mechanical effort limiting devices, if any.

e) After the total test programme, all parts, including contacts, shall be in good condition and not show undue wear in accordance with the relevant clauses of IEC 694; see also point 6 of table 3 of IEC 694.

Add, page 61, the following new subclause after 6.104:

6.105 *Tests to verify the proper function of the position indicating device*

Besides the type tests prescribed in clause 6, during which the correct functioning of the indicating devices shall be verified, the equipment shall pass one of the tests in 6.105.1 and 6.105.2, according to the type of switching device.

The force or torque measured or applied during the tests refers to disconnectors for opening attempts and to earthing switches for closing attempts. The force or torque measured during the tests is the force F_m or the torque T_m respectively transmitted through the opening point from the upstream part to the downstream part of the power kinematic chain under the test condition.

6.105.1 *Tests on the power kinematic chain*

6.105.1.1 *Disconnectors and earthing switches with dependent operating mechanism without strain limiting device.*

a) Electrical, hydraulic and pneumatic operating mechanism.

The test shall be carried out according to the following procedure:

- the disconnector or earthing switch is put in the test position;
- the power kinematic chain is opened at the opening point;
- the operating mechanism is supplied at the maximum value of the supply voltage or rated pressure given in 4.8 and 4.10 of IEC 694;
- the force F_m or torque T_m is measured upstream of the opening point during an attempt to cause the switching device to leave the test position;
- a force of 1,5 F_m or a torque of 1,5 T_m is applied at the opening point of the power kinematic chain downstream of the opening point.

Test results: refer to 6.105.3.

NOTE – The operating mechanism itself may be used to apply 1,5 times the maximum force or torque.

b) Manual operating mechanism.

The test shall be carried out according to the following procedure:

- the disconnector or earthing switch is put in test position;
- a force of 750 N is applied to the centre of the gripping part of the operating handle of the operating mechanism.

Test results: refer to 6.105.3.

c) In case of switching devices with both types of mechanism in a) and b), the force or torque to be applied at the opening point is the highest value of:

- either 1,5 F_m or 1,5 T_m
- or the maximum force or torque transmitted during manual operation with a force of 750 N applied to the operating handle of the operating mechanism.

6.105.1.2 *Disconnectors and earthing switches with dependent operating mechanism with strain limiting device.*

- The maximum force F_m or torque T_m transmitted by the limiting device is stated by the manufacturer.
- The disconnector or earthing switch is put in the test position.
- The power kinematic chain is opened at the opening point.
- The operating mechanism is supplied at the maximum value of the supply voltage or rated pressure given in 4.8 and 4.10 of IEC 694 or, in the case of a manual operating mechanism, a force up to the operation of the limiting device with a maximum of 750 N is applied to the centre of the gripping part of the operating handle of the operating mechanism.

– The force or the torque transmitted by the strain limiting device is measured upstream of the opening point during an attempt to cause the switching device to leave the test position and it is verified that the measured value is lower than that declared by the manufacturer.

– A force of 1,5 F_m or torque of 1,5 T_m is applied at the opening point of the power kinematic chain downstream of the opening point.

Test results: refer to 6.105.3.

6.105.1.3 *Disconnectors and earthing switches with independent operating mechanism*

– The disconnector or earthing switch is put in the test position.

– The power kinematic chain is opened at the opening point.

– The operating mechanism is supplied at maximum value of the supply voltage or rated pressure given in 4.8 and 4.10 of IEC 694 or, in case of manual operating mechanism, a force of up to 750 N is applied to the centre of the gripping part of the operating handle of the operating mechanism.

– The force F_m or the torque T_m transmitted is measured at the opening point during an attempt to cause the switching device to leave the test position. A force of 1,5 F_m or a torque of 1,5 T_m is applied at the opening point of the power kinematic chain downstream of the opening point.

Test results: refer to 6.105.3.

6.105.2 *Test on position indicating kinematic chain*

When the position indicating device is marked directly on a mechanical part of the power kinematic chain, no test is required.

If the part of position indicating kinematic chain between the power kinematic chain and the position indicating device included is inside an enclosure providing a minimum degree of protection IP2XC according to IEC 529 and which passes a mechanical impact test according to 6.6.2 of the future revision of IEC 694, with an energy of 2J, no supplementary tests are required.

The blows shall be applied to the points of the enclosure that are likely to be the weakest in relation to the protection of the indicating kinematic chain and the indicating device.

In all other cases, a test shall be carried out locking the position indicating device instead of the moving contact.

Test results: refer to 6.105.3.

6.105.3 *Test results*

Each test is passed if:

– after the test, the position indicating device indicates correctly the position of the moving contacts;

– there is not any permanent distortion on the position indicating kinematic chain;

If a distortion or break occurs in the power kinematic chain upstream of the connecting point, it is permitted to replace components in order to complete the required operations.

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7.101 *Mechanical operating tests*

Add the following paragraph to this subclause:

During the mechanical operating tests it shall be verified that the position indicating device indicates correctly the position of the moving contacts.

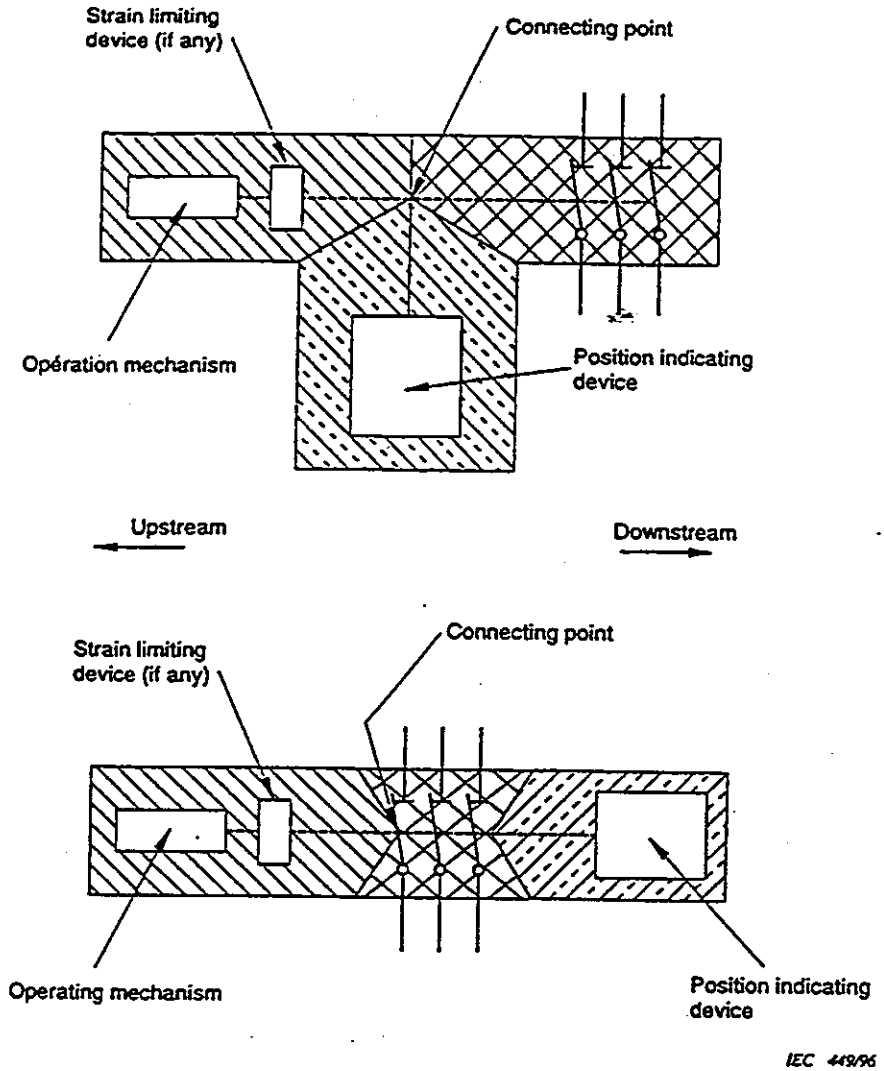

Figure 10 – Position indicating device – Mechanical connection system

Publications de la CEI préparées par le Comité d'Etudes n° 17

56 (1987) Disjoncteurs à courant alternatif à haute tension.
Amendement 1 (1992).
Amendement 2 (1995).

129 (1984) Sectionneurs et sectionneurs de terre à courant alternatif.
Amendement 1 (1992).
Amendement 2 (1996).

158: — Appareillage de commande à basse tension.

158-2 (1982) Deuxième partie: Contacteurs à semiconducteurs (contacteurs statiques).

158-3 (1985) Troisième partie: Prescriptions complémentaires pour conducteurs sujets à certification.

265: — Interrupteurs à haute tension.

265-1 (1983) Première partie: Interrupteurs à haute tension pour tensions assignées supérieures à 1 kV et inférieures à 52 kV.
Modification n° 1 (1984).
Amendement 2 (1994).

265-2 (1988) Deuxième partie: Interrupteurs à haute tension de tension assignée égale ou supérieure à 52 kV.
Amendement 1 (1994).

298 (1990) Appareillage sous enveloppe métallique pour courant lternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 52 kV.
Amendement 1 (1994).

420 (1990) Combinés interrupteurs-fusibles à haute tension pour courant alternatif.

427 (1989) Essais synthétiques des disjoncteurs à courant alternatif à haute tension.
Amendement 1 (1992).
Amendement 2 (1995).

439: — Ensembles d'appareillage à basse tension.

439-1 (1992) Première partie: Ensembles de série et ensembles dérivés de série.
Amendement 1 (1995).

439-2 (1987) Deuxième partie: Règles particulières pour les canalisations préfabriquées.
Amendement n° 1 (1991).

439-3 (1990) Troisième partie: Règles particulières pour ensembles d'appareillage BT destinés à être installés en des lieux accessibles à des personnes non qualifiées pendant leur utilisation – Tableaux de répartition.
Amendement 1 (1993).

439-4 (1990) Quatrième partie: Règles particulières pour nsembles de chantier (EC).
Amendement 1 (1995).

439-5 (1996) Partie 5: Règles particulières pour les ensembles destinés à être installés à l'extérieur, en des lieux publics – Ensembles d'appareillage pour réseaux de distribution (ERD).

466 (1987) ppareillage sous enveloppe isolante pour courant alternatif de tension assignée supérieure à 1 kV et inférieure ou égale à 38 kV.
Amendement 1 (1994).

470 (1974) Contacteurs haute tension à courant alternatif.
Modification n° 1 (1975).

517 (1990) Appareillage sous enveloppe métallique à isolation gazeuse de tension assignée égale ou supérieure à 72,5 kV.
Amendement 1 (1994).

518 (1975) Normalisation dimensionnelle des bornes de l'appareillage à haute tension.

(suite)

IEC publications prepared by Technical Committee No. 17

56 (1987) High-voltage alternating-current circuit breakers.
Amendment 1 (1992).
Amendment 2 (1995).

129 (1984) Alternating current disconnectors and earthing switches.
Amendment 1 (1992).
Amendment 2 (1996).

158: — Low-voltage controlgear.

158-2 (1982) Part 2: Semiconductor contactors (solid state contactors).

158-3 (1985) Part 3: Additional requirements for contactors subject to certification.

265: — High-voltage switches.

265-1 (1983) Part 1: High-voltage switches for rated voltages above 1 kV and less than 52 kV.
Amendment No. 1 (1984).
Amendment 2 (1994).

265-2 (1988) Part 2: High-voltage switches for rated voltages of 52 kV and above.
Amendment 1 (1994).

298 (1990) A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV.
Amendment 1 (1994).

420 (1990) High-voltage alternating current switch-fuse combinations.

427 (1989) Synthetic testing of high-voltage alternating current circuit-breakers.
Amendment 1 (1992).
Amendment 2 (1995).

439: — Low-voltage switchgear and controlgear assemblies.

439-1 (1992) Part 1: Type-tested and partially type-tested assemblies.
Amendment 1 (1995).

439-2 (1987) Part 2: Particular requirements for busbar trunking systems (busways).
Amendment No. 1 (1991).

439-3 (1990) Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use – Distribution boards.
Amendment 1 (1993).

439-4 (1990) Part 4: Particular requirements for assemblies for construction sites (ACS).
Amendment 1 (1995).

439-5 (1996) Part 5: Particular requirements for assemblies intended to be installed outdoors in public places – Cable distribution cabinets (CDCs) for power distribution in networks.

466 (1987) A.C. insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV.
Amendment 1 (1994).

470 (1974) High-voltage alternating current contactors.
Amendment No. 1 (1975)

517 (1990) Gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above.
Amendment 1(1994).

518 (1975) Dimensional standardization of terminals for high-voltage switchgear and controlgear.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 17 *(suite)*

632: — Démarreurs de moteurs à haute tension.

632-1 (1978) Première partie: Démarreurs directs (sous pleine tension) en courant alternatif.

694 (1996) Clauses communes pour les normes de l'appareillage à haute tension.

715 (1981) Dimensions de l'appareillage à basse tension. Montage normalisé sur profilés-supports pour le support mécanique des appareils électriques dans les installations d'appareillage à basse tension.
Amendement 1 (1995).

859 (1986) Raccordement de câbles pour appareillage sous enveloppe métallique à isolation gazeuse pour tension assignée égale ou supérieure à 72,5 kV.

890 (1987) Méthode de détermination par extrapolation des échauffements pour les ensembles d'appareillage à basse tension dérivés de série (EDS).
Amendement 1 (1995).

932 (1988) Spécifications complémentaires pour l'appareillage sous enveloppe de 1 kV à 72,5 kV destiné à être utilisé dans des conditions climatiques sévères.

947: — Appareillage à basse tension.

947-1 (1988) Première partie: Règles générales.
Amendement 3 (1995).

947-2 (1995) Partie 2: Disjoncteurs.

947-3 (1990) Troisième partie: Interrupteurs, sectionneurs, interrupteurs-sectionneurs et combinés-fusibles.
Amendement 1 (1994).

947-4-1 (1990) Quatrième partie: Contacteurs et démarreurs de moteurs – Section un: Contacteurs et démarreurs électromécaniques.
Amendement 1 (1994).

947-4-2 (1995) Partie 4: Contacteurs et démarreurs de moteurs – Section 2: Gradateurs et démarreurs à semiconducteurs de moteurs à courant alternatif.

947-5-1 (1990) Cinquième partie: Appareils et éléments de commutation pour circuits de commande – Section un: Appareils électromécaniques pour circuits de commande.
Amendement 1 (1994).
Amendement 2 (1996).

947-5-2 (1992) Partie 5: Appareils et éléments de commutation pour circuits de commande – Section 2: Détecteurs de proximité.
Amendement 1 (1994).
Amendement 2 (1995).

947-6-1 (1989) Sixième partie: Matériels à fonctions multiples – Section un: Matériels de connexion de transfert automatique.
Amendement 1 (1994).

947-6-2 (1992) Section deux: Appareils (ou matériel) de connexion de commande de protection (ACP).

947-7-1 (1989) Septième partie: Matériels accessoires – Section un: Blocs de jonction pour conducteurs en cuivre.

947-7-2 (1995) Section 2: Blocs de jonction de conducteurs de protection pour conducteurs en cuivre.

999:— Dispositifs de connexion – Prescriptions de sécurité pour les organes de serrage à vis et sans vis pour conducteurs électriques en cuivre.

999-1 (1990) Partie 1: Prescriptions générales et prescriptions particulières pour conducteurs de 0,5 mm² à 35 mm² (inclus).

(suite)

IEC publications prepared by Technical Committee No. 17 *(continued)*

632: — High-voltage motor starters.

632-1 (1978) Part 1: Direct-on-line (full voltage) a.c. starters.

694 (1996) Common clauses for high-voltage switchgear and controlgear standards.

715 (1981) Dimensions of low-voltage switchgear and controlgear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and controlgear installations.
Amendment 1 (1995).

859 (1986) Cable connections for gas-insulated metal-enclosed switchgear for rated voltages of 72,5 kV and above.

890 (1987) A method of temperature-rise assessment by extrapolation for partially type-tested assemblies (PTTA) of low-voltage switchgear and controlgear.
Amendment 1 (1995).

932 (1988) Additional requirements for enclosed switchgear and controlgear from 1 kV to 72,5 kV to be used in severe climatic conditions.

947: — Low-voltage switchgear and controlgear.

947-1 (1988) Part 1: General rules.
Amendment 3 (1995).

947-2 (1995) Part 2: Circuit-breakers.

947-3 (1990) Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units.
Amendment 1 (1994).

947-4-1 (1990) Part 4: Contactors and motor-starters – Section One: Electromechanical contactors and motor-starters.
Amendment 1 (1994).

947-4-2 (1995) Part 4: Contactors and motor-starters – Section 2: AC semiconductor motor controllers and starters.

947-5-1 (1990) Part 5: Control circuit devices and switching elements – Section One: Electromechanical control circuit devices.
Amendment 1 (1994).
Amendment 2 (1996).

947-5-2 (1992) Part 5: Control circuit devices and switching elements – Section 2: Proximity switches.
Amendment 1 (1994).
Amendment 2 (1995).

947-6-1 (1989) Part 6: Multiple function equipment – Section One: Automatic transfer switching equipment.
Amendment 1 (1994).

947-6-2 (1992) Section Two: Control and protective switching devices (or equipment) (CPS).

947-7-1 (1989) Part 7: Ancillary equipment – Section One: Terminal blocks for copper conductors.

947-7-2 (1995) Section 2: Protective conductor terminal blocks for copper conductors.

999:— Connecting devices – Safety requirements for screw-type and screwless-type clamping units for electrical copper conductors.

999-1 (1990) Part 1: General requirements and particular requirements for conductors from 0,5 mm² to 35 mm² (included).

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 17 *(suite)*

999-2 (1995)	Prescriptions pour conducteurs de 35 mm² à 300 mm².
1095 (1992)	Contacteurs électromécaniques pour usages domestiques et analogues.
1117 (1992)	Méthode pour déterminer la tenue aux courts-circuits des ensembles d'appareillage dérivés de série (EDS).
1128 (1992)	Sectionneurs à courant alternatif. Transfert de barres par les sectionneurs. Amendement 1 (1994).
1129 (1992)	Sectionneurs de terre à courant alternatif. Etablissement et coupure de courants induits. Amendement 1 (1994).
1166 (1993)	Disjoncteurs à courant alternatif à haute tension – Guide pour la qualification sismique des disjoncteurs à courant alternatif à haute tension.
1208 (1992)	Disjoncteurs à courant alternatif à haute tension – Guide pour la maintenance.
1233 (1994)	Disjoncteurs haute tension à courant alternatif – Etablissement et coupure de charge inductive.
1259 (1994)	Appareillage sous enveloppe métallique à isolation gazeuse de tension assignée égale ou supérieure à 72,5 kV – Prescriptions pour l'établissement et la coupure de courants de jeux de barres à vide par les sectionneurs.
1330 (1995)	Postes préfabriqués haute tension/basse tension.
1633 (1995)	Disjoncteurs à courant alternatif à haute tension – Guide pour la procédure d'essai d'établissement et de coupure de courants de court-circuit et de courants de charge pour les disjoncteurs sous enveloppe métallique et à cuve mise à la terre.
1634 (1995)	Appareillage à haute tension – Utilisation et manipulation de gaz hexafluorure de soufre (SF_6) dans l'appareillage à haute tension.
1641 (1996)	Ensembles d'appareillage à basse tension sous enveloppe – Guide pour l'essai en conditions d'arc dues à un défaut interne.

IEC publications prepared by Technical Committee No. 17 *(continued)*

999-2 (1995)	Part 2: Particular requirements for conductors from 35 mm² to 300 mm².
1095 (1992)	Electromechanical contactors for household and similar purposes.
1117 (1992)	A method for assessing the short-circuit withstand strength of partially type-tested assemblies (PTTA).
1128 (1992)	Alternating current disconnectors. Bus-transfer current switching. Amendment 1 (1994).
1129 (1992)	Alternating current earthing switches. Induced current switching. Amendment 1 (1994).
1166 (1993)	High-voltage alternating current circuit-breakers – Guide for seismic qualification of high-voltage alternating current circuit breakers.
1208 (1992)	High-voltage alternating current circuit-breakers – Guide for maintenance.
1233 (1994)	High-voltage alternating current circuit-breakers – Inductive load switching.
1259 (1994)	Gas-insulated metal-enclosed switchgear for rated voltages 72,5 kV and above – Requirements for switching of bus-charging currents by disconnectors.
1330 (1995)	High-voltage/low-voltage prefabricated substations.
1633 (1995)	High-voltage alternating current circuit-breakers – Guide for short-circuit and switching test procedures for metal-enclosed and dead tank circuit-breakers.
1634 (1995)	High-voltage switchgear and controlgear – Use and handling of sulphur hexafluoride (SF_6) in high-voltage switchgear and controlgear.
1641 (1996)	Enclosed low-voltage switchger and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault.