Indian Standard

SPECIFICATION FOR LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

PART 3 SWITCHES, DISCONNECTORS, SWITCH DISCONNECTORS AND FUSE COMBINATION UNITS

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Indian Standard

SPECIFICATION FOR
LOW-VOLTAGE SWITCHGEAR AND
CONTROLGEAR

PART 3 SWITCHES, DISCONNECTORS, SWITCH DISCONNECTORS AND
FUSE COMBINATION UNITS

NATIONAL FOREWORD

This Indian Standard (Part 3) which is identical with IEC Pub 947-3 (1990) is one in the
series of standards on LV switchgear equipment covering requirements for switches and their
family of items together with fuse combination units. This standard shall be read in conjunction
with Part 1 of this standard covering general requirements.

The text of the IEC Standard has been considered and approved by ET 07, Low Voltage Switch-
gear and Controlgear Sectional Committee of BIS, as suitable for publication as Indian Standard,
superseding the contents of IS 4064 (Parts 1 and 2).

With reference to the definitions contained in 2.5 and 2.6 of this standard, it is stated that the
terms 'Switchfuse' and 'Fuseswitch' have been defined in these clauses due to these terms being
in vogue though however no distinction is being made in so far as requirements and tests for
compliance are concerned.

CROSS REFERENCE

In this Indian Standard the following International Standards are referred to. Read in their
respective place the following:

<table>
<thead>
<tr>
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<th>Indian Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 (441) (1984)</td>
<td>IS 1885 (Part 17)</td>
</tr>
<tr>
<td>417 (1973)</td>
<td>Nil</td>
</tr>
<tr>
<td>617-7 (1983)</td>
<td>IS 12032 (Part 7)</td>
</tr>
</tbody>
</table>

In the case of IEC Pub 417, noting that Indian Standard identical to this is under print, the
Technical Committee responsible for this standard has decided that it is acceptable for use in
conjunction with this standard.
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General

The provisions of the general rules dealt with in Part 1 (IEC Publication 947-1) are applicable to this standard, where specifically called for. Clauses and sub-clauses, tables, figures and appendices of the general rules thus applicable are identified by reference to Part 1, e.g., Sub-clause 1.2.3 of Part 1, Table IV of Part 1, or Appendix A of Part 1.

§ 1 Scope

This standard applies to switches, disconnectors, switch-disconnectors and fuse-combination units to be used in distribution circuits and motor circuits of which the rated voltage does not exceed 1 000 V a.c. or 1 500 V d.c.

The manufacturer shall specify the type, ratings and characteristics according to the relevant standard of any incorporated fuses.

This standard does not apply to equipment coming within the scope of IEC Publications 947-2, 947-4-1 and 947-5-1; however, when switches and fuse combination units coming into the scope of this standard are normally used to start, accelerate and/or stop an individual motor they shall also comply with the additional requirements given in Appendix A.

This standard does not include the additional requirements necessary for electrical apparatus for explosive gas atmospheres.

Notes

1. Depending on its design, a switch (or disconnector) can be referred to as "a rotary switch (disconnector)", "cam-operated switch (disconnector)", "knife-switch (disconnector)", etc.

2. If they are not manually operated, switches and disconnectors may have to comply with additional requirements.

3. In this standard, the word "switch" also applies to the apparatus referred to in French as "commutateurs", intended to modify the connections between several circuits and inter alia to substitute a part of a circuit for another.

4. In general, throughout this standard switches, disconnectors, switch-disconnectors and fuse-combination units will be referred to as "equipment".
1.2 Object

The object of this standard is to state:

a) the characteristics of the equipment;

b) the conditions with which the equipment shall comply with reference to:
   1) operation and behaviour in normal service;
   2) operation and behaviour in case of specified abnormal conditions, e.g. short circuit;
   3) dielectric properties;

c) the tests for confirming that these conditions have been met and the methods to be adopted for these tests;

d) the information to be marked on the equipment or made available by the manufacturer, e.g. in the catalogue.

2. Definitions

For the majority of the definitions required in connection with this standard, see Clause 2 of Part 1.

Necessary additional definitions are given in this clause together with pertinent device definitions. The device definitions are also summarised in Table 1.

2.1 Switch (mechanical) (IEV 441-14-10)

A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit.

Note.- A switch may be capable of making, but not breaking, short-circuit currents.

2.2 Disconnector

A mechanical switching device which, in the open position, complies with the requirements specified for the isolating function.

Notes 1.- This definition differs from IEV 441-14-05 by referring to isolating function instead of isolating distance.

2.- A disconnector is capable of opening and closing a circuit when either a negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.
2.3 **Switch-disconnector (IEV 441-14-12)**

A switch which, in the open position, satisfies the isolating requirements specified for a disconnector.

2.4 **Fuse-combination unit (IEV 441-14-04)**

A combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions.

*Note.* (Not included in IEV 441-14-04). This is a general term for fuse switching devices (see also Sub-clauses 2.5 to 2.10 and Table I).

2.5 **Switch-fuse (IEV 441-14-14)**

A switch in which one or more poles have a fuse in series in a composite unit.

2.6 **Fuse-switch (IEV 441-14-17)**

A switch in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact.

2.7 **Disconnector-fuse (IEV 441-14-15)**

A disconnector in which one or more poles have a fuse in series in a composite unit.

2.8 **Fuse-disconnector (IEV 441-14-18)**

A disconnector in which a fuse-link or fuse-carrier with fuse-link forms the moving contact.

2.9 **Switch-disconnector-fuse (IEV 441-14-16)**

A switch-disconnector in which one or more poles have a fuse in series in a composite unit.

2.10 **Fuse-switch-disconnector (IEV 441-14-19)**

A switch-disconnector in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact.

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

An operation solely by means of directly applied manual energy such that the speed and force of the operation are dependent upon the action of the operator.

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

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

An operation solely by means of directly applied manual energy such that the manual force is increased up to a threshold value beyond which the independent switching operation is achieved unless delibera-
tely delayed by the operator.

2.14 Stored energy operation (of a mechanical switching device) (IEV 441-16-15)

An operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions.

Note.-- This kind of operation may be subdivided according to:

1. the manner of storing the energy (spring, weight, etc.);
2. the origin of the energy (manual, electric, etc.);
3. the manner of releasing the energy (manual, electric, etc.).

| TABLE I |
| Summary of equipment definitions |

<table>
<thead>
<tr>
<th>Function</th>
<th>Making and breaking current</th>
<th>Isolating</th>
<th>Making, breaking and isolating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch</td>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Fuse-combination unit 2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch-fuse</td>
<td>2.5</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Disconnector-fuse</td>
<td>2.7</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Switch-disconnector-fuse</td>
<td>2.9</td>
<td>2.10</td>
<td></td>
</tr>
</tbody>
</table>
3. Classification

3.1 According to the utilization category

See Sub-clause 4.4.

3.2 According to the method of operation of manually operated equipment

- dependent manual operation (see Sub-clause 2.11);
- independent manual operation (see Sub-clause 2.12);
- semi-independent manual operation (see Sub-clause 2.13).

Note.- The method of operation on closing may be different from the method for opening.

3.3 According to suitability for isolation

- suitable for isolation (see Sub-clause 7.1.6 of Part 1 and Sub-clause 7.1.6.1);
  not suitable for isolation.

3.4 According to the degree of protection provided

See Sub-clause 7.1.11 of Part 1.

4. Characteristics

4.1 Summary of characteristics

The characteristics of the equipment shall be stated in terms of the following as applicable:

- type of equipment (Sub-clause 4.2);
- rated and limiting values for the main circuit (Sub-clause 4.3).
- utilization category (Sub-clause 4.4);
- control circuits (Sub-clause 4.5);
- auxiliary circuits (Sub-clause 4.6);
- switching overvoltages (Sub-clause 4.9).
4.2 Type of equipment

The following shall be stated:

4.2.1 Number of poles

4.2.2 Kind of current

Kind of current (a.c. or d.c.) and, in the case of a.c., number of phases and rated frequency.

4.2.3 Number of positions of the main contacts
(if more than two)

4.3 Rated and limiting values for the main circuit

Rated values are assigned by the manufacturer. They shall be stated in accordance with Sub-clauses 4.3.1 to 4.3.6.4 but it may not be necessary to establish all the rated values listed.

4.3.1 Rated voltages

An equipment is defined by the following rated voltages:

4.3.1.1 Rated operational voltage ($U_e$)

Sub-clause 4.3.1.1 of Part 1 applies.

4.3.1.2 Rated insulation voltage ($U_i$)

Sub-clause 4.3.1.2 of Part 1 applies.

4.3.1.3 Rated impulse withstand voltage ($U_{imp}$)

Sub-clause 4.3.1.3 of Part 1 applies.

4.3.2 Currents

An equipment is defined by the following currents:

4.3.2.1 Conventional free air thermal current ($I_{th}$)

Sub-clause 4.3.2.1 of Part 1 applies.

4.3.2.2 Conventional enclosed thermal current ($I_{the}$)

Sub-clause 4.3.2.2 of Part 1 applies.

4.3.2.3 Rated operational currents ($I_e$) (or rated operational powers)

Sub-clause 4.3.2.3 of Part 1 applies.

4.3.2.4 Rated uninterrupted current ($I_u$)

Sub-clause 4.3.2.4 of Part 1 applies.
4.3.3 Rated frequency

Sub-clause 4.3.3 of Part 1 applies.

4.3.4 Rated duty

The rated duties considered as normal are as follows:

4.3.4.1 Eight-hour duty

Sub-clause 4.3.4.1 of Part 1 applies.

4.3.4.2 Uninterrupted duty

Sub-clause 4.3.4.2 of Part 1 applies.

4.3.5 Normal load and overload characteristics

4.3.5.1 Ability to withstand motor switching overload currents

See Appendix A.

4.3.5.2 Rated making capacity

Sub-clause 4.3.5.2 of Part 1 applies with the following additions:

The rated making capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table III, Sub-clause 7.2.4.1.

Note.- In the case of disconnectors having a making capacity, although they are of utilization category AC-20 or DC-20, this value may be stated separately by the manufacturer together with the relevant test parameters.

4.3.5.3 Rated breaking capacity

Sub-clause 4.3.5.3 of Part 1 applies with the following additions:

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table III, Sub-clause 7.2.4.1.

Note.- In the case of disconnectors having a breaking capacity, although they are of utilization category AC-20 or DC-20, this value may be stated separately by the manufacturer together with the relevant test parameters.
4.3.6 Short-circuit characteristics

4.3.6.1 Rated short-time withstand current ($I_{cw}$)

The rated short-time withstand current of a switch, a disconnector or a switch-disconnector is the value of short-time withstand current, assigned by the manufacturer, that the equipment can carry without any damage under the test conditions of Sub-clause 8.3.5.1.

The value of the rated short-time withstand current shall be not less than twelve times the maximum rated operational current and, unless otherwise stated by the manufacturer, the duration of the current shall be 1 s.

For a.c., the value of the current is the r.m.s. value of the a.c. component and it is assumed that the highest peak value likely to occur does not exceed $n$ times this r.m.s. value, the factor $n$ being given by Table XVI of Part 1.

4.3.6.2 Rated short-circuit making capacity ($I_{cm}$)

The rated short-circuit making capacity of a switch or a switch-disconnector is the value of short-circuit making capacity assigned to the equipment by the manufacturer for the rated operational voltage, at rated frequency (if any) and at a specified power-factor (or time-constant). It is expressed as the maximum prospective peak current.

For a.c., the relationship between power-factor, prospective peak current and r.m.s. current shall be in accordance with Table XVI Part 1.

4.3.6.3 Vacant

4.3.6.4 Rated conditional short-circuit current

Sub-clause 4.3.6.4 of Part 1 applies.

4.4 Utilization category

The utilization categories define the intended applications and are given in Table II.

Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and the rated operational voltage, as well as the power-factors or time-constants of the circuit. The conditions for making and breaking given in Table III correspond in principle to the applications listed in Table II.

The designation of utilization categories is completed by the suffix A or B according to whether the intended applications require frequent or infrequent operations (see Table IV).
Utilization categories with suffix B are appropriate for devices which, due to design or application, are only intended for infrequent operation. This could apply, for example, to disconnectors normally only operated to provide isolation for maintenance work or switching devices where the fuse link blade forms the moving contact.

**TABLE II**

*Utilization categories*

<table>
<thead>
<tr>
<th>Nature of current</th>
<th>Utilization category</th>
<th>Typical applications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequent operation</td>
<td>Infrequent operation</td>
</tr>
<tr>
<td><strong>Alternating current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC-20A(*)</td>
<td>AC-20B(*)</td>
<td>Connecting and disconnecting under no-load conditions</td>
</tr>
<tr>
<td>AC-21A</td>
<td>AC-21B</td>
<td>Switching of resistive loads including moderate overloads</td>
</tr>
<tr>
<td>AC-22A</td>
<td>AC-22B</td>
<td>Switching of mixed resistive and inductive loads, including moderate overloads</td>
</tr>
<tr>
<td>AC-23A</td>
<td>AC-23B</td>
<td>Switching of motor loads or other highly inductive loads</td>
</tr>
<tr>
<td><strong>Direct current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-20A(*)</td>
<td>DC-20B(*)</td>
<td>Connecting and disconnecting under no-load conditions</td>
</tr>
<tr>
<td>DC-21A</td>
<td>DC-21B</td>
<td>Switching of resistive loads including moderate overloads</td>
</tr>
<tr>
<td>DC-22A</td>
<td>DC-22B</td>
<td>Switching of mixed resistive and inductive loads, including moderate overloads (e.g. shunt motors)</td>
</tr>
<tr>
<td>DC-23A</td>
<td>DC-23B</td>
<td>Switching of highly inductive loads (e.g. series motors)</td>
</tr>
</tbody>
</table>

(*) The use of these utilization categories is not permitted in the United States of America.

Category AC-23 includes occasional switching of individual motors. The switching of capacitors or of tungsten filament lamps shall be subject to agreement between manufacturer and user.

The utilization categories referred to in Tables II and III do not apply to an equipment normally used to start, accelerate and/or stop individual motors. The utilization categories for such an equipment are dealt with in Appendix A.

4.5 Control circuits

Sub-clause 4.5 of Part 1 applies.

4.6 Auxiliary circuits

Sub-clause 4.6 of Part 1 applies.
4.7 Relays and releases

Sub-clause 4.7 of Part 1 applies.

4.8 Vacant

4.9 Switching overvoltages

Sub-clause 4.9 of Part 1 applies.

5. Product information

5.1 Nature of information

Sub-clause 5.1 of Part 1 applies as appropriate for a particular design.

5.2 Marking

Each equipment shall be marked in a durable and legible manner with the following data:

a) Indication of the open and closed position. The open or closed position shall be respectively indicated by the graphical symbols 417-IEC-5007 or 417-IEC-5008 of IEC Publication 417 (see Sub-clause 7.1.5.1 of Part 1);

b) Suitability for isolation.

The appropriate symbols of Table I shall be used.

c) Additional marking for disconnectors:

Devices of utilization category AC-20A, AC-20B, DC-20A and DC-20B shall be marked "Do not open under load" unless the device is interlocked to prevent such opening.

Note.- Symbols of the various types of equipment are given in Table I.

The markings shall be on the equipment itself or on a nameplate or nameplates attached to the equipment, and shall be located at a place such that they are visible and legible from the front after mounting (see Sub-clause 6.3 of Part 1).

The following data shall also be marked on the equipment but need not be visible from the front when the equipment is mounted:

d) manufacturer's name or trade mark;

e) type designation or serial number;
f) rated operational currents (or rated powers) at the rated operational voltage and utilization category (see Sub-clauses 4.3.1, 4.3.2 and 4.4);

g) value (or range) of the rated frequency or the indication "d.c." (or the symbol ___);

h) for fuse-combination units, the fuse type and maximum rated current and the power loss of the fuse-link;

i) IEC 947-3, if the manufacturer claims compliance with this standard;

j) degree of protection of enclosed equipment (see Appendix C of Part 1);

The following terminals shall be identified:

k) line and load terminals unless the connection is immaterial (see Sub-clause 8.3.3.3.1);

l) neutral pole terminal, if applicable, by the letter "N" (see Sub-clause 7.1.7.4 of Part 1);

m) protective earth terminal (see Sub-clause 7.1.9.3 of Part 1);

The following data shall be made available in the manufacturer's published information:

n) rated insulation voltage;

o) rated impulse withstand voltage for equipment suitable for isolation or when determined;

p) pollution degree, if different from 3;

q) rated duty;

r) rated short-time withstand current and duration, where applicable;

s) rated short-circuit making capacity, where applicable;

t) rated conditional short-circuit current, where applicable.

5.3 Instructions for installation, operation and maintenance

Sub-clause 5.3 of Part 1 applies.

6. Normal service, mounting, and transport conditions

Clause 6 of Part 1 applies with the following addition:

Pollution degree (see Sub-clause 6.1.3.2 of Part 1).
Unless otherwise stated by the manufacturer, the equipment is intended for installation under environmental conditions of pollution degree 3.

7. Constructional and performance requirements

7.1 Constructional requirements

Note. Further requirements concerning materials and current-carrying parts are under consideration for Sub-clauses 7.1.1 and 7.1.2 of Part 1. Their application to this standard will be subject to further consideration.

Sub-clause 7.1 of Part 1 applies, with the following additions:

7.1.3 Clearances and creepage distances

For equipment for which the manufacturer has declared a value of rated impulse withstand voltage \( U_{\text{imp}} \), minimum values are given in Tables XIII and XV of Part 1.

For other equipment, guidance for minimum values is given in Appendix B.

7.1.6.1 Additional constructional requirements for equipment suitable for isolation

The equipment shall be marked according to Sub-clause 5.26).

For equipment of rated operational voltage greater than 50 V, the strength of the actuating mechanism and the reliability of the indication of the open position shall be checked according to Sub-clause 8.2.5. Moreover, when means are provided to lock the equipment in the open position, locking shall only be possible when the main contacts are in the open position (see Sub-clause 8.2.5).

This requirement does not apply to equipment where the main contact position is visible in the open position and/or the open position is indicated by another means than the actuator.

When no indication is provided, all the main contacts shall be clearly visible in the open position.

The clearance across the open contacts of the same pole when in the open position shall not be less than the minimum clearances given in Table XIII of Part 1 and shall also comply with the requirements of Sub-clause 7.2.3.1b) of Part 1.

Note. If auxiliary contacts are provided for interlocking purposes, the operating time of the auxiliary contacts should be declared by the manufacturer.
7.1.8 Additional requirements for equipment provided with a neutral pole

Sub-clause 7.1.8 of Part 1 applies except for the note referring to an overcurrent release.

7.2 Performance requirements

7.2.1 Operating conditions

7.2.1.1 General

Sub-clause 7.2.1.1 of Part 1 applies.

7.2.2 Temperature rise

Sub-clause 7.2.2 of Part 1 applies with the following addition:

For fuse-combination units, the temperature rise of the fuse-link contacts during the test according to Sub-clause 8.3.3.1 shall not cause any damage of a nature which impairs the subsequent performance of the equipment in test sequence 1.

7.2.3 Dielectric properties

If the manufacturer has declared a value of the rated impulse withstand voltage \( U_{\text{imp}} \), the requirements of Sub-clause 7.2.3 of Part 1 apply and the equipment shall satisfy the dielectric tests specified in Sub-clause 8.3.3.4 of Part 1.

If no value of the rated impulse withstand voltage has been declared, and for the verification of dielectric withstand specified in the relevant sub-clauses of this standard, the equipment shall satisfy the dielectric tests specified in Sub-clauses 8.3.3.2.1, 8.3.3.2.2, 8.3.3.2.3 and 8.3.3.2.4 of this standard.

7.2.4 Ability to make and break under no-load, normal load and overload conditions

7.2.4.1 Making and breaking capacities

The rated making and breaking capacities are stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table III.

The test conditions are specified in Sub-clause 8.3.3.3.1.
TABLE III

Verification of rated making and breaking capacities (see Sub-clause 8.3.3.3)

Conditions for making and breaking corresponding to the various utilization categories

<table>
<thead>
<tr>
<th>Utilization category</th>
<th>Rated operational current</th>
<th>Making (1)</th>
<th>Make-break</th>
<th>Number of operating cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$I/I_e$</td>
<td>$U/U_e$</td>
<td>$\cos \phi$</td>
</tr>
<tr>
<td>AC-20A(2) - AC-20B(2)</td>
<td>All values</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AC-21A - AC-21B</td>
<td>All values</td>
<td>1.5</td>
<td>1.05</td>
<td>0.95</td>
</tr>
<tr>
<td>AC-22A - AC-22B</td>
<td>All values</td>
<td>3</td>
<td>1.05</td>
<td>0.65</td>
</tr>
<tr>
<td>AC-23A - AC-23B</td>
<td>$0 &lt; I_e \leq 100A$</td>
<td>10</td>
<td>1.05</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>$100A &lt; I_e$</td>
<td>10</td>
<td>1.05</td>
<td>0.35</td>
</tr>
<tr>
<td>DC-20A(2) - DC-20B(2)</td>
<td>All values</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DC-21A - DC-21B</td>
<td>All values</td>
<td>1.5</td>
<td>1.05</td>
<td>1</td>
</tr>
<tr>
<td>DC-22A - DC-22B</td>
<td>All values</td>
<td>4</td>
<td>1.05</td>
<td>2.5</td>
</tr>
<tr>
<td>DC-23A - DC-23B</td>
<td>All values</td>
<td>4</td>
<td>1.05</td>
<td>15</td>
</tr>
</tbody>
</table>

$I = $ Making current
$I_c = $ Breaking current
$I_e = $ Rated operational current
$U = $ Applied voltage
$U_{e_{op}} = $ Rated operational voltage
$L/R = $ Power frequency or d.c. recovery voltage

(1) For a.c. the making current is expressed by the r.m.s. value of the periodic component of the current.

(2) The use of these utilization categories is not permitted in the United States of America.
7.2.4.2 Operational performance

Tests concerning the verification of the operational performance of an equipment are intended to verify that the equipment is capable of making and breaking without failure, the currents flowing in its main circuit for the intended use.

The number of operating cycles and the test circuit parameters for the operational performance test for the various utilization categories are given in Tables IV and V.

The test conditions are specified in Sub-clause 8.3.4.1.

### TABLE IV

<table>
<thead>
<tr>
<th>Rated operational current $I_e$</th>
<th>Number of operating cycles per hour</th>
<th>Number of operating cycles</th>
<th>AC and DC categories</th>
<th>AC and DC categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without current</td>
<td>With current</td>
<td>Total</td>
<td>Without current</td>
</tr>
<tr>
<td>$0 &lt; I_e &lt; 100$</td>
<td>120</td>
<td>8 500</td>
<td>1 500</td>
<td>10 000</td>
</tr>
<tr>
<td>$100 &lt; I_e &lt; 315$</td>
<td>120</td>
<td>7 000</td>
<td>1 000</td>
<td>8 000</td>
</tr>
<tr>
<td>$315 &lt; I_e &lt; 630$</td>
<td>50</td>
<td>4 000</td>
<td>1 000</td>
<td>5 000</td>
</tr>
<tr>
<td>$630 &lt; I_e &lt; 2 500$</td>
<td>20</td>
<td>2 500</td>
<td>500</td>
<td>3 000</td>
</tr>
<tr>
<td>$2 500 &lt; I_e$</td>
<td>10</td>
<td>1 500</td>
<td>500</td>
<td>2 000</td>
</tr>
</tbody>
</table>

The values in the table apply to all utilization categories except AC-20A, AC-20B, DC-20A and DC-20B. These categories shall comply with the total number of operating cycles in columns 5 or 8, but all without current unless some breaking and/or making capacity is claimed (see notes to Sub-clauses 4.3.5.2 and 4.3.5.3). In this case the verification shall be made at the values of voltage, current and power-factor claimed and for the number of operating cycles given in the table. Column 2 gives the minimum operating rate. The operating rate for any utilization category may be increased with the consent of the manufacturer.
### TABLE V

*Test circuit parameters for Table IV*

<table>
<thead>
<tr>
<th>Utilization category</th>
<th>Value of the rated operational current $I_e$</th>
<th>Making (1)</th>
<th>Breaking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$I/I_e$</td>
<td>$U/U_e$</td>
</tr>
<tr>
<td>AC-21A AC-21B</td>
<td>All values</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AC-22A AC-22B</td>
<td>All values</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AC-23A AC-23B</td>
<td>All values</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DC-21A DC-21B</td>
<td>All values</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DC-22A DC-22B</td>
<td>All values</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DC-23A DC-23B</td>
<td>All values</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

$I_e$ = Making current  
$I_c$ = Breaking current  
$I_e$ = Rated operational current  
$U$ = Voltage before make (Applied voltage)  
$U_e$ = Rated operational voltage  
$U_r$ = Power frequency or d.c. recovery voltage

(1) For a.c., the making current is expressed by the r.m.s. value of the periodic component of the current.

#### 7.2.4.3 Mechanical durability

Sub-clause 7.2.4.3.1 of Part 1 applies. Test conditions are specified in Sub-clause 8.5.1.

#### 7.2.4.4 Electrical durability

Sub-clause 7.2.4.3.2 of Part 1 applies. Test conditions are specified in Sub-clause 8.5.2.

#### 7.2.5 Ability to make, break or withstand short-circuit currents

The equipment shall be so constructed as to be capable of withstanding, under the conditions specified in this standard, the thermal, dynamic and electrical stresses resulting from short-circuit currents.

Short-circuit currents may be encountered during current making, current carrying in the closed position and current interruption.

The ability of the equipment to make, carry and break short-circuit currents is stated in terms of one or more of the following ratings:

1. Rated short-time withstand current (see Sub-clause 4.3.6.1).
2. Rated short-circuit making capacity (see Sub-clause 4.3.6.2).
3. Rated conditional short-circuit current (see Sub-clause 4.3.6.4).

7.2.6 Switching overvoltages

Sub-clause 7.2.6 of Part 1 applies.

7.2.7 Additional performance requirements for equipment suitable for isolation

These requirements only apply to equipment with rated operational voltage greater than 50 V.

With the equipment in new condition and the contacts in the open position the equipment shall withstand the dielectric test of Sub-clause 8.3.3.2.

If tests according to Sub-clauses 8.3.3.3 and 8.3.4.1 have been made, the equipment in the condition after the tests shall meet the leakage current requirements of Sub-clause 8.3.3.5.

8. Tests

8.1 Kind of tests

8.1.1 General

Sub-clause 8.1.1 of Part 1 applies.

8.1.2 Type tests

Sub-clause 8.1.2 of Part 1 applies. Type tests are given in Table VII of this standard.

8.1.3 Routine tests

Sub-clause 8.1.3 of Part 1 applies. Routine tests are specified in Sub-clause 8.4.

8.1.4 Sampling tests

Sampling tests for clearance verification according to Sub-clause 8.3.3.4.3 of Part 1 are under consideration.

8.1.5 Special tests

Special tests (see Sub-clause 2.6.4 of Part 1) are specified in Sub-clause 8.5.

8.2 Type tests for constructional requirements

Sub-clause 8.2 of Part 1 applies. (See however note of Sub-clause 7.1.)
8.2.5 Verification of the strength of actuator mechanism and position indicating device

This sub-clause only applies to equipment suitable for isolation with a rated operational voltage greater than 50 V.

8.2.5.1 Condition of equipment for tests

The test on the actuator shall be part of test sequence I (see Sub-clause 8.3.3 and Table IX).

8.2.5.2 Method of test

The necessary force $F$ for opening shall first be measured and the force should be applied to the extremity of the actuator.

With the equipment in the closed position, fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be kept closed by appropriate means. The actuator shall be submitted to the test force as defined in Table VI according to its type.

This force shall be applied without shock to the actuator in a direction to open the contacts for a period of 10 s.

The direction of the force, as shown in Figure 1, shall be maintained throughout the test.

If locking means are provided to lock the actuator in the open position it shall not be possible to lock the actuator in this position while the test force is applied.

8.2.5.3 Condition of equipment after test

After the test and when the test force is no longer applied to the actuator with the actuator being left free, the indication of the open position shall not be wrongly given.

| TABLE VI |
| Actuator test force |

<table>
<thead>
<tr>
<th>Type of actuator</th>
<th>Test force</th>
<th>Minimum test force $F$</th>
<th>Maximum test force $F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pushbutton Fig. 1a</td>
<td>3F</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>One-finger operated Fig. 1b</td>
<td>3F</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>Two-finger operated Fig. 1c</td>
<td>3F</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>One-hand operated Fig. 1d and 1e</td>
<td>3F</td>
<td>150</td>
<td>400</td>
</tr>
<tr>
<td>Two-hand operated Fig. 1f</td>
<td>3F</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>Two-hand operated Fig. 1g</td>
<td>3F</td>
<td>200</td>
<td>600</td>
</tr>
</tbody>
</table>

$F$ is the normal operating force in new condition. The test force shall be $3F$ with the stated minimum and maximum values and be applied as shown in Figure 1.
Fig. 1. - Actuator applied force $F$. 
TABLE VII

List of type tests applicable to a given equipment

<table>
<thead>
<tr>
<th>Test</th>
<th>Switch</th>
<th>Fuse-switch</th>
<th>Switch-fuse</th>
<th>Disconnector</th>
<th>Disconnector-fuse</th>
<th>Fuse-disconnector</th>
<th>Switch-disconnector</th>
<th>Switch-disconnector-fuse</th>
<th>Fuse-switch disconnector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature-rise</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Temperature-rise verification</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dielectric properties</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dielectric verification</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage current</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rated making and breaking capacities (overload)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Operational performance</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rated short-time withstand current</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rated short-circuit making capacity</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rated conditional short-circuit current</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Strength of actuator mechanism</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- = test
- = no test required
8.3 **Type tests for performance**

Performance type tests to which equipment may be submitted according to its kind are listed in Table VII.

8.3.1 **Test sequences**

Type tests are grouped together in a number of sequences as shown in Table VIII.

For each sequence, tests shall be made in the order listed in accordance with the requirements of the appropriate sub-clause.

**TABLE VIII**

*Overall scheme of test sequences*

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>General performance characteristics (see Sub-clause 8.3.3 and Table IX)</td>
<td>Temperature-rise&lt;br&gt;Dielectric properties&lt;br&gt;Making and breaking capacities (1)&lt;br&gt;Dielectric verification (1)&lt;br&gt;Leakage current (2)&lt;br&gt;Temperature-rise verification (1)&lt;br&gt;Strength of actuator mechanism (2)</td>
</tr>
<tr>
<td>Operational performance capability (see Sub-clause 8.3.4 and Table XII)</td>
<td>Operational performance&lt;br&gt;Dielectric verification&lt;br&gt;Leakage current (2)&lt;br&gt;Temperature-rise verification</td>
</tr>
<tr>
<td>Short-circuit performance capability (3) (see Sub-clause 8.3.5 and Table XII)</td>
<td>Short-time withstand current&lt;br&gt;短路容量 (3)&lt;br&gt;Short-circuit making capacity&lt;br&gt;Dielectric verification&lt;br&gt;Leakage current (2)&lt;br&gt;Temperature-rise verification</td>
</tr>
<tr>
<td>Conditional short-circuit current (3) (see Sub-clause 8.3.6 and Table XIII)</td>
<td>Fuse protected short-circuit withstand&lt;br&gt;Fuse protected short-circuit making&lt;br&gt;Dielectric verification&lt;br&gt;Leakage current (2)&lt;br&gt;Temperature-rise verification</td>
</tr>
</tbody>
</table>

(1) Not required for disconnectors (AC-20 or DC-20). See notes of Sub-clauses 4.3.5.2 and 4.3.5.3.

(2) Only required for equipment suitable for isolation of rated voltage greater than 50 V.

(3) Either test sequence III or test sequence IV to be made according to the ratings stated by the manufacturer.

3.3.2 **General test conditions**

8.3.2.1 **General requirements**

Sub-clause 8.3.2.1 of Part 1 applies to all type tests as applicable. The equipment at the start of any test sequence shall be in new, and clean condition.
The force applied for any opening operation shall not be greater than the test force determined in Sub-clause 8.2.5.2 and shall be applied in the same manner without shock.

Where doubt exists as to the correct opening operation, no more than three attempts to operate the equipment to the open position are allowed.

8.3.2.2 Test quantities

Sub-clause 8.3.2.2 of Part 1 applies.

8.3.2.3 Evaluation of test results

The behaviour of the equipment during the tests and its condition after the tests are specified in the appropriate test clause.

8.3.2.4 Test report

Sub-clause 8.3.2.4 of Part 1 applies.

8.3.3 Test sequence I: General performance characteristics

This test sequence applies to the types of equipment listed in Table IX and comprises the tests according to the table.

8.3.3.1 Temperature-rise

Sub-clause 8.3.3.3 of Part 1 applies with the following additions:

The test shall be made at the conventional enclosed thermal current (see Sub-clause 4.3.2.2 of Part 1).

Fuse-combination units shall be fitted with fuse-links having a rated current equal to the conventional thermal current of the combination unit.

The fuse-link shall have a power loss not exceeding the maximum value specified by the equipment manufacturer.

Note. - The test may be made with a "dummy" fuse-link of essentially similar design to the standardized fuse-link and having the specified power loss.

Details of the fuse-links used for the test, i.e. the manufacturer's name and reference, the rated current, the power loss of the fuse-link, and the breaking capacity, shall be given in the test report. The type test with the specified fuse-links shall be deemed to cover the use of any other fuse-link having a power loss, at the conventional thermal current of the combination unit, not exceeding the power loss of the fuse-link used for the test.
### TABLE IX

**Test sequence 1: General performance characteristics**

<table>
<thead>
<tr>
<th>Test</th>
<th>Sub-clause No.</th>
<th>Type of equipment and order of tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Switch</td>
</tr>
<tr>
<td>Temperature-rise</td>
<td>8.3.3.1</td>
<td>1</td>
</tr>
<tr>
<td>Dielectric properties</td>
<td>8.3.3.2</td>
<td>2</td>
</tr>
<tr>
<td>Making and breaking capacities</td>
<td>8.3.3.3</td>
<td>3</td>
</tr>
<tr>
<td>Dielectric verification</td>
<td>8.3.3.4</td>
<td>4</td>
</tr>
<tr>
<td>Leakage current (2)</td>
<td>8.3.3.5</td>
<td>-</td>
</tr>
<tr>
<td>Temperature-rise verification</td>
<td>8.3.3.6</td>
<td>5</td>
</tr>
<tr>
<td>Strength of actuator mechanism (2)</td>
<td>8.3.3.7</td>
<td>-</td>
</tr>
</tbody>
</table>

(1) This test is not required for disconnectors (AC-20 or DC-20). See notes of Sub-clauses 4.3.5.2 and 4.3.5.3.

(2) Test required only for \( U_e \) greater than 50 V.
8.3.3.2 Test of dielectric properties

The test shall be made:

- in accordance with Sub-clause 8.3.3.4 of Part 1 if the manufacturer has declared a value of the rated impulse withstand voltage \( U_{imp} \) (see Sub-clause 4.3.1.3);

- in accordance with Sub-clauses 8.3.3.2.1, 8.3.3.2.2, 8.3.3.2.3 and 8.3.3.2.4, if no value of \( U_{imp} \) has been declared, and for the verification of dielectric withstand in the relevant sub-clauses of this standard.

Equipment suitable for isolation shall be tested according to Sub-clause 8.3.3.4 of Part 1, with a value of test voltage as specified in Table XIV of Part 1 and corresponding to the value of \( U_{imp} \) declared by the manufacturer. This requirement does not apply to the verification of dielectric withstand made during test sequences.

8.3.3.2.1 Condition of the equipment for tests

Dielectric tests shall be made on new equipment mounted approximately as under usual service conditions, including internal wiring, and in a dry condition.

When the base of the equipment is of insulating material, metallic parts shall be placed at all the fixing points in accordance with the conditions of normal installation of the equipment and these parts shall be considered as part of the frame of the equipment. When the equipment is in an insulating enclosure, the latter shall be covered by a metal foil connected to the frame. If the operating handle is metallic, it shall be connected to the frame; if it is of insulating material, it shall be covered by a metal foil connected to the frame.

Equipment not supplied with an enclosure but intended to be used in an enclosure shall be tested in an enclosure stated by the manufacturer to be equivalent to the smallest that is applicable in service.

When the dielectric strength of the equipment is dependent upon the taping of leads or the use of special insulation, such taping or special insulation shall also be used during the tests.

8.3.3.2.2 Application of the test voltage

The test voltage shall be applied for 1 min as follows:

a) With the main contacts closed:

1) between all live parts of all poles connected together and the frame of the equipment;

2) between each pole and all the other poles connected to the frame of the equipment.
On equipment having more than one closed position, the test shall be carried out in each closed position.

b) With the main contacts open:

1) between all live parts of all poles connected together and the frame of the equipment;
2) between the terminals of one side connected together and the terminals of the other side connected together.

For the purpose of the above tests, an insulated neutral is to be considered as a pole of the equipment.

On equipment having more than one open position, the test shall be carried out in each open position.

8.3.3.2.3 Value of the test voltage

The test voltage shall have a practically sinusoidal waveform and a frequency between 45 Hz and 62 Hz.

The high-voltage transformer used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

The overcurrent relays shall not trip when the output current is less than 100 mA.

Glow discharges without drops in voltage are neglected.

Unless otherwise specified, the value of the test voltage shall be as given in Table X.

TABLE X

Dielectric test voltage corresponding to the rated insulation voltage

<table>
<thead>
<tr>
<th>Rated insulation voltage $U_1$ (V)</th>
<th>Dielectric test voltage (a.c.) (r.m.s.) (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_1 \leq 60$</td>
<td>1 000</td>
</tr>
<tr>
<td>$60 &lt; U_1 \leq 300$</td>
<td>2 000</td>
</tr>
<tr>
<td>$300 &lt; U_1 \leq 660$</td>
<td>2 500</td>
</tr>
<tr>
<td>$660 &lt; U_1 \leq 800$</td>
<td>3 000</td>
</tr>
<tr>
<td>$800 &lt; U_1 \leq 1 000$</td>
<td>3 500</td>
</tr>
<tr>
<td>$1 000 &lt; U_1 \leq 1 500^*$</td>
<td>3 500</td>
</tr>
</tbody>
</table>

* For d.c. only
8.3.3.2.4 Results to be obtained

The test is considered to have been passed if there is no puncture or flash-over.

8.3.3.3 Making and breaking capacities

8.3.3.3.1 Test values and conditions

Sub-clause 8.3.3.5 of Part 1 applies regarding equipment provided with a neutral pole.

The test values are stated in Table III, Sub-clause 7.2.4.1, according to the utilization category.

The stated number of make-break operating cycles shall be made with a time interval between close-open cycles of 30 s ± 10 s except that for equipment of conventional thermal current of 400 A or more, the time interval may be increased by agreement between manufacturer and user and the interval shall be stated in the test report.

During each make-break operating cycle, equipment need only stay in the closed position for a period long enough to allow the switching operation to be completed and to enable the current value to be established and the moving parts of the equipment to come to rest. After each operating cycle, the recovery voltage shall be maintained for at least 0.05 s.

For convenience of testing, equipment of utilization categories AC-23A and AC-23 B make-break operating cycles may be replaced, with the agreement of the manufacturer, by the stated number of 10 \( I_e \) make cycles followed by the same number of 8 \( I_e \) make-break cycles.

For a.c. the power-factor of the test circuit shall be determined in accordance with Sub-clause 8.3.4.1.3 of Part 1. The values shall be in accordance with Table III, Sub-clause 7.2.4.1.

For d.c. the time-constant of the test circuit shall be determined in accordance with Sub-clause 8.3.4.1.4 of Part 1. The values shall be in accordance with Table III, Sub-clause 7.2.4.1.

The test voltage and the load shall be applied to the appropriate terminals of the equipment. For equipment in which a moving contact remains connected to one of the terminals when the equipment is in the open position, this test shall be repeated with the supply and load connections interchanged, unless the terminals are specifically and clearly marked for load and supply.
In the case of tests carried out on fuse-combination units, fuse-links may be replaced by suitable copper links of dimensions and mass electrically equivalent to those of the fuse-links recommended by the manufacturer.

8.3.3.3.2 Test circuit

Sub-clause 8.3.3.5.2 of Part 1 applies.

8.3.3.3 Transient recovery voltage

Sub-clause 8.3.3.5.3 of Part 1 applies only to utilization categories AC-22 and AC-23. For tests for utilization categories DC-22 and DC-23 the test circuit load may be replaced by a motor producing the specified current and time constant value if agreed between manufacturer and user.

8.3.3.4 Switching overvoltages

Under consideration.

8.3.3.5 Behaviour of equipment during making and breaking capacity tests

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

8.3.3.6 Condition of equipment after the making and breaking capacity tests

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the test and without maintenance the equipment shall comply with the requirements of Sub-clause 8.3.3.4.

The contacts shall be in a suitable condition to carry the rated operational current without maintenance and shall comply with the temperature-rise verification of Sub-clause 8.3.3.6.

If the equipment is suitable for isolation, it shall comply with Sub-clauses 8.3.3.5 and 8.3.3.7.
8.3.3.4 Dielectric verification

After the test according to Sub-clause 8.3.3.3, a test shall be made to check that the equipment shall be capable, without maintenance, of withstanding a voltage equal to twice its rated insulation voltage according to Sub-clause 8.3.3.2.2.

8.3.3.5 Leakage current

This test is made only on equipment suitable for isolation of rated operational voltage $U_r$ greater than 50 V. The leakage current shall be checked across each contact gap and from each terminal to the frame.

The value of leakage current, with a test voltage equal to 1.1 times the rated operational voltage of equipment shall not exceed:

- 0.5 mA per pole for equipment of utilization category AC-20A, AC-20B, DC-20A or DC-20B.
- 2 mA per pole for equipment of all other utilization categories.

8.3.3.6 Temperature-rise verification

After the tests according to Sub-clause 8.3.3.3, the temperature-rise of the main terminals shall be checked according to Sub-clause 8.3.3.1. The terminals shall not exceed 80 K temperature-rise at the rated operational current of the utilization category of the equipment tested.

8.3.3.7 Strength of actuator mechanism

Sub-clause 8.2.5 applies to equipment suitable for isolation of rated operational voltage greater than 50 V.

8.3.4 Test sequence II: Operational performance capability

This test sequence applies to the types of equipment listed in Table XI and comprises the tests according to this table.

They are made to verify compliance with Sub-clause 7.2.4.2.

8.3.4.1 Operational performance test

8.3.4.1.1 Test values and conditions

The test values are stated in Tables IV and V, Sub-clause 7.2.4.2 according to the utilization category.

The time interval between Table IV operating cycles with current and without current and the sequential order of the tests shall be stated in the test report.
## TABLE XI

**Test sequence II: Operational performance capability**

<table>
<thead>
<tr>
<th>Test</th>
<th>Sub-clause No.</th>
<th>Switch</th>
<th>Fuse-switch and switch-fuse</th>
<th>Disconnector-fuse and fuse-disconnector</th>
<th>Switch-disconnector</th>
<th>Switch-disconnector-fuse and fuse-switch-disconnector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational performance</td>
<td>8.3.4.1</td>
<td>1</td>
<td>1</td>
<td>(1)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dielectric verification</td>
<td>8.3.4.2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Leakage current (2)</td>
<td>8.3.4.3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Temperature-rise verification</td>
<td>8.3.4.4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

(1) Load-breaking operations are not required for category AC-20 and DC-20. See also notes of Sub-clauses 4.3.5.2 and 4.3.5.3 as applicable.

(2) Test required only for \( U_e \) greater than 50 V.
During each make-break operating cycle, the equipment need only stay in the closed position for a period long enough to allow the switching operation to be completed and to enable the current value to be established and the moving parts of the equipment to come to rest. After each operating cycle, the recovery voltage shall be maintained for at least 0.05 s.

For a.c. the power-factor of the test circuit shall be determined in accordance with Sub-clause 8.3.4.1.3 of Part 1. The values shall be in accordance with Table V, Sub-clause 7.2.4.2.

For d.c. the time-constant of the test circuit shall be determined in accordance with Sub-clause 8.3.4.1.4 of Part 1. The values shall be in accordance with Table V, Sub-clause 7.2.4.2.

8.3.4.1.2 Test circuit

Sub-clause 8.3.3.5.2 of Part 1 applies.

8.3.4.1.3 Transient recovery voltage

It is not necessary to adjust the transient recovery voltage.

8.3.4.1.4 Switching overvoltages

Under consideration.

8.3.4.1.5 Behaviour of the equipment during the operational performance test

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

Some wear on the mechanism and contacts is allowed provided that the equipment functions correctly.

8.3.4.1.6 Condition of the equipment after the operational performance test

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.
A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the tests and without maintenance the equipment shall comply with the requirements of Sub-clause 8.3.4.2.

The contacts shall be in a suitable condition to carry the rated operational current without maintenance and shall comply with the temperature-rise verification of Sub-clause 8.3.4.4.

If the equipment is suitable for isolation, it shall comply with Sub-clause 8.3.4.3.

8.3.4.2 Dielectric verification

Sub-clause 8.3.3.4 applies.

8.3.4.3 Leakage current

Sub-clause 8.3.3.5 applies.

8.3.4.4 Temperature-rise verification

Sub-clause 8.3.3.6 applies.

8.3.5 Test sequence III: Short-circuit performance capability

This test sequence applies to the types of equipment listed in Table XII and comprises the tests according to this table.

This test sequence is not mandatory if a value of rated short-circuit making capacity is not stated by the manufacturer (see Sub-clause 8.3.5.2.1) and test sequence IV (Sub-clause 8.3.6) is carried out.

The tests are made to verify compliance with Sub-clause 7.2.5.

8.3.5.1 Short-time withstand current test

8.3.5.1.1 Test values and conditions

The test conditions of Sub-clause 8.3.4.3 of Part 1 apply.

The test current shall be the rated short-time withstand current stated according to Sub-clause 4.3.6.1.

8.3.5.1.2 Test circuit

Sub-clause 8.3.4.1.2 of Part 1 applies.

For a.c., the power-factor of the test circuit shall be in accordance with Sub-clause 8.3.4.1.3 of Part 1.

For d.c., the time-constant of the test circuit shall be in accordance with Sub-clause 8.3.4.1.4 of Part 1.
### TABLE XII

**Test sequence III: Short-circuit performance capability**

<table>
<thead>
<tr>
<th>Test</th>
<th>Sub-clause No.</th>
<th>Switch</th>
<th>Fuse-switch and switch-fuse</th>
<th>Disconnector</th>
<th>Disconnector-fuse and fuse-disconnector</th>
<th>Switch-disconnector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-time withstand current</td>
<td>8.3.5.1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Short-circuit making capacity (1)</td>
<td>8.3.5.2</td>
<td>2</td>
<td>Not</td>
<td>Not</td>
<td>2</td>
<td>Not</td>
</tr>
<tr>
<td>Dielectric verification</td>
<td>8.3.5.3</td>
<td>3</td>
<td>applicable</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Leakage current (3)</td>
<td>8.3.5.4</td>
<td>4</td>
<td></td>
<td>3</td>
<td>4</td>
<td>applicable</td>
</tr>
<tr>
<td>Temperature-rise verification</td>
<td>8.3.5.5</td>
<td>4</td>
<td></td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

(1) Test sequence III is not mandatory if test sequence IV is carried out.

(2) Switches and switch-disconnectors not having a rated short-circuit making capacity (see Sub-clause 2.1) shall meet the requirements of test sequence IV (see Table XIII).

(3) Test required only for \(U_e\) greater than 50 V.
8.3.5.1.3 *Test circuit calibration*

The calibration of the test circuit is carried out by placing temporary connections \( B \) of negligible impedance as close as reasonably possible to the terminals provided for connecting the equipment under test.

For a.c., resistors \( R_1 \) and reactors \( X \) are adjusted so as to obtain, at the applied voltage, a current equal to the rated short-time withstand current as well as the power-factor as indicated in Sub-clause 8.3.4.1.3 of Part 1.

For d.c., resistors \( R_1 \) and reactors \( X \) are adjusted so as to obtain, at the applied voltage, a current the maximum value of which is equal to the rated short-time withstand current as well as the time-constant as indicated in Sub-clause 8.3.4.1.4 of Part 1.

3.3.5.1.4 *Test procedure*

The temporary connections \( B \) are replaced by the equipment under test and the test current is applied for the specified time with the equipment in the closed position.

8.3.5.1.5 *Behaviour of the equipment during the test*

The equipment shall perform during the test in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

8.3.5.1.6 *Conditions of the equipment after the test*

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the test and without maintenance if the equipment is a switch or a switch-disconnector, it shall be subjected to the short-circuit making capacity test, Sub-clause 8.3.5.2, as listed in Table XII.

If the equipment is suitable for isolation, it shall comply without maintenance with the dielectric verification of Sub-clause 8.3.5.3.

The contacts of a disconnector shall be in a suitable condition without maintenance to carry the rated operational current and shall comply with the temperature-rise of Sub-clause 8.3.5.5.
8.3.5.2 Short-circuit making capacity test

8.3.5.2.1 Test values and conditions

The test shall be made on the same equipment as for the test of Sub-clause 8.3.5.1 without any maintenance.

The test current shall be that assigned by the manufacturer as stated in Sub-clause 4.3.6.2.

8.3.5.2.2 Test circuit

Sub-clause 8.3.5.1.2 applies.

8.3.5.2.3 Test circuit calibration

The calibration of the test circuit is carried out by placing temporary connections \( B \) of negligible impedance as close as reasonably possible to the terminals provided for connecting the equipment under test.

Depending upon whether the equipment is rated a.c. or d.c. the calibration is made as follows:

a) For a.c.:

The tests shall be made at the rated frequency of the equipment.

The prospective current shall be applied for at least 0.05 s and its value is the r.m.s. value determined from the calibration record. This value shall be equal to or higher than the specified value in at least one pole.

The average value of all phases shall comply with the tolerances in Sub-clause 8.3.2.2 of Part 1.

The highest peak value of the prospective current during its first cycle shall be not less than \( n \) times the rated short-circuit current, the value of \( n \) being as stated in the third column of Table XVI, Sub-clause 8.3.4.1.3 of Part 1.

b) For d.c.:

The current shall be applied for the specified time and its mean value, determined from the record, shall be at least equal to the specified value.

If the testing station is unable to make these tests on d.c., they may, if agreed between manufacturer and user, be made on a.c., provided suitable precautions are taken, for instance, the peak value of current shall not exceed the permissible current.

For an equipment having the same rated current for a.c. and d.c. the a.c. test shall be taken as valid for the d.c. rating.
8.3.5.2.4 Test procedure

The temporary connections are replaced by the equipment under test and the equipment shall be closed twice with an interval of approximately 3 min between these operations on a prospective peak current not less than the rated short-circuit making capacity of the equipment. The current shall be maintained for at least 0.05 s.

The closing mechanism shall be operated so as to simulate service conditions as closely as possible.

8.3.5.2.5 Behaviour of the equipment during the test

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall not be permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

8.3.5.2.6 Condition of the equipment after the test

It shall be demonstrated immediately after the test that the equipment will open and close satisfactorily during a no-load open/close operation.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the equipment to be able to carry its rated operational current.

After the test and without maintenance the equipment shall comply with the dielectric verification of Sub-clause 8.3.5.3.

The contacts shall be in a suitable condition without maintenance to carry the highest rated operational current and shall comply with the temperature-rise verification of Sub-clause 8.3.5.4.

8.3.5.3 Dielectric verification

Sub-clause 8.3.3.4 applies.

8.3.5.4 Leakage current

Sub-clause 8.3.3.5 applies, except that the maximum value of leakage current shall not exceed 2 mA per pole for all utilization categories.

8.3.5.5 Temperature-rise verification

Sub-clause 8.3.3.6 applies.
8.3.6 Test sequence IV: Conditional short-circuit current

This test sequence applies to the types of equipment listed in Table XII and comprises the tests according to the table.

This test sequence is not mandatory if a value of rated conditional short-circuit current is not stated by the manufacturer and test sequence III (see Sub-clause 8.3.5) is carried out.

For switches, disconnectors and switch-disconnectors the short-circuit protective device of the equipment may be a circuit-breaker or a fuse and shall be arranged on the load side of the equipment under test.

The type of circuit breaker or fuse shall be that stated by the manufacturer as suitable for the equipment.

Details of the protective device used for the test i.e. manufacturer's name, type designation, rated voltage, current and short-circuit breaking capacity shall be given in the test report.

The type test with the specified protective device shall be deemed to cover the use of any other protective device having a Joule integral \((I^2t)\) and cut-off current at the rated voltage, prospective current and power-factor not exceeding the specified values for the type of protective device used for the test.

The tests are made to verify compliance with Sub-clause 7.2.5.

8.3.6.1 Circuit-breaker protected short-circuit withstand

Under consideration.

8.3.6.2 Fuse protected short-circuit withstand

8.3.6.2.1 Test values and conditions

The fuse-links shall be of the rated maximum current and rated breaking capacity deemed suitable by the manufacturer for use with the equipment.

The test shall be made as follows:

a) Withstand test

A prospective current corresponding to the rated conditional short-circuit current stated by the manufacturer shall be applied with the equipment in the closed position.

b) Making test

After the withstand test a) all equipment except disconnectors according to Table XIII shall be fitted with new fuse-links and closed on to the rated conditional short-circuit current.
TABLE XIII

Test sequence IV: Conditional short-circuit current

<table>
<thead>
<tr>
<th>Test</th>
<th>Sub-clause No.</th>
<th>Switch (1)</th>
<th>Fuse-switch and switch-fuse (1)</th>
<th>Disconnector (1)</th>
<th>Disconnector-fuse and fuse-disconnector (1)</th>
<th>Switch-disconnector-fuse and fuse-switch-disconnector (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse protected short-circuit withstand</td>
<td>8.3.6.2.1 a)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fuse protected short-circuit making</td>
<td>8.3.6.2.1 b)</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dielectric verification</td>
<td>8.3.6.3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Leakage current (2)</td>
<td>8.3.6.4</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Temperature-rise verification</td>
<td>8.3.6.5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

(1) Test sequence IV is not mandatory if test sequence III is carried out (see Table XII).

(2) Test required only for $U_e$ greater than 50 V.
8.3.6.2.2 **Test circuit**

Sub-clause 8.3.5.1.2 applies.

8.3.6.2.3 **Test circuit calibration**

Sub-clause 8.3.5.2.3 applies.

8.3.6.2.4 **Test procedure**

The temporary connections are replaced by the equipment under test and the test current applied according to Sub-clause 8.3.6.2.1.

The recovery voltage shall be maintained for at least 0.05 s after interruption of the test current by the fuse.

8.3.6.2.5 **Behaviour of the equipment during the test**

Sub-clause 8.3.5.2.5 applies.

8.3.6.2.6 **Condition of the equipment after the test**

Sub-clause 8.3.5.2.6 applies.

8.3.6.3 **Dielectric verification**

Sub-clause 8.3.3.4 applies.

8.3.6.4 **Leakage current**

Sub-clause 8.3.5.4 applies.

8.3.6.5 **Temperature-rise verification**

Sub-clause 8.3.3.6 applies.

8.4 **Routine tests**

8.4.1 **General**

Routine tests shall be carried out on equipment in clean, new condition, suitably mounted to carry out the tests and generally in accordance with Sub-clause 8.3.2.1 of Part 1, as applicable.

8.4.2 **Mechanical operational test**

A test shall be made to verify the correct mechanical operation of the equipment by five closing and opening operations.

8.4.3 **Dielectric test**

The method of Sub-clause 8.3.3.4 applies. The value of the test voltage shall be in accordance with Table X and the duration of application of the test voltage may be reduced to 1 s.
8.5 Special tests

Resistance to mechanical and/or electrical wear is demonstrated by the operational performance test detailed in Sub-clause 8.3.4.1.

Where abnormal service conditions are expected (see also note to Sub-clause 7.2.4.3 of Part 1), the following tests may be necessary:

8.5.1 Mechanical durability

The mechanical durability test (see Sub-clauses 7.2.4.3 and 8.1.5), where required, is made in accordance with the appropriate requirements of Sub-clause 8.3.4.1, except that for equipment suitable for isolation, the maximum value of leakage current shall not exceed 6 mA per pole for all utilization categories.

The total number of operating cycles shall be as declared by the manufacturer.

8.5.2 Electrical durability

The electrical durability test (see Sub-clauses 7.2.4.4 and 8.1.5), where required, is made in accordance with the appropriate requirements of Sub-clause 8.3.4.1, except that for equipment suitable for isolation, the maximum value of leakage current shall not exceed 6 mA per pole for utilization categories AC-21, AC-22, AC-23, DC-21, DC-22 and DC-23.

Equipment of utilization categories AC-20A, AC-20B, DC-20A and DC-20B is not submitted to this test.

The total number of operating cycles shall be as declared by the manufacturer.
APPENDIX A

EQUIPMENT FOR DIRECT SWITCHING OF A SINGLE MOTOR

Switches, switch-disconnectors and fuse-combination units normally intended for direct switching of individual motors shall comply with the additional requirements of this appendix. These requirements are essentially the same as the appropriate sub-clauses of IEC Publication 947-4-1 and equipment complying with this appendix may state on the nameplate the appropriate utilization category according to Table A1.

A4.3.4 Rated duty

Additional rated duties considered as standard are as follows:

A4.3.4.3 Intermittent periodic duty or intermittent duty

Sub-clause 4.3.4.3 of Part 1 applies with the following additions:

A4.3.4.3.1 Classes of intermittent duty

According to the number of operating cycles which they shall be capable of carrying out per hour, equipment is divided into the following classes:

- Class 1: up to 1 operating cycle per hour;
- Class 3: up to 3 operating cycles per hour;
- Class 12: up to 12 operating cycles per hour;
- Class 30: up to 30 operating cycles per hour;
- Class 120: up to 120 operating cycles per hour.

A4.3.4.4 Temporary duty

Sub-clause 4.3.4.4 of Part 1 applies.

A4.3.5 Making and breaking capacities

An equipment is defined by its making and breaking capacities, in accordance with utilization categories as specified in Table A11 (see Sub-clause A4.4).

A4.4 Utilization category

The utilization categories as given in Table A1 are considered standard in this appendix. Any other type of utilization category shall be based on agreement between manufacturer and user but information given in the manufacturer’s catalogue or tender may take the place of such an agreement.
Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and of the rated operational voltage, and by the power-factors or time-constants as shown in Table A1 and other test conditions used in the definitions of the rated making and breaking capacities.

For equipment defined by their utilization category, it is therefore unnecessary to specify separately the rated making and breaking capacities as these values depend directly on the utilization category as shown in Table A1.

The utilization categories of Table A1 correspond in principle to the applications listed in Table A1.

### TABLE A1

<table>
<thead>
<tr>
<th>Utilization category</th>
<th>Typical applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-2</td>
<td>Slip-ring motors: starting, plugging (1), switching off</td>
</tr>
<tr>
<td>AC-3</td>
<td>Squirrel-cage motors: starting, switching off of motors during running</td>
</tr>
<tr>
<td>AC-4</td>
<td>Squirrel-cage motors: starting, plugging (1), inching (2)</td>
</tr>
<tr>
<td>DC-3</td>
<td>Shunt motors: starting, plugging (1), inching (2), dynamic breaking of d.c. motors</td>
</tr>
<tr>
<td>DC-5</td>
<td>Series-motors: starting, plugging (1), inching (2), dynamic breaking of d.c. motors</td>
</tr>
</tbody>
</table>

(1) Plugging is understood to mean stopping or reversing the motor rapidly by reversing motor primary connections while the motor is running.

(2) Inching (jogging) is understood to mean energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.

*Note:* The switching of rotor circuits, capacitors or tungsten filament lamps shall be subject to special agreement between manufacturer and user.
TABLE AII
Rated making and breaking capacity conditions corresponding to several utilization categories

<table>
<thead>
<tr>
<th>Utilization category</th>
<th>Make and break conditions</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I_c/I_e</td>
<td>U_r/U_e</td>
<td>cos Φ</td>
<td>On-time</td>
<td>Off-time</td>
<td>Number of operating cycles</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------</td>
<td>---------</td>
<td>--------</td>
<td>---------</td>
<td>----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>AC-2</td>
<td>4.0</td>
<td>1.05</td>
<td>0.65</td>
<td>0.05</td>
<td>(3)</td>
<td>50</td>
</tr>
<tr>
<td>AC-3L5 (3)</td>
<td>8.0</td>
<td>1.05</td>
<td>(1)</td>
<td>0.05</td>
<td>(3)</td>
<td>50</td>
</tr>
<tr>
<td>AC-3L5 (3)</td>
<td>10.0</td>
<td>1.05</td>
<td>(1)</td>
<td>0.05</td>
<td>(3)</td>
<td>50</td>
</tr>
<tr>
<td>DC-3</td>
<td>4.0</td>
<td>1.05</td>
<td>2.5</td>
<td>0.05</td>
<td>(3)</td>
<td>50</td>
</tr>
<tr>
<td>DC-5</td>
<td>4.0</td>
<td>1.05</td>
<td>15.0</td>
<td>0.05</td>
<td>(3)</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make conditions</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilization category</td>
<td>I/I_e</td>
<td>U_r/U_e</td>
<td>cos Φ</td>
<td>On-time</td>
<td>Off-time</td>
<td>Number of operating cycles</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------</td>
<td>---------</td>
<td>--------</td>
<td>---------</td>
<td>----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>AC-3</td>
<td>10</td>
<td>1.05(4)</td>
<td>(1)</td>
<td>0.05</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>AC-4</td>
<td>12</td>
<td>1.05(4)</td>
<td>(1)</td>
<td>0.05</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

I = Current made. The making current is expressed in d.c. or a.c. r.m.s. symmetrical values but it is understood that for a.c. the peak value of the asymmetrical current corresponding to the power-factor of that circuit may assume a higher value.

I_c = Current made and broken, expressed in d.c. or a.c. r.m.s. symmetrical values.

I_e = Rated operational current.

U = Applied voltage.

U_r = Power frequency or d.c. recovery voltage.

U_e = Rated operational voltage.

cos Φ = Power-factor of test circuit.

L/R = Time-constant of test circuit.

(1) cos Φ = 0.45 for I_e < 100 A, 0.35 for I_e > 100 A.

(2) Time may be less than 0.05 s provided that contacts are allowed to become properly seated before re-opening.

(3) See Table AIII.

(4) For U/U_e a tolerance of ±20% is accepted.

(5) The make conditions shall also be verified but may be combined with the make and break test if agreed by the manufacturer. The making current multiples are to be as shown for I/I_e and the breaking current as shown for I_c/I_e. The off-time is to be taken from Table AIII.

(6) Twenty-five operating cycles with one polarity and twenty-five operating cycles with reverse polarity.
### TABLE AIII

**Relationship between current broken $I_c$ and off-time for the verification of the rated making and breaking capacities**

<table>
<thead>
<tr>
<th>Current broken $I_c$ (A)</th>
<th>Off-time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_c \leq 100$</td>
<td>10</td>
</tr>
<tr>
<td>$100 &lt; I_c \leq 200$</td>
<td>20</td>
</tr>
<tr>
<td>$200 &lt; I_c \leq 300$</td>
<td>30</td>
</tr>
<tr>
<td>$300 &lt; I_c \leq 400$</td>
<td>40</td>
</tr>
<tr>
<td>$400 &lt; I_c \leq 600$</td>
<td>60</td>
</tr>
<tr>
<td>$600 &lt; I_c \leq 800$</td>
<td>80</td>
</tr>
<tr>
<td>$800 &lt; I_c \leq 1000$</td>
<td>100</td>
</tr>
<tr>
<td>$1000 &lt; I_c \leq 1300$</td>
<td>140</td>
</tr>
<tr>
<td>$1300 &lt; I_c \leq 1600$</td>
<td>180</td>
</tr>
<tr>
<td>$1600 &lt; I_c$</td>
<td>240</td>
</tr>
</tbody>
</table>

The values of off-time may be reduced if agreed by the manufacturer.

**A7.2.4.2 Operational performance**

Sub-clause 7.2.4.2 of Part 1 applies with the following additions:

Equipment shall be capable of making and breaking currents without failure under the conventional conditions stated in Table AIV for the required utilization categories and the number of operations indicated therein.
TABLE AIV

Operational performance conditions for making and breaking corresponding to several utilization categories

<table>
<thead>
<tr>
<th>Utilization category</th>
<th>Make and break conditions</th>
<th>Number of operating cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_c/I_e$</td>
<td>$U_r/U_e$</td>
</tr>
<tr>
<td>AC-2</td>
<td>2.0</td>
<td>1.05</td>
</tr>
<tr>
<td>AC-3</td>
<td>2.0</td>
<td>1.05</td>
</tr>
<tr>
<td>AC-4</td>
<td>6.0</td>
<td>1.05</td>
</tr>
<tr>
<td>DC-3</td>
<td>2.5</td>
<td>1.05</td>
</tr>
<tr>
<td>DC-5</td>
<td>2.5</td>
<td>1.05</td>
</tr>
</tbody>
</table>

$I_c$ = Current made or broken. The making current is expressed in d.c. or a.c. r.m.s. symmetrical values, but it is understood that the actual value will be the peak value corresponding to the power-factor of the circuit.

$I_e$ = Rated operational current.

$U_r$ = Power frequency or d.c. recovery voltage.

$U_e$ = Rated operational voltage.

(1) $\cos \phi = 0.45$ for $I_e < 100$ A, 0.35 for $I_e > 100$ A.

(2) Time may be less than 0.05 s provided that contacts are allowed to become properly seated before re-opening.

(3) These off-times shall be not greater than the values specified in Table AIII.

(4) 3 000 operating cycles with one polarity and 3 000 operating cycles with reverse polarity.

A7.2.4.3 Mechanical durability

Sub-clause 7.2.4.3.1 of Part 1 applies with the following addition:

The preferred numbers of no-load operating cycles expressed in millions are:

0.001 - 0.003 - 0.01 - 0.03 - 0.1 - 0.3 and 1.

If no mechanical endurance is stated by the manufacturer, a class of intermittent duty implies a minimum mechanical endurance corresponding to 8 000 h of operation at the highest corresponding frequency of operating cycles.
A7.2.4.4 *Electrical durability*

Sub-clause 7.2.4.3.2 of Part 1 applies with the following addition:

The total number of on-load operating cycles shall be as declared by the manufacturer.

A8.3.3.3 *Verification of making and breaking capacities*

See Sub-clause 8.3.3.3 except that the test values shall be in accordance with Tables AII and AIII.

A8.3.4.1 *Operational performance test*

See Sub-clause 8.3.4.1 except that the test conditions shall be in accordance with Table AIV.

A8.5 *Special tests*

Resistance to mechanical and/or electrical wear is demonstrated by the operational performance test detailed in Sub-clause A8.3.4.1.

Where abnormal service conditions are expected (see also note to Sub-clause 7.2.4.3 of Part 1) the following tests may be necessary:

A8.5.1 *Mechanical durability test*

A8.5.1.1 *Condition of the equipment for tests*

The equipment shall be installed as for normal service; in particular, the conductors shall be connected in the same manner as for normal use.

During the test there shall be no voltage or current in the main circuit. The equipment may be lubricated before the test if lubrication is prescribed in normal service.

A8.5.1.2 *Operating conditions*

The equipment shall be operated as in normal service.

A8.5.1.3 *Test procedure*

a) The tests are carried out at the frequency of operations corresponding to the class of intermittent duty. However, if the manufacturer considers that the equipment can satisfy the required conditions when using a higher frequency of operations, he may do so.

b) The number of operating cycles to be carried out shall be not less than the number of no-load operating cycles stated by the manufacturer.
c) After each tenth of the total number of operations has been carried out, it is permissible before carrying on with the test:

- to clean the whole equipment without dismantling;
- to lubricate parts for which lubrication is prescribed by the manufacturer for normal service;
- to adjust the travel and the pressure of the contacts if the design of the equipment enables this to be done.

d) This maintenance work shall not include any replacement of parts.

A8.5.1.4 Results to be obtained

Following the tests of mechanical durability, the equipment shall still be capable of complying with the normal operating conditions at room temperature. There shall be no loosening of the parts used for connecting the conductors.

A8.5.2 Electrical durability test

With respect to its resistance to electrical wear, an equipment is, by convention, characterized by the number of on-load operating cycles, corresponding to the different utilization categories given in Table AV which can be made without repair or replacement.

In all cases, the speed and number of operating cycles shall be chosen by the manufacturer.

The tests shall be taken as valid if the values recorded in the test report differ from the values specified only within the tolerances stated in Sub-clause 8.3.2.2.2 of Part 1.

Tests shall be carried out with the equipment under the appropriate conditions of Sub-clauses A8.5.1.1 and A8.5.1.2 using the test procedure, where applicable, of Sub-clause A8.5.1.3, except that replacement of contacts is not permitted.

After the test, the equipment shall fulfil the normal operating conditions and withstand a dielectric test voltage of twice the rated operational voltage $U_e$, but not less than 900 V, applied only as specified in Sub-clause 8.3.3.2.2 items a)1 and a)2.
**TABLE AV**

*Verification of the number of on-load operating cycles*  
*Conditions for making and breaking*  
*corresponding to several utilization categories*

<table>
<thead>
<tr>
<th>Utilization category</th>
<th>Value of the rated operational current</th>
<th>Make</th>
<th></th>
<th></th>
<th>Break</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I/I&lt;sub&gt;e&lt;/sub&gt;</td>
<td>U/U&lt;sub&gt;e&lt;/sub&gt;</td>
<td>cos&lt;sub&gt;φ&lt;/sub&gt;</td>
<td>I&lt;sub&gt;c&lt;/sub&gt;/I&lt;sub&gt;e&lt;/sub&gt;</td>
</tr>
<tr>
<td>AC-2</td>
<td>All values</td>
<td>2.5</td>
<td>1</td>
<td>0.65</td>
<td>2.5</td>
</tr>
<tr>
<td>AC-3</td>
<td>I&lt;sub&gt;e&lt;/sub&gt; &lt; 17A</td>
<td>6</td>
<td>1</td>
<td>0.65</td>
<td>1</td>
</tr>
<tr>
<td>AC-4</td>
<td>I&lt;sub&gt;e&lt;/sub&gt; &gt; 17A</td>
<td>6</td>
<td>1</td>
<td>0.35</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>I&lt;sub&gt;e&lt;/sub&gt; &lt; 17A</td>
<td>6</td>
<td>1</td>
<td>0.65</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>I&lt;sub&gt;e&lt;/sub&gt; &gt; 17A</td>
<td>6</td>
<td>1</td>
<td>0.35</td>
<td>6</td>
</tr>
<tr>
<td>DC-3</td>
<td>All values</td>
<td>2.5</td>
<td>1</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>DC-5</td>
<td>All values</td>
<td>2.5</td>
<td>1</td>
<td>7.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

- **I<sub>e</sub>** = Rated operational current.  
- **U<sub>e</sub>** = Rated operational voltage.  
- **I** = Current made. In a.c. the conditions for making are expressed in r.m.s. symmetrical values but it is understood that the peak value of asymmetrical current, corresponding to the power-factor of the circuit, may assume a higher value.  
- **U** = Applied voltage.  
- **U<sub>r</sub>** = Power frequency and d.c. recovery voltage.  
- **I<sub>c</sub>** = Current broken.  

1. Tolerance for cos<sub>φ</sub>: ±0.05.  
2. Tolerance for L/R : ±15%.
APPENDIX B
CLEARANCES AND CREEPAGE DISTANCES

B1. General

B1.1 Suitable values for clearances and creepage distances depend, to a great extent on variable factors such as atmospheric conditions, the type of insulation employed, the disposition of the creepage paths and conditions of the system in which the equipment is to be used. For these reasons, the selection of the proper values is the responsibility of the manufacturer.

B1.2 It is recommended that the surface of the insulating parts should be designed with ridges so arranged as to break the continuity of conductive deposits which may form.

B1.3 Conducting parts covered only with varnish or enamel, or protected only by oxidation or a similar process, should not be considered as being insulated from the point of view of clearances and creepage distances.

B1.4 Clearances and creepage distances shall be maintained under the following circumstances:

a) On the one hand, without external electrical connections, and on the other hand, when conductors, either insulated or bare, of the type and of any dimensions specified for the equipment, are installed according to the manufacturer's instructions, if any.

b) After interchangeable parts have been changed, taking into account maximum permissible manufacturing tolerances.

c) Taking into consideration possible deformations either due to the effect of temperature, ageing, shocks, vibrations or due to short-circuit conditions which the equipment is intended to endure.

B2. Determination of clearances and creepage distances

In determining clearances and creepage distances, it is recommended that the following points be considered:

B2.1 In determining creepage distances, grooves at least 2 mm wide and 2 mm deep are measured along their contour. Grooves having any dimension less than these dimensions and any groove liable to be clogged with dirt are neglected and only the direct distance is measured.
B2.2 In determining creepage distances, ridges less than 2 mm high are neglected. Those at least 2 mm high:

- are measured along their contour, if they are an integral part of a component in insulating material (for instance by moulding or welding);
- are measured along the shorter of two paths: length of joint or profile of ridge, if they are not integral parts of a component in insulating material.

B2.3 The application of the foregoing recommendations is illustrated by examples 1 to 11 of Appendix G of Part 1.
APPENDIX C

ITEMS SUBJECT TO AGREEMENT BETWEEN MANUFACTURER AND USER

Note. - For the purpose of this appendix:

- "agreement" is used in a very wide sense;
- "user" includes testing stations.

Appendix J of Part 1 applies with regard to clauses and sub-clauses of this standard, with the following additions:

<table>
<thead>
<tr>
<th>Clause or sub-clause number of this standard</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4</td>
<td>Switching of capacitors or of tungsten filament lamps</td>
</tr>
<tr>
<td>7.1.6.1 Note</td>
<td>Operating time of auxiliary contacts provided for interlocking</td>
</tr>
<tr>
<td>7.2.4.2 and Table IV</td>
<td>Increase of the operating rate for the verification of the operational performance</td>
</tr>
<tr>
<td>8.3.3.1</td>
<td>Time interval greater than (30 , \text{s} \pm 10 , \text{s}) between close-open cycles for making and breaking capacity test of equipment of (I_{th} &gt; 400 , \text{A})</td>
</tr>
<tr>
<td></td>
<td>For categories AC-23A and AC-23B testing of making and breaking capacities by make cycles at (10 , I_e) followed by the same number of make-break cycles at (8 , I_e)</td>
</tr>
<tr>
<td>8.3.3.3.3</td>
<td>Verification of making and breaking capacities for utilization categories DC-22 and DC-23: replacement of the load of the test circuit by a motor</td>
</tr>
<tr>
<td>8.3.5.2.3</td>
<td>A.c. test circuit calibration for the short-circuit making capacity test in the case of d.c. equipment</td>
</tr>
<tr>
<td>Appendix A</td>
<td>Utilization categories other than those listed in Table AII</td>
</tr>
<tr>
<td>A4.4</td>
<td>Switching of rotor circuits</td>
</tr>
</tbody>
</table>
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