Announcing: Publication of Technical Information Letter (T.I.L.) CSA D-35, on Interim Certification Requirements for Pullout Switches
Class No: 4652 04, SWITCHES - Miscellaneous
4652 84, SWITCHES - Miscellaneous - Certified to US Standards
To purchase the Standard, visit us at www.shop.csa.ca

Who is affected?
Manufacturers of pullout switches of the detachable type, rated 600V and 400A maximum.

What do you do?
1. CSA Group Service Delivery staff will contact you to address compliance with each revision as applicable to the product designs covered in your affected Certification Reports. In addition to updates to your Certificate(s) of Compliance & Report(s), testing may be required to comply with these revisions.

2. Please respond within thirty (30) days of receiving CSA Group’s “Application for CSA Certification Services” and “Quotation” communication. You must respond no later than November 15, 2017 in order to guarantee the update to your certification is completed by May 15, 2018. If testing is needed, we will inform you of the samples required.

Approvals:

Should this T.I.L. not be incorporated into the standard within five (5) years, it may be withdrawn and certifications will be cancelled.

This announces the publication of Technical Information Letter (T.I.L.) CSA D-35, Interim Certification Requirements for Pullout Switches. See Attachment 2. This T.I.L. is intended to be used in conjunction with CAN/CSA C22.2 No. 4-04, Enclosed and Dead-Front Switches.

Background and Rationale:
This T.I.L. is being published because there is no certification standard for pullout switches in Canada. CSA Standard C22.2 No. 4-04, Enclosed and Dead-Front Switches, specifically excludes pullout switches from its scope and CSA Standard C22.2 No. 29-15, Panelboards and Enclosed Panelboards, includes requirements for pullout switches, including the Overload test from C22.2 No. 4-04. However, many pullout switches are not intended to be disconnecting devices and would not comply with the overload test.
ATTACHMENT 1

TECHNICAL INFORMATION LETTER CSA D-35

CSA Group

Product Group: Industrial Control

Issued By: Mike Lusk, Technical Advisor, Industrial Control and Power Distribution

Approved By: John Jakob, Technical Manager

EQUIPMENT: Industrial Control Equipment

ITEM: Interim Certification Requirements for Pullout Switches

REFERENCES:
- C22.2 No. 4-16 – Enclosed and Dead-Front Switches
- C22.2 No. 29-15 – Panelboards and Enclosed Panelboards
- UL 1429, Fourth Edition, Pullout Switches

Purpose

This Technical Information Letter (T.I.L.) provides requirements for the electrical safety of non-enclosed and enclosed pullout switches of the detachable type, rated up to 600 V and 400A.

Background

There is no current certification standard for pullout switches in Canada. Annex B of C22.2 No. 4-16 refers to standard C22.2 No. 29-15 for pullout switches, but that standard covers panelboards. Clause 1.10 (d) in C22.2 No. 4-16, Enclosed and Dead-Front Switches, specifically excludes pullout switches from the scope. Also, standard C22.2 No. 29-15, Panelboards and Enclosed Panelboards, includes requirements to be applied to pullout switches including the Overload test from C22.2 No. 4-16. However, many pullout switches are not intended for use as disconnecting devices and would not comply with the overload test requirements.

Rationale

Upon industry request, this provides requirements for pullout switches.

Requirements

1 Scope

1.1 This covers construction, marking and test requirements for pullout switches of the detachable type, rated up to 600 V and 400A.

1.2 These requirements apply to non-enclosed and enclosed pullout switches of the detachable type.
1.3 These requirements apply to pullout switches rated 600 V or less, 400 A or less, with or without horsepower ratings, and with or without high-available fault current ratings.

1.4 These requirements apply to pullout switches mounted in an enclosure which may contain meter sockets or bonding assemblies or both.

1.5 These requirements do not apply to hinged pullout switches which are covered in C22.2 No. 4, Enclosed and Dead-Front Switches.

1.6 These requirements do not apply to enclosed pullout switches containing more than one independent switch which are covered in C22.2 No. 29, Panelboards.

1.7 Pullout switches shall not be used in the service box.

2 Definitions

The following definitions shall apply in this Standard:

**Pullout Switch** - Device in which the pulling or the removal of a detachable pullout member is designed to accomplish a switching operation.

**Detachable pullout** – a type of pullout switch that is operated by physical removal and reinsertion of a detachable pullout member.

**Dead-front shield** — a barrier that is used behind a required door to cover wiring spaces and uninsulated live parts that would otherwise be exposed when the door is open.

**Enclosed pullout switch** – a pullout switch, with or without fuseholders, having all current-carrying parts completely enclosed when the detachable member is in the installed position (in the case of detachable pullouts)

**Enclosure** – a surrounding case constructed to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specified environmental conditions.

**Isolating switch** – a switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

3 Reference Publications

These requirements refer to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

C22.2 No. 0-10, General requirements – Canadian Electrical Code, Part II
C22.2 No. 0.15-15, Adhesive labels
C22.2 No. 0.4-04, Bonding of electrical equipment
C22.2 No. 4-16, Enclosed and Dead Front Switches
4 Construction

General

4.1 General requirements are given in CAN/CSA-C22.2 No. 0.

4.2 All parts of a pullout switch shall be assembled at the factory, except as noted in clause 4.3.

4.3 A pullout switch may have provision for factory- or field-installed accessories such as neutral assemblies provided that:

   a) The switch is for use with and without such accessories;
   b) Each accessory is acceptable for the intended use;
   c) Each accessory can be installed without disassembly of factory-assembled parts and without the use of a special tool unless such a tool and instructions for its use are furnished with the accessory;
   d) A barrier that is necessary to maintain spacings is securely attached at the factory to the switch or to the accessory to be installed;
   e) The accessory is a complete unit and does not require assembly in the field. Cutting or splicing of existing wires or resoldering of connections shall not be permitted;
   f) Screws for mounting the accessory are furnished with that assembly but need not be assembled in place; and
   g) The accessory and switch are marked in accordance with Clause 17.31.

4.4 Live parts of a fuse, including the fuse ferrules, shall not be relied upon to perform the switching function of a pullout switch.

4.5 A meter socket provided with the pullout switch shall comply with the requirements of CAN/CSA C22.2 No. 115.

4.6 A detachable pullout switch member shall be made of rigid metal such as silver, silver alloy, copper, copper alloy, aluminum, copper clad aluminum, aluminum alloy, or other metal acceptable for the application.

5. Enclosure

5.1 An enclosure shall comply with the requirements of C22.2 No. 94.1, except for additional requirements as described in Clauses 5.2 through 5.14.

5.2 The enclosure of a switch intended for surface mounting or flush mounting may be formed of sheet steel not less than 1.07 mm (0.042 in.) thick, excluding any coating thickness, if:
a) The length does not exceed 457 mm (18 in.) and the width does not exceed 356 mm (14 in.);
b) No surface of the enclosure has an area of more than 1626 cm² (252 in²);
c) The depth of the enclosure is not more than 127 mm (5 in.); and

d) The thickness of a cover, front, door, trim and the like, provided as part of an enclosure intended for
flush mounting is as specified in C22.2 No. 94.1.

5.3
All current-carrying parts shall be enclosed when the pull-out switch is closed and shall not be exposed to
accidental contact when the switch is in any position. Refer to Clauses 5.4 and 5.5.

5.4
Bare live parts of the switch assembly shall be considered not exposed to accidental contact where they are
recessed or set back, as indicated in Figure 1, by not less than 3.2 mm (0.13 in.) from an opening having at
least one dimension that is not more than 9.5 mm (0.37 In.).

5.5
The dimensions in Clause 5.4 shall apply to the bare live parts of a pull-out switch member as indicated in
Figure 2 (a), except that blades or other current-carrying parts may be recessed or set back, as indicated in
Figure 2 (b), by less than 3.2 mm (0.13 in.) where the exposure of such bare live parts is not more than 3.2 mm
(0.13 In.).

5.6
Enclosures shall be constructed so that no bare live parts are exposed when the pull-out switch member is
tilted at any angle at which it can be inserted. Where protection is provided by shields or barriers that can be
moved or deflected, the protection shall comply with the requirements in Clause 5.4.

5.7
The normal operation of pull-out switches shall not expose switch wiring.

5.8
Detachable pull-out switch members shall be constructed so that they cannot be inserted into a holder of
smaller current-carrying capacity in the same equipment.

5.9
Pull-fuse unit bases shall be secured either by a single screw with a minimum size of No. 10–32 and a thread
engagement of at least three full threads, or by two or more independent fastening means requiring a tool for
removal.

5.10
The pullout switch enclosure shall include a dead front shield that allows access to a switch handle without
exposing live parts.

5.11
A dead front shield shall be supported independently of any support that will be provided by units that may be
field-installed. The dead front shield shall be so constructed that it can be readily installed and removed without
the likelihood of contacting an uninsulated live part or damaging the insulation of any insulated live part inside
the enclosure.

5.12
In addition to complying with the requirements in C22.2 No. 94.1, an enclosed pullout switch rated as
Enclosure Type 3S shall have an operating mechanism, if provided, that will support the additional weight of
the ice and withstand removal of ice by a hand tool to gain access to the interior of the enclosure. Auxiliary
means may be provided to break the ice and to provide for operation of an external mechanism.

5.13
An external operating mechanism such as a disconnect, mounted on or through an enclosure, shall withstand the environmental tests specified in C22.2 No. 94.1, for the marked enclosure type.

5.14
Knockouts provided in the enclosure of a pullout switch shall be located so that installation of conduit bushings will not reduce electrical spacings below those specified in Clause 13. In measuring electrical spacings, it shall be assumed that the bushings are for the largest conduit that may be used to accommodate the maximum number and AWG size of rubber-insulated conductors required by the switch rating.

6 Doors and Covers

6.1
For an enclosed pullout switch, a door shall be provided to cover a fusible detachable pullout member. The door shall be secured by hinges or other means to prevent it from being removed, and shall comply with the requirements for doors, hinges, and latches in C22.2 No. 94.1.

7 Operating Mechanism

7.1
The operating mechanism shall be designed and constructed to provide the strength and rigidity necessary to perform its intended function. Screws and nuts serving to attach operating parts to crossbars or other movable members shall be staked, upset, or otherwise locked in position to prevent loosening under continued use. Stops shall be provided to prevent undue strain from switch parts.

7.2
There shall be no interference between the ends of the recessed female contact and the male blade of a removable member that will stop insertion of blades of the removable member at any angle permitted by the construction.

7.3
A handle shall be provided for operation of a pullout switch and shall be constructed to prevent a risk of fire, electric shock, or injury to persons. An operating handle and door of conducting material shall be bonded to the enclosure.

7.4
A metal rod using the wall of the box as a bearing shall be considered to be in electrical connection with the enclosure.

7.5
In a fusible pullout switch having a fuse mounting means as an integral part of the detachable pullout switch member, the member shall not be:

(a) insertable in the holder for a detachable pullout switch member of the same manufacturer that has a lower current rating; or
(b) interchangeable with members intended to accept a different class of fuse, except that a Class H fuseholder may accept a Class K or Class R fuse.

7.6
A detachable pullout switch member may be interchangeable with a member intended to accept different classes of fuses if interchangeability is limited to fuses having the same ampere rating, voltage rating, and short circuit rating, and the pullout switches have been short-circuit tested for the maximum value of $I^2t$ and $I_p$ of any of the fuses to be used.

7.7
In a non-fusible pullout switch, a detachable pullout switch member shall not be insertable in a holder for a detachable pullout switch member of the same manufacturer that has a higher current rating.

7.8
Unless marked as indicated in Clause 17.46 to indicate that the pullout switch is not provided with fuses, pullout switches shall be provided with a fuseholder for each ungrounded conductor.

7.9
Fuseholders shall not be arranged for accommodating fuses in parallel.

7.10
There shall be no fuseholder in series with any conductor that is intentionally grounded.

7.11
A pullout switch shall provide indication whether the circuit is open or closed. There shall be an “off” position with the pullout member installed in the base. When installed in the “off” position, the pullout member shall be retained in place when the door is closed and latched. Removal of fuses shall not be considered as complying with the “off” position requirement. The “off” position may be accomplished by removing a detachable pullout member of an enclosed pullout switch and storing it inside the enclosure.

8  Insulating Material

8.1
Insulating material in contact with live parts shall have the minimum values specified in Table 1 and shall comply with the mold stress relief test in Clause 18.15.

8.2
The mold stress relief test is not required for rigid thermosetting materials.

8.3
The overall thickness of switch bases shall not be less than 12.5 mm (1/2 in.) if made of porcelain.

8.4
Vulcanized fiber, impregnated hard wood, and cold-molded and phenolic compositions are acceptable as materials for crossbars. Ordinary fiber, rubber, and hot-molded shellac and tar compositions shall not be used for the mounting of uninsulated live parts.

8.5
A neutral bus bar is considered to be a live part and shall be mounted on a base that complies with Clause 8.1.

8.6
Live screw heads or nuts on the underside of a base intended for surface mounting shall be countersunk not less than 3.2 mm (1/8 in.), and then covered with a waterproof, insulating, sealing compound that will not soften at a temperature 15°C higher than the temperature observed during the Heating Test of Clause 18.2 at the point where it is used, but not less than 65°C. If such parts are staked, upset, or kept from loosening by the use of a lockwasher, insulation from the mounting surface by material other than sealing compound or by through-air spacing from the mounting surface of not less than 12.7 mm (1/2 in.) shall be permitted.

9  Current-carrying Parts

9.1
A current-carrying part shall be made of metal such as silver, silver alloy, copper, copper alloy, aluminum, aluminum alloy, or other metal that is adequately rigid. The ampacity of current-carrying parts such as neutrals,
interconnecting bus bars, or wiring, where not otherwise specified, shall comply with the applicable requirements in C22.2 No. 29.

9.2 Current carrying parts such as binding head screws No. 10 or larger, machine screws, bolts, studs, nuts, and washers used for terminal parts may be made of iron or steel protected with a plating of zinc having a thickness of not less than 0.005 mm (0.00002 in.) and the conductor or terminal to be secured shall be clamped against a surface of nonferrous metal that will carry the greater part of the current.

9.3 Copper or brass shall not be used for the plating of steel wire-binding screws, nuts, and stud terminals.

9.4 Uninsulated live parts, other than soldering lugs or pressure wire connectors, shall be secured to the mounting surface to prevent them from rotating or loosening.

9.5 Friction between surfaces shall not be the sole means to prevent uninsulated live parts from rotating. Rotation may be prevented by the use of:

(a) two screws or rivets;
(b) shoulders or mortises;
(c) a dowel pin, lug, or offset;
(d) a connecting strap or clip fitted into an adjacent part; or
(e) another equivalent method.

9.6 Where parts are held together by screws, a threaded part shall have not less than two full threads engagement, not finer than the threads given in Table 2, if the screw passes entirely through the parts. If the screw does not pass entirely through the threaded parts, it shall engage full, clean-cut threads for a distance of not less than the diameter of the screw.

9.7 If a break jaw, hinge jaw, or fuse contact is held in a slot or hole milled in a mounting piece, the parts shall fit together closely and comply with Table 3.

10 Wiring Terminals

10.1 Except as specified in Clauses 10.10 and 10.11, a pullout switch shall be provided with wiring terminals for the connection of conductors having an ampacity not less than the current rating of the device. For a pullout switch having a horsepower or kilowatt rating, the wiring terminals shall be capable of accommodating conductors having an ampacity equal to 125% of the FLA of the motor corresponding to the horsepower or kilowatt rating.

10.2 A wiring terminal shall be provided with a soldering lug firmly bolted or held by a screw or provided with a pressure wire connector.

10.3 A wire binding screw shall be permitted at a wiring terminal intended for the connection of a 10 AWG (5.3 mm²) or smaller copper conductor. Upturned edges or the equivalent shall be provided to retain the conductor under the head of the screw when the screw is loosened enough to enable shifting of the conductor.
10.4
The binding head screw shall not be smaller than M5 with a minimum pitch of 0.80 mm or a No. 10 with not more than 32 threads/in.

10.5
A terminal plate tapped for a binding head screw shall be of metal not less than 1.27 mm (0.050 in.) thick and shall have not less than two full threads engagement.

10.6
Extrusion of a tapped hole in the terminal plate for a binding head screw to allow at least two full threads engagement shall be permitted, provided that the thickness of the unextruded metal is not less than the pitch of the thread.

10.7
A binding head screw shall not thread into material other than metal.

10.8
The point of attachment of a soldering lug, a pressure wire connector, or the terminal of a binding head screw shall not overhang the base.

10.9
The sizes of field installed conductors having ampacities as referenced in Clause 10.1 shall be determined from Table 4 based on:

a) The use of aluminum wire at all terminals, except those terminals identified for use with copper wire only;
b) The use of wire rated 75°C (167°F) for all wire sizes 1/0 AWG and larger.
c) The use of wire rated 60°C (140°F) for all wire sizes 1 AWG and smaller, except that if the switch is marked only for 75°C wire at any terminals in accordance with Clause 17.41, conductor size shall be based on the use of wire rated 75°C at those terminals.

10.10
Pressure terminal connectors for field connection (line or load) need not be provided if all of the following conditions are met:

a) Component terminal assemblies shall be available from the equipment manufacturer, or one or more acceptable pressure terminal connectors shall be specified for field installation on the equipment;
b) Fastening devices, such as studs, nuts, bolts, spring washers, and flat washers, required for installation shall either be provided as part of the terminal assembly or shall be mounted on or separately packaged with the equipment;
c) The installation of the terminal assembly shall not require the loosening or disassembly of parts other than a cover or other part giving access to the terminal location. The means for securing the terminal connector shall be readily accessible for tightening before and after installation of conductors;
d) If the pressure terminal connector provided in a terminal assembly requires the use of a special tool for securing the conductor, any necessary instructions shall be included with the equipment;
e) after installation of the pressure terminal connectors in the intended manner, the product complies with these requirements in this standard; and
f) The equipment shall be marked in accordance with Clause 17.32.

10.11
A terminal may be omitted if:

a) The switch is intended to be used with equipment where the terminal is unnecessary;
b) A means, such as bus-bar link or the equivalent, is provided to connect the switch and other equipment together, and

c) Both pieces of equipment are marked in accordance with Clause 17.32.
10.12 A wiring terminal provided for the connection of a grounded neutral conductor or an electrode grounding conductor shall be readily accessible so that the wires can be disconnected after installation.

10.13 If conductors of the next larger size than that described in Clause 10.1 can be inserted into the terminals of a pullout switch, the terminals shall be capable of securing such larger conductors, unless the terminals are marked as specified in Clause 17.44.

10.14 A pressure wire connector that is not intended to be removable or interchangeable shall be capable of securing the range of wire sizes intended to be used with the pullout switch.

10.15 The range of wire sizes intended to be used with an ampere-rated pullout switch shall correspond to the range of fuse sizes accommodated by the switch. For a switch having both ampere and horsepower or kilowatt ratings, the range of wire sizes shall be considered to include those for the ampere rating and also the wire sizes for the horsepower or kilowatt ratings; however, a connector need not be acceptable for all horsepower or kilowatt ratings if markings indicate the range of acceptable wire sizes.

10.16 A pressure wire connector provided with or specified for use with a pullout switch shall comply with the applicable requirements in C22.2 No. 65 for wire connectors and soldering lugs.

10.17 Pullout switches that are marked for use with aluminum conductors shall have means for terminating aluminum binding conductors separate from copper binding conductors.

10.18 The tightening torque for a field-wiring terminal shall be as specified by the switch manufacturer and shall be marked as specified in Clause 17.41. The specified tightening torque shall not be less than 90 percent of the value employed in the static heating test in C22.2 No. 65.

10.19 A torque value of less than 90 percent shall be permitted if the connector is investigated in accordance with the requirements in C22.2 No. 65 using the lesser assigned torque value.

11 Bonding Terminals

11.1 Unless in compliance with Clause 17.32, a sufficient number of terminating means shall be provided, either in factory-installed or in kit form, to ensure proper connection for all grounding and bonding wires in accordance with CAN/CSA-C22.2 No. 0.4.

11.2 An equipment-bonding terminal or terminal assembly and associated parts shall be of a metal or metals that are not likely to be adversely affected by electrolysis.

11.3 An equipment-binding terminal shall be made of nonferrous, stainless steel, or other metal that is resistant to corrosion.
11.4
A pressure wire connector employed at an equipment bonding terminal shall comply with the requirements for pressure wire connectors except that:

a) The connector may be of iron or steel; and
b) The connector need only comply with the secureness and pullout requirements.

11.5
A terminal intended for bonding shall be marked as specified in Clause 17.35.

11.6
If parts are held together by screws, including connection of the equipment-bonding terminal or terminal assembly to the enclosure, the threaded part shall have at least two full threads engagement.

12 Field Conversion

12.1
A pullout switch constructed to accommodate Class “H” type fuses and intended for field conversion to accept Class “J,” “R,” “T,” or “C” fuses shall be marked in accordance with Clauses 17.23 to 17.27 and shall comply with the requirements in Clauses 12.2 to 12.11.

12.2
A pullout switch shipped from the factory with complete fuseholders shall have them positioned to accept Class “H” fuses.

12.3
A pullout switch intended to accept Class “J” fuses by repositioning the load base or fuseholder per Clause 12.5 may have the fuseholders in the “J” fuse position when the known use is for “J” fuses and the switch is marked as specified in Clause 17.24.

12.4
A pullout switch may be shipped from the factory without load fuse clips or without the complete load fuse base provided that the switch is provided with explicit instructions for ordering the necessary components to complete the switch to accept either Class “H”, “J”, or “R” type fuses.

12.5
The intended repositioning of a load side fuseholder assembly (common or individual pole construction) or the individual fuse clips to accommodate Class “J” fuses shall have factory-provided mounting holes. The repositioning shall be by the use of common tools by front access to the pullout switch.

12.6
A load side fuseholder assembly (common or individual pole construction) or individual fuse clips that are intended to be installed to accommodate Class “R” fuses only shall be installed by the use of common tools by front access to the pullout switch.

12.7
Fuse clips that are intended to be added or replaced shall be capable of being added or replaced in such a manner that proper alignment of the clips will be maintained and other parts such as the terminal assembly will not be disturbed.

12.8
The field installation of a fuse clip shall not adversely affect the fuse clip in any manner such as spreading the fuse clip.
12.9
A rejection means for Class “R” fuses intended to be installed in a load fuse base containing a
Class “H” fuseholder shall be permitted provided:

a) The fuseholder assembly is constructed to receive the rejection means without further modification;
b) The fuse rejection means is capable of being installed with common tools or without any tools by front
access to the pullout switch;
c) Once installed, the fuse rejection means cannot be removed using common tools without damaging the
assembly and rendering it unusable; and.
d) The fuse rejection means has the mechanical strength to comply with the requirements for Class
“R” fuseholders. Refer to C22.2 No. 39.

12.10
The package containing the fuseholder bases or clip assemblies shall include all necessary hardware, such as
screws, lock washers, and the like, to secure the fuseholder in place.

12.11
Spacings as specified in Clause 13, and fuse alignment shall be maintained regardless of the class of fuse
installed. It shall not be necessary to add barriers or other parts to maintain the required spacings. However,
the moving of barriers that are part of the load side fuseholder assembly shall be permitted.

13  Spacings

13.1
Except as noted in Clauses 13.4 to 13.14, the spacings in a pullout switch shall be as indicated in Table 5.
Bonded metal includes the enclosure and any metal that may be in electrical connection with the enclosure.

13.2
Except as specified in Clause 13.3, terminals and other live parts intended to be connected to the grounded
conductor of a circuit shall be considered to be uninsulated live parts unless such parts are mounted directly on
or in permanent electrical connection with the enclosure.

13.3
If the connection is solely by means of a screw, strap, or other bonding device that can be readily removed and
is not depended upon to perform a mechanical function, the pullout switch shall:

a) Comply with Clause 13.1 when the bonding device is removed, or
b) Be marked as described in Clause 17.48.

13.4
In measuring between an uninsulated live part and a conduit bushing installed at a knockout, it shall be
assumed that a conduit bushing having the dimensions specified in Table 6 is in place.

13.5
There shall be a minimum spacing of 3.2 mm (1/8 in.) between line and load terminals of the same polarity.

13.6
Wire connectors shall be kept from turning to the extent that spacings would be reduced to less than those
required in Clause 13.1; however, if minimum spacings are maintained when lugs are turned 30 degrees
toward each other or toward other uninsulated live or grounded parts, no means to prevent turning are
required.

13.7
Spacings at the wiring terminals of a 30 A switch shall be measured with the device wired in accordance with
Table 7.
13.8
The spacings at wiring terminals employing wire connectors shall be measured with the device wired with conductors having an ampacity not less than the current rating of the switch.

13.9
In measuring over-surface spacings, a metal part such as a screw head or washer interposed between uninsulated live parts of opposite polarity or between uninsulated live parts and grounded metal shall be considered as reducing the spacing by an amount equal to the dimension of the metal part in the direction of the measurement.

13.10
Spacings of not less than 25.4 mm (1 in.) shall be maintained between any uninsulated live part and a metal door, unless spacings of not less than 12.7 mm (1/2 in.) are maintained where the potential is 250 V or less and any of the following conditions are met:

a) The door is of steel not less than 2.36 mm (0.093 in.) thick if uncoated or 2.46 mm (0.097 inch) thick if galvanized;
b) The door has the strength and rigidity equivalent to that of a flat door of the same overall length, width and material as specified in (a);
c) The door is lined with insulating material such as fiber or phenolic composition not less than 0.8 mm (1/32 in.) thick; or

d) a metal door is prevented from being deflected to contact a live part.

13.11
Through air and over surface spacings as specified in Clause 13 shall also be maintained from live parts of a pullout switch to an ungrounded isolated metal handle that is part of the switch.

13.12
In measuring over surface spacings, any slots, grooves, and the like that are 0.33 mm (0.013 in.) wide or less in the contour of insulating material may be disregarded.

13.13
Spacings in pullout switches are to be measured with the removable member in both the full “on” and “off” positions.

13.14
Spacings shall be measured through cracks unless a clamped joint complies with the Clamped Joint Test, Clause 18.13.

Note: A clamped joint is a joint between two pieces of insulation that are under pressure. See Figure 4.

14 Insulating Barriers

14.1
The insulating barrier referred to in Clauses 14.2 to 14.10 separates uninsulated live parts of opposite polarity or separates an uninsulated live part from a grounded metal part (including the enclosure) where the through-air spacings are less than the minimum values specified in Table 5.

14.2
A barrier that is the sole means of separation or that is used with an air space less than 0.33 mm (0.013 in.) shall be:

a) A material suitable for supporting an uninsulated live part;

b) Secured in place;
d) Located so that it will not be adversely affected by operation of the equipment in service; and

e) have a minimum thickness of 0.71 mm (0.028 in.).

14.3
A barrier located between the enclosure and an uninsulated live part electrically connected to a grounded circuit conductor (neutral) may be of vulcanized fibre and not less than 0.71 mm (0.028 in.) thick.

14.4
A barrier of insulating material other than vulcanized fibre may have a thickness less than 0.71 mm (0.028 in.) if it withstands the application of the dielectric-withstand test in Clause 18.16 at a potential of 5000V, 60Hz.

14.5
A barrier used with a minimum air space of 0.33 mm (0.013 in.) shall consist of:

a) material that has insulating properties as specified in Table 1 or, for other than vulcanized fibre, comply with Table 8;

b) material that can withstand the stress associated with normal handling, installation, and use of the equipment;

c) material that is secured in place;

d) material that is located so that it will not be adversely affected by operation of the equipment in service; and

e) material not less that 0.33 mm (0.013 in.) thick.

14.6
Vulcanized fibre with a minimum thickness of 0.71 mm (0.028 in.) and used in conjunction with a minimum 0.71 mm (0.028 in.) air space need not comply with Table 1.

14.7
Material other than vulcanized fiber, used in conjunction with an air gap more than 50% of the required through air spacing specified in Clause 13 may have a thickness:

a) Not less than 0.33 mm (0.013 in.); or

b) Less than 0.33 mm (0.013 in.) if it withstands a 60 Hz dielectric-withstand voltage of 2 500 V applied in accordance with the requirements in 18.16.

14.8
The barrier shall comply with the mold stress relief test in 18.15.

14.9
A wrap of thermoplastic tape, acceptable for use as sole insulation, may be employed if all of the following conditions are met:

a) At a point where the spacing prior to the application of the tape is not less than half the required through-air spacing, the wrap is not less than 0.33 mm (0.013 in.) thick and is applied in two or more layers;

b) At a point where the spacing prior to the application of the tape is less than half the required through-air spacing, the wrap is not less than 0.71 mm (0.028 in.) thick;

c) The tape is not subject to compression;

d) The tape is not wrapped over a sharp edge; and

e) The temperature rating of the tape is not less than the temperature rise observed on the tape during the Heating test of Clause 18.2 plus 40°C. If a Heating test is not required, the temperature rating shall be 105°C minimum.

14.10
If spacings would otherwise be less than the minimum values specified in Table 5, thermoplastic tubing may be used if all of the following conditions are met:
a) It is not subjected to compression, repeated flexure, or sharp bends;
b) All edges of the conductor covered with the tubing are well rounded and free from sharp edges;
c) For chemically dilated tubing, a solvent recommended by the tubing manufacturer is used;
d) Tubing wall thickness (after assembly) is not less than 0.56 mm (0.022 in.) for tubing 12.7 mm (1/2 in.) or less in diameter, not less than 0.69 mm (0.027 in.) for tubing 14.3 or 15.9 mm (9/16 or 5/8 in.) in diameter, and not less than 0.71 mm (0.028 in.) for larger diameter tubing, and
e) Temperature marking on the tubing is not less than the temperature rise observed on the thermoplastic tubing during the Heating test of Clause 18.2 plus 40°C. If a Heating test is not required, the temperature marking shall be 105°C minimum.

15 Wire Bending Space

15.1 Wire bending space shall be in compliance with requirements of C22.2 No. 0.12.

16 Ratings:

16.1 A pullout switch shall be rated in amperes and volts and may, in addition, be rated in horsepower. A short-circuit-current rating of a pullout switch shall be in accordance with Clauses 17.14 to 17.23.

16.2 The voltage rating of a pullout switch shall be 120, 240, 277, 480, 600, 208Y/120, 120/240, 480Y/277, or 600Y/347 V ac, or 125, 250, 125/250 or 600 V dc.

16.3 The voltage rating of a pullout switch shall not exceed the voltage rating of the fuse it accommodates.

16.4 The ampere rating of a pullout switch shall be 30, 60, 100, 200, or 400 A, except that a pullout switch intended for use with a Class G fuse shall be rated 15, 20, 30, or 60 A.

16.5 Pullout switches consisting of two or more independent switches (not interconnected with other switches) shall have a separate ampere rating for each switch.

16.6 The horsepower rating of an enclosed switch shall be one of values indicated in Table 9 or 10.

16.7 The horsepower rating of an enclosed switch incorporating fuseholders shall not be higher than indicated in Table 11.

16.8 In addition to the horsepower ratings corresponding to the number of poles provided, as shown in Table 11, a switch may have a horsepower rating or ratings applicable to a switch having the same size fuseholders but fewer poles if, upon investigation, the switch is found to be acceptable for the assigned rating.

16.9 The short circuit current rating of a switch shall be one or more of the values shown in Table 12. The rating shall not be greater than that of the specified overcurrent protective device. The rating shall be 10 000 A for plug, Class H, and Class K fuses. The rating shall not be less than 25 000 A for Class G, J, L, R, C, or T fuses.
17 Markings

17.1 A marking shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly applied lettering on a label secured by adhesive that, upon investigation, is found to be acceptable for the application. Ordinary usage, including likely exposure to weather and other ambient conditions, handling, storage, and the like of the equipment is considered in the determination of the acceptability of the application.

Note: In Canada, there are two official languages, English and French. Appendix C lists acceptable French translations of the markings specified in this Standard.

17.2 Markings on an enclosed switch that is marked with an enclosure type shall be investigated for compliance with the requirements applicable to the specific enclosure type referenced. Markings on a switch not marked with a specific enclosure type designation shall be investigated for compliance with the requirements applicable to a label used inside the enclosure of a Type 1 box.

17.3 A pullout switch shall be marked in a location such that the markings will be visible after installation. The markings shall include the following:

a) manufacturer’s name, trademark, or other recognized symbol of identification;
b) catalogue or type number, or other mark used for distinguishing purposes, and
c) electrical rating, as follows:
   1. Voltage - 120, 240, 277, 480, 600, 208Y/120, 120/240, 480Y/277, or 600Y/347 V ac, or 125, 250, 125/250 or 600 V dc;
   2. Current - 30, 60, 100, 200, or 400 A;
   3. Frequency - expressed in hertz for alternating current, or dc for direct current; and
   4. Short circuit current rating.

17.4 A fused pullout switch shall include the marking: “Continuous load current not to exceed 80 percent of the rating of fuses employed”.

17.5 If a pullout switch is marked with voltage or horsepower ratings or both applicable only to a switch having fewer poles than those provided in the switch, the switch shall be marked to indicate the proper circuit arrangement for these ratings.

17.6 If the rating of a pullout switch that incorporates fuseholders includes one or more of the ratings indicated in Table 11, the associated standard rating shall also be marked on the switch. In addition, both of the following shall apply:

a) Each horsepower or kilowatt rating shall be clearly associated with the word “standard” (or “std.”) or “maximum” (or “max.”), whichever is appropriate for that rating; and.
b) The switch shall be marked with the statement: “The starting current of motors of more than the standard horsepower or kilowatt ratings may require the use of fuses with appropriate time-delay characteristics.”
17.7 Both the standard and maximum ratings shall be marked permanently on the switch. The statement required because of the increased ratings shall be located with such ratings, except that this statement and the ratings need not appear together if a marking calling attention to the statement and its location appears with the ratings.

17.8 A switch marked with a horsepower or kilowatt rating greater than 74.6 kW (100 hp) shall be marked with the following or equivalent statement, “Not for use as motor controller”.

17.9 If the electrical safety features, including performance and spacing to grounded metal parts of a switch, are dependent upon the proper connection of line and load conductors, the marking shall indicate the proper connections.

17.10 The words “line” and “load” shall be marked at terminals to indicate the proper connections. If it is impracticable to place such markings at terminals, a wiring diagram may be attached to the inside of the enclosure to indicate the proper connections.

17.11 Adhesive labels, if used, shall comply with the applicable requirements in C22.2 No. 0.15.

17.12 If a manufacturer produces or assembles switches at more than one factory, each finished switch shall have a distinctive marking, which may be in code, by which it may be identified as the product of a particular factory.

17.13 The “on” and “off” positions of the pullout switch shall be marked on the outside of the enclosure with a contrasting color from the background color.

17.14 A pullout switch intended to accept Class K, Class H, or plug fuses shall be marked, “Suitable for use on a circuit capable of delivering not more than 10 000 amperes, rms symmetrical, ______ volts maximum” or the equivalent.

17.15 A fused pullout switch intended for field conversion shall be marked as indicated in Clause 17.23.

17.16 An unfused pullout switch shall be marked, “This switch is suitable for use on a circuit capable of delivering not more than ______ amperes (short-circuit current rating), rms symmetrical, when protected by ______ fuses (Type ___ circuit breaker) rated ______ amperes (fuse current rating) maximum” or with an equivalent marking.

17.17 If the short-circuit current rating in Clause 17.15 is 10 000 A, the Class of fuse may be omitted, but the current rating shall be provided.

17.18 If the short-circuit current rating in Clause 17.15 is 5 000, 7 500, or 10 000 A and the continuous current rating of the circuit breaker does not exceed that of the switch, the omission of the type designation and manufacturer of the circuit breaker shall be permitted.
17.19
If the short-circuit current rating in Clause 17.15 is 5 000, 7 500, or 10 000 A and the continuous current rating of the circuit breaker exceeds that of the switch and the switch was tested for three cycles as indicated in 18.7.3, the omission of the type designation and manufacturer of the circuit breaker shall be permitted.

17.20
If the tests mentioned in clauses 18.7 and 18.9 are conducted with the overcurrent protection means on the line side of the unfused switch, the marking shall also specify that the fuses (or circuit breakers) shall be installed ahead of the switch.

17.21
The marking in Clause 17.15 may be repeated for several different types of protection.

17.22
A pullout switch constructed to accept only Class C, G, J, L, R, or T fuses shall be marked with the following statement: “Suitable for use on a circuit capable of delivering not more than _____ amperes (short-circuit current rating), rms symmetrical, _____ volts maximum; Use Class (C, G, J, L, R, or T) fuses.”

17.23
A pullout switch that is constructed to accept Class H or K fuses but can be converted in the field to accept Class C, J, R, or T fuses, shall be marked as specified in Clause 17.26, with the following:

a) When used with Class K or H fuses, “Suitable for use on a circuit capable of delivering not more than 10 000 amperes, rms symmetrical, _____ volts, maximum.”

b) When used with Class J (or T) fuses, “(When used with Class R fuses and fuse clip assembly No. _____ properly installed,) this switch is suitable for use on a circuit capable of delivering not more than _____ amperes (short-circuit current rating), rms symmetrical, _____ volts (fuse voltage rating) maximum,” or equivalent wording.

c) To indicate that the short-circuit current rating is only applicable when Class J (T or R) fuses are used: “Danger – Unless Class J (T or R) fuses are used, this switch may present a risk of fire and injury to persons if installed on circuits capable of delivering more than 10 000 amperes, rms symmetrical,” or equivalent wording and the equivalent in French, “Danger - A moins de catégorie J (T ou R) fusibles sont utilisés, ce commutateur peut présenter un risque d'incendie et de blessures si elle est installée sur des circuits capables de fournir plus de 10 000 Ampères, rms symétrique”, shall be marked.

17.24
A pullout switch intended to accept Class J fuses by repositioning load fuse base or fuse clip assemblies shall be provided with instructions for repositioning the load base fuseholder or fuse clips and associated barriers so that Class J fuses can be accepted. The markings shall be as specified in Clause 17.26.

17.25
A switch intended for field conversion by replacing or adding parts shall be provided with explicit instructions for ordering the required components in order to accomplish one of the following:

a) Replacing the load side fuseholder or fuse clip assemblies so that it will accept only Class R fuses;

b) Adding the load side fuseholder or fuse clip assemblies so that it will accept either Class H, Class J or only Class R fuses;

c) Adding the rejection means to the fuse clip assemblies so that it will accept only Class R fuses; or

d) Adding bus bars or equivalent assemblies so it will accept only Class T fuses.

17.26
The markings in Clause 17.23 to 17.25 shall be permanently marked on the switch and shall be visible when the fuseholders are arranged to accept a Class H fuse or Class L fuse, as appropriate.
17.27 Each field conversion kit for a pullout switch shall be provided with a part number or equivalent on the package and shall be supplied with instructions to convert the switch in the field to accept Class J, R, or T fuses. These instructions shall be permitted to be part of the switch marking.

17.28 An enclosed switch shall be marked with an enclosure type designation indicating the environmental conditions for which it is acceptable. An enclosed switch that complies with the environmental conditions for more than one enclosure type designation may be marked with multiple designations. The marking shall be permitted to be on the inside or outside surface but shall be visible after installation.

17.29 An enclosed switch marked with an enclosure designation of Type 3, 3S, 4, 4X, 6, or 6P may additionally be marked, “Raintight.” An enclosed switch marked with an enclosure designation of Type 3R may additionally be marked, “Rainproof.”

17.30 Unless the installed meter is entirely enclosed when installed, an enclosed switch having an opening for accommodating a watt-hour meter may be marked with an enclosure designation of Type 1, 2, or 3R and shall not be marked with any other type designation.

17.31 As specified in Clause 4.3, if an accessory is shipped separately from the switch with which it is intended to be used, the following markings shall be provided:

a) The accessory shall be marked with its own catalogue number or the equivalent and with the name or trademark of the manufacturer and, except for neutral assemblies, with the electrical rating;

b) The switch shall be marked to indicate the catalogue number or the equivalent of each of the accessories intended to be used with it. In the case of neutral assemblies, the switch shall also be marked with an indication of the voltage ratings for which the neutral assembly must be used; and

c) Installation instructions shall be furnished with the accessory unless the construction makes the installation obvious. Instructions for wiring of an accessory shall be permanently attached to the enclosed switch or to the accessory so as to be visible after installation.

17.32 If pressure terminal connectors are not provided on the equipment as shipped, the equipment shall be marked indicating which pressure terminal connector or component terminal assemblies are for use with the equipment. A wire connector of the type or types mentioned may be installed on the equipment at the factory with instructions for proper connection of conductors. The terminal assembly packages shall carry an identifying marking, wire size, and manufacturer’s name or trademark.

17.33 A neutral main or line terminal may be marked with a letter “G” or “Ground” stamped on the bus or so located that it will indicate plainly the connection for which it is intended.

17.34 If a terminal is omitted in accordance with Clause 10.11, the switch and the equipment intended to be connected to it shall each be marked to indicate that one is to be used with the other. Both pieces of equipment shall also identify, by a marking or the equivalent, the means by which connections between them should be made.

17.35 The enclosed switch equipment-bonding terminal or assembly marking mentioned in Clause 11.5 shall be one of the following:
a) “Equipment-Bonding Terminal” or an equivalent abbreviation, or  
b) The symbol shown in Figure 3.

17.36  
If the symbol shown in Figure 3 is used in accordance with Clause 17.35 (b) the markings provided with the enclosed switch shall define the symbol, unless the marking of Clause 17.35 (a) is utilized.

17.37  
If any terminal of a switch is marked to indicate that aluminum wire may be used at that terminal, such as by the symbol “AL”, and if such marking is visible, the switch shall be marked in accordance with Clause 17.38, 17.39 or 17.40, whichever applies.

17.38  
If a terminal is not for use with aluminum wire, the switch shall be marked, “Use copper wire only”, or equivalent.

17.39  
If the wiring space and other factors are such that all terminals of the switch are for use with aluminum and copper wire, the enclosed switch shall be marked, “Use copper or aluminum wire”, or equivalent.

17.40  
If the wiring space and other factors are such that some terminals of the switch are for use with aluminum and copper wire and the remainder of the terminals are for use with copper wire only, the switch shall be marked “Use copper wire only except at terminals _____”, or equivalent. The marking shall identify the terminals that are for use with aluminum wire.

17.41  
As specified in Clause 10.18, a switch shall be marked to indicate the specific tightening torque for each wire connector in the switch that is intended for field wiring. If different connectors are used for line or load, the specific torques to be applied to each connector shall be indicated.

17.42  
A pullout switch shall be marked with the required temperature rating of all field-installed conductors.

17.43  
A terminal of a switch capable of securing two or more combinations of conductors, any of which has an ampacity acceptable for the application, shall be identified and marked unless the switch is acceptable for use with the combination of conductors requiring the largest wiring space, in accordance with C22.2 No. 0.12. The terminal shall be identified by a marking, such as on a wiring diagram, which will state the number and sizes of conductors that may be used.

17.44  
If the terminals of a switch are marked to indicate the maximum wire size, the marking shall be visible when the connector is in place.

17.45  
If a pressure terminal connector that is provided with the switch requires the use of a special tool to secure the conductor, instructions shall be provided with the switch specifying the use of such a tool.

17.46  
As specified in Clause 7.9, unless overcurrent protection is provided in the pullout switch, the pullout switch shall be marked “Caution– Does Not Contain Fuses,” or an equivalent wording and the equivalent in French, “Mise en garde- Ne contient pas Fusibles”, shall be marked.
17.47
A cautionary marking shall be prefixed with the word “CAUTION”, “WARNING”, or “DANGER” in letters not less than 3.2 mm (1/8 in.) high. The remaining letters of such marking, unless specified otherwise in individual marking requirements, shall not be less than 1.6 mm (1/16 in.) high.

17.48
If the construction is as described in Clause 13.3 and the spacings would not comply with the requirements in Clause 13 when the bonding device is removed, the enclosed switch shall be marked “Bonded Neutral – Remove bonding device for test purposes only” or equivalent.

18 Tests

18.1 General
To determine if a pullout switch complies with requirements, a representative device of each rating shall be subjected to the tests as specified in Tables 13 and 14.

18.1.1
A switch marked with two or more ratings shall be tested at each rating unless a test at one rating is representative of a performance at the other ratings.

18.1.2
Where an enclosed pullout switch contains one or more meter sockets, appropriate simulated meters, as specified in C22.2 No. 115, shall be installed during the tests.

18.1.3
Except as specified in Clause 18.1.4, if an unfused pullout switch, intended to be used on the load side of fuse(s) or molded case circuit breaker in accordance with Clauses 16.9 and 17.16, is constructed the same as a fused pullout switch and has the same or lower rating, tests on the fused pullout switch shall represent the unfused construction provided the unfused pullout switch meets the following conditions:

a) The conductor that replaces the fuse and fuseholder shall be made of the same material as the switch blade,
b) The cross section of the conductor that replaces the fuse and fuseholder shall not be less than the switch blade or the combined cross section of the fuseholder and test fuse ferrule or blade used during the Temperature Test on the fused switch, and
c) The fuse used in the test is of the same class or electrical rating, or both, as the overcurrent protection device intended to protect the unfused switch.

18.1.4
The requirements in Clause 18.1.3 shall not apply for an unfused switch having a short circuit withstand rating greater than 10,000 A that is intended to be protected by a circuit breaker for the short circuit withstand test.

18.1.5
A pullout switch shall be tested in an enclosure representing the most severe condition of intended use in regard to:

a) Enclosure size;
b) Spacings between live parts and grounded metal; and
c) Mounting position.

18.1.6
Unless a device is intended for use on a single-phase circuit only, all tests except the heating test, Clause 18.2 and the dielectric voltage-withstand test, Clause 18.6, shall be made on a 3-phase circuit. The heating test may be made on either a 3-phase or a single-phase circuit (all poles in series).
18.1.7
If a machine is used to operate the switch during testing, the closing and opening speed shall not exceed 76 cm/second (30 in./second), and shall provide positive insertion and withdrawal of pullout type switches.

18.1.8
Except as noted in Clause 18.5.2, all current-interrupting tests shall be made on test circuits adjusted so that the closed-circuit voltage is not less than the rated voltage of the switch and the open-circuit voltage is not more than 110 percent of that voltage, except that for a switch rated at more than 25 hp or more than 100 A, the closed-circuit voltage may be as much as 10 percent less than the rated voltage of the switch if the open-circuit voltage is not less than the rated voltage nor more than 110 percent of that voltage. The open-circuit voltage may be more than 110 percent of the rated voltage if agreeable to those concerned.

18.1.9
To determine if a pullout switch complies with the requirements for short-circuit withstand, low level dielectric voltage-withstand and closing, as specified in Sections 18.7 to 18.9, a representative sample of each rating shall be subjected to the tests. A switch marked with two or more short-circuit withstand ratings shall be tested at each rating unless a test at one rating is representative of the other ratings.

18.1.10
Notwithstanding Clause 18.1.9, an unfused switch marked for use with overcurrent protective devices having a continuous current rating not greater than the switch rating and a fused switch incorporating fuseholders with current ratings not greater than the switch rating are acceptable for a 10,000 A short-circuit withstand rating without short-circuit testing.

18.2 Heating Test (without fuses)

18.2.1
The heating test may be conducted at any convenient voltage.

18.2.2
When subjected to the heating test in Clauses 18.2.3 to 18.2.8, no parts of a pullout switch shall exceed the temperature rise values in Table 15 and, if fuses are used, no fuse element shall melt.

18.2.3
For the heating test, the switch shall be energized by a 60 Hz current as follows:

a) General-use switch without a horsepower rating: rated current.

b) General-use switch with a horsepower rating: rated current, or 115 percent of current (from Table 9 or Table 10) corresponding to the horsepower rating, whichever is greater.

18.2.4
Temperatures shall be measured by thermocouples consisting of wires no larger than 24 AWG (0.21 mm²) and no smaller than 30 AWG (0.05 mm²).

18.2.5
A thermocouple junction and adjacent thermocouple lead wire shall be securely held in good thermal contact with the surface of the material whose temperature is being measured.

18.2.6
A new switch shall be mounted as in actual service, with the door and other openings closed. The switch shall be wired with not less than 1.2 m (4 ft) of Type RH, TW, TW75, or THW copper wire per terminal, the wire size corresponding to the current rating of the switch. For a switch rated 30, 60, or 100 A, the wire size shall be based on the temperature rating of the wire as indicated by the marking on the switch. Where a switch is marked with dual wire temperature ratings (for example, 60/75°C), the test shall be conducted with the highest
temperature wire (for example, 75°C). The test shall be conducted at any convenient voltage. The test shall continue until constant temperatures are attained.

*Note: A temperature shall be considered to be constant when three successive readings taken at 15-minute intervals do not indicate any change.*

18.2.7
Except as noted in Clause 18.2.8, dummy fuses shall be used in place of regular fuses in clips or female screw-shells.

18.2.8
A switch employing Class T fuses or 400 A Class J fuses shall be tested with fuses in place and carrying 80 percent of its rated current continuously.

18.3 Heating Test (with Fuses)

18.3.1 30 and 60 A Class H fuses

18.3.1.1 Pullout switches rated 30 A and 60 A and intended for use with Class H or K fuses shall be subjected to the heating test in Clause 18.3.1.2 with nonrenewable time delay Class R or K fuses.

18.3.1.2 The selected fuses shall be subjected to a heating test in free air in open type fuseholders at 110 percent of rated current in accordance with the temperature test in C22.2 No. 248.6. The fuse ferrule and body temperatures shall be measured using thermocouples.

18.3.1.3 Following the test in Clause 18.3.1.2, each fuse shall be inserted and withdrawn ten times from the fuseholders in the pullout switch and then the fuses shall be placed in the pullout switch. The switch shall then be subjected to a temperature test as described in Clause 18.3.1.4.

18.3.1.4 The pullout switch shall be mounted in a metal enclosure as described in Clause 18.1.5 except Class R or K fuses shall be used in place of dummy fuses. All other test conditions shall be as described in the Heating Test, Clause 18.2. The current applied shall be adjusted to 80 percent of the switch rating. The fuse thermocouples shall be located at the same points as when tested in the open.

18.3.1.5 When tested in accordance with Clause 18.3.1.4, the temperature rise on the fuse ferrule and on the body shall not exceed the temperature rise on the same fuse recorded during the test in Clause 18.3.1.2. The temperature rise on insulating or sealing materials of the switch shall be at least 40°C (104°F) less than the maximum temperature for which they have been found acceptable. The temperature rise at field wiring terminals shall not be more than 50°C (122°F) for terminals identified for use with 60°C (140°F) wire and 65°C (150°F) for terminals identified for use with 75°C (167°F) wire.

18.3.2 Class CC, G, J, and R fuses

18.3.2.1 Pullout switches rated 60 A or less and intended for use with Class CC, G, J or R fuses shall be subjected to the heating test in Clause 18.3.2.2

18.3.2.2 The pullout switch shall be mounted in a metal enclosure as described in Clause 18.1.5. Fuses having the same rating as the switch shall be used. Class R fuses shall be of other than the dual element type. Except for
fuses being used in place of dummy fuses, all other test conditions shall be as described in the Heating Test, Clause 18.2. The current applied shall be adjusted to 80 percent of the switch rating.

18.3.2.3
When tested in accordance with Clause 18.3.2.2, the temperature rise on the line and load terminals shall be not more than 50°C (90°F) for terminals identified for use with 60°C (140°F) wire and 65°C (117°F) for terminals identified for use with 75°C (169°F) wire and on other current-carrying parts shall not be more than 35°C (63°F) above the values given in Table 15. No fuse link shall melt during the test. The temperature rise on insulating or sealing materials of the switch shall be at least 40°C (104°F) less than the maximum temperature for which the materials have been found acceptable.

18.4 Overload-Cycle-Heating Test

18.4.1 As outlined for the Heating test, Clause 18.2, dummy fuses are to be used that are reduced in cross section or are made of material that will produce the required results. The dummy fuses may also be heated internally or externally by a resistance energized from a separate source to produce the required results. The surfaces of the ferrule or blade of each dummy fuse that make electrical contact with the clip of the fuseholder shall be made of unplated copper or copper alloy and are to be cleaned and reconditioned as necessary. These surfaces are then allowed to oxidize at room ambient for at least 30 days before being inserted in the fuseholders. The current is to be adjusted to 100 ±10 percent of the rating of the switch so as to produce a temperature rise not less than noted in Table 16 on all fuse clips. The switch is then to be cycled at the above mentioned current at a rate of 8 hours “on” and 4 hours “off” for 24 hours. During the second “on” period, the current is to be readjusted, if necessary, to bring the temperatures on the fuse clips back to the required temperatures, and actual temperatures are to be recorded after conditions are constant. The switch is then to be cycled for 60 operations at the rate of 8 hours “on” and 4 hours “off”. The temperature rises are to be recorded at the end of every sixth cycle. No temperature rise recorded shall differ more than 10°C (50°F) from the average of all temperature rises measured at that point.

18.4.2 The Overload Cycle-Heating Test is not required for bolt-on type fuse constructions.

18.5 Endurance test

18.5.1 After a pullout switch has been subjected to the endurance test specified in Clause 18.5.2 to 18.5.5 under the test conditions described in Clause 18.5.6, there shall be no electrical or mechanical malfunction of the device, and there shall there be no undue pitting, burning, or welding of the contacts.

18.5.2 A pullout switch shall be subjected to testing by means of a machine as described in Clause 18.1.8 and with the following conditions:

a) the number of cycles and rate of operation as indicated in Table 17;
b) Making and breaking 100 percent of its rated current;
c) For alternating current, an open-circuit voltage of not less than the rated voltage of the switch, and the closed-circuit voltage not be less than 90 percent of the rated voltage of the switch or the normal-frequency recovery voltage equal to the rated voltage of the device;
d) Within 5 percent of the rated voltage of the switch if direct current is used, and
e) For alternating current switches, a power of 0.75 – 0.80 maximum.

18.5.3 For a switch having both ampere and horsepower ratings, the endurance test for the ampere rating may be representative of the horsepower rating.
18.5.4
For horsepower rated switches, the endurance test shall be conducted at the rated current of the device or the
current selected from the appropriate motor full load currents in Table 9 and 10, whichever is greater. A fused
motor-circuit switch shall be tested at 125 percent of the current given in Table 9 and Table 10.

18.5.5
The current for the common wire of a 2-phase, 3-wire system is 1.414 times the value in Table 9 for a 2-phase,
4-wire system.

18.5.6 Test conditions

18.5.6.1
A switch shall be mounted as in actual service with the door or cover and any other openings closed. The line
terminals shall be connected to a supply circuit, and the load terminals shall be connected to the necessary
resistance or impedance.

18.5.6.2
A switch intended for use on dc circuits and a switch not specifically marked for alternating current only shall
be tested with direct current, with a noninductive resistance load, and with the device so connected that the
enclosure will be positive in potential with respect to the nearest arcing point.

18.5.6.3
A switch intended for ac circuits only shall be tested with alternating current with an inductive load. The test
shall be made on a circuit having a maximum frequency of 60 Hz. Resistance and reactance components of
the load shall not be connected in parallel, except that an air-core reactor in any phase may be shunted by
resistance, the loss in which is approximately 1 percent of the total power consumption in that phase. The
shunting resistance used with an air-core reactor may be calculated from the following formula:

\[ R_{SH} = 100[(1/PF) - PF]E/I \]

Where

\( R_{SH} \) – Shunt resistance
\( PF \)– power factor
\( E \) - closed-circuit phase voltage
\( I \) - phase current.

18.5.6.4
A switch intended for use on circuits having one conductor grounded shall be tested with the enclosure
connected through a 30 A non time-delay, non-renewable-type cartridge fuse to the grounded conductor. If an
enclosed switch is intended for use on other types of circuits, the enclosure shall be connected through a
similar fuse to the live pole least likely to strike to ground.

18.5.6.5
A 2-wire and a 3-wire switch intended for use on either 3-wire dc or single-phase ac circuits with grounded
neutral shall be tested on a 3-wire dc circuit with grounded neutral, with the switch connected to the outside
conductors of the circuit, and with the enclosure grounded as indicated in 18.5.6.4. If the switch is intended for
use with alternating current only, it shall be tested with alternating current in a similar manner and in
accordance with Clause 18.5.6.3.

18.5.6.6
A 3-wire switch without a solid neutral intended for use on ac circuits other than that described in Clause
18.5.6.5 and a 4-wire switch having a solid neutral shall be tested on a 3-phase circuit with a 3-phase balanced
load.
18.5.6.7
A 4-wire switch without a solid neutral and a 5-wire switch shall be tested on a single-phase circuit with connections to adjacent poles, one pole being that nearest the enclosure. If the spacings between the poles differ, an additional test shall be made with connections to the pair of poles having the least separation.

18.6 Dielectric voltage-withstand test

18.6.1
A switch (with fuses, if any, in place) shall withstand for 1 minute without breakdown the application of a 60 Hz essentially sinusoidal voltage of 1 000 V plus twice the maximum rated voltage:

a) Between live parts and the enclosure with the switch closed, and:
   1) With the pullout member removed;
   2) With the pullout member inserted in the “off” position; and
   3) With the pullout member, with fuses in place, inserted in the “on” position.

b) Between terminals of opposite polarity with the switch closed;

c) Between the line and load terminals with the switch open (i.e. with the switch in the “off” position with the pullout head removed and with pullout head inserted in the “off” position); and

d) Between live parts and any isolated metal handle that is part of the switch.

18.6.2
To determine if a switch complies with the requirement in Clause 18.6.1, the device shall be stressed by means of a 500 VA or larger transformer, the output voltage of which can be varied. The applied voltage shall be increased from zero until the required test value is reached and held at that value for 1 minute. The increase in the applied voltage shall be at a uniform rate. A transformer less than 500 VA shall be permitted if the output voltage is measured directly.

18.7 Short-circuit withstand test

18.7.1
The following switches shall be subjected to the tests outlined in Clauses 18.7 to 18.10:

a) Switches rated higher than 10 000 A short circuit current rating,

b) Unfused switches having a 5 000, 7 500, or a 10 000 A short-circuit current rating and marked for use with overcurrent protective devices having a continuous current rating greater than that of the switch, and

c) Fused motor-circuit switches incorporating fuseholders of a current rating greater than that of the switch.

*Note: The 5 000 and 7 500 A levels are applicable only to combinations of the switch and a circuit breaker.*

18.7.2
For switches rated for 10 000 A and below available fault current, an untested sample shall be permitted.

18.7.3
A circuit capable of providing the maximum short-circuit current for which the switch is rated shall be closed on the sample. The switch shall withstand the designated current until the overcurrent protective device or devices specified in Clause 18.7.5 opens or, for a switch not marked as requiring a specific overcurrent protective device, for 3 cycles. After the test, the device shall comply with all of the following conditions:

a) The fuse connected to the enclosure shall not open;

b) There shall be no breakage to the extent that the integrity of the mounting of live parts is impaired,

c) The door latch, without bolt or lock installed, shall have prevented the door from being blown open (deformation of the case alone is considered to be acceptable);

d) The switch shall be capable of being opened manually with the operating handle;
e) Fuses (neither end of a bar or tube as described in Clause 18.7.8) shall not be completely ejected from the fuse clips and no fuse (or line end of a bar or tube) shall bridge from a fuse clip to grounded metal, and
f) The pullout head shall not be ejected from its receiving jaws.

18.7.4
For the test mentioned in 18.7.3:

a) The open-circuit voltage of the power-supply circuit shall not be less than the maximum rated voltage of the switch.

b) The available rms symmetrical short-circuit current in amperes shall not be less than the short-circuit current rating of the switch.

c) The circuit shall be as indicated in Figure 5, with any overcurrent protection device on the load side, and shall include the necessary measuring equipment and the fuse-mounting means. External overcurrent protective devices are to be connected where the “CL” fuses are indicated.

d) The power factor of the circuit shall be as follows:
   - 0.45 – 0.50 lagging for a circuit of 0 – 10 000 A;
   - 0.25 – 0.30 lagging for a circuit of 10 001 – 20 000 A; or
   - 0.15 – 0.20 lagging for circuits over 20 000 A

e) The enclosure of the switch shall be connected through a 30 A nonrenewable, non time delay-type fuse to the pole of the switch considered least likely to arc to the enclosure. The fuse shall have a voltage rating not less than the rating of the switch being tested. This connection shall be made to the load side of the limiting impedance by a 10 AWG copper wire having a length of 1.22 – 1.83 m (4 – 6 ft). The fuse may be connected to the grounded conductor if the switch is intended for use on a grounded system.

18.7.5
The overcurrent protection devices specified in Clause 18.7.4 shall be one of the following:

a) For fused switches rated 10kAIC and less, be externally connected Class H fuses (maximum rating for the case size of the rating specified),

b) For fused switches rated higher than 10kAIC, fuses as described in Clause 18.7.9, or

c) For unfused switches, externally connected fuses as described in Clause 18.7.9, or circuit breakers as marked on the switch.

18.7.6
Performing the test specified in Clause 18.7.4 without overcurrent protective devices shall be permitted if it can be shown that the test-circuit current was maintained for a period of time at least equal to the opening time of the specified overcurrent protective devices at the level of current involved.

18.7.7
For the performance of the test, the line and load terminals of the switch shall be connected to the corresponding test-circuit terminals by short copper wire leads, maximum 1.22 m (4 ft) per terminal, each of which has an ampacity not less than the current rating of the switch. Leads more than 1.22 m (4 ft) in length may be used if the excess length is included in the test circuit when it is calibrated.

18.7.8
For a switch rated greater than 10kAIC that employs an integral fuseholder, a copper bus or tube having a cross-section not smaller than the blade (or ferrule) of the fuse that the fuseholder is intended to accommodate shall be installed in each fuseholder in the switch. Each of these bars or tubes may be individually reinforced to enable it to withstand the short-circuit forces. If the fuse is intended to be secured in place by bolts, the test shall be conducted with the bolts in place if the bar or tube would not otherwise remain in position. Otherwise, the test shall be performed with the bolts omitted.
18.7.9
Fuses used shall have characteristics representing the peak let-through current (Ip) and clearing I^2t values associated with the maximum rated fuses that the device accepts, or by which the device is to be externally protected. For an unfused switch, it shall be assumed that protection will be provided by the maximum fuse in the case size of the indicated fuse. Each of these fuses shall be of such characteristics that when tested on a single-phase circuit, it will permit a peak let-through current and a clearing I^2t of not less than the corresponding values specified in the requirements for the class and current and voltage ratings of the fuse intended for use in the switch being tested. The use of special test fuses having the required characteristics shall be permitted (see Table 17). The use of special test fuses of the same physical dimensions as a fuse the enclosed switch is intended to accommodate may be used in place of the dummy fuses in the switch. To obtain the required values of these characteristics, it may be necessary to employ a fuse having a current rating larger than that of the fuse which the switch accommodates and of a different class.

18.7.10
Fuses used for tests shall be selected from a lot from which two samples have been selected and calibrated to determine that their I^2T and Ip characteristics comply with the prescribed values called for in 18.6.9. Two samples from the lot shall be calibrated if the fuses are of Class CC, G, J, R (K5), or T.

18.7.11
With the device in the fully closed position, the test circuit shall be closed on the device. For devices tested on a single-phase circuit, controlled closing shall be employed so that maximum current flow (Ip) is obtained. The closing angle shall be essentially at the zero of the voltage wave (maximum offset) or later, to produce the start of arcing within 30 electrical degrees prior to system peak voltage.

18.8 Low-level dielectric voltage-withstand test

18.8.1
Unless the same sample is to be subjected to the closing test, a switch that has been subjected to the short-circuit withstand test shall comply with the requirements in 18.6, except that the test voltage shall be twice the rated voltage of the switch but not less than 900 V.

18.9 Short-circuit closing test

18.9.1
A switch shall be closed on a circuit capable of providing the maximum short-circuit current for which the switch is rated. After the circuit has cleared, the switch shall comply with the requirements of Clause 18.7.3 (a) to (f).

18.9.2
The sample for this test shall either be the one used for the short-circuit withstand test or a previously untested sample. The conditions of the closing test shall be the same as for the short-circuit withstand test. Complete physical closure of the switch contacts need not be established.

18.10 Low-level dielectric voltage-withstand test

18.10.1
The dielectric voltage-withstand test described in Clause 18.6 shall be performed following the closing test except that the test voltage shall be twice the rated voltage of the switch but not less than 900 V.

18.11 Strength of insulating base and support test

18.11.1
The insulating base of a switch shall not be damaged when wire connectors securing short lengths of conductors of rated ampacity are tightened to 110 percent of the torque value marked on the switch. For a switch marked for use with copper/aluminum conductors, the wire connectors shall be tightened to the highest torque value of either conductor.
18.11.2 Damage is considered to have occurred if the base insulating material cracks or rotates; if bosses, recesses, or other means to prevent turning do not perform their intended function; if straps or bus bars bend or twist; or if members move at electrical joints. Minor chipping or flaking of brittle insulating material is acceptable if the performance is not otherwise impaired. Momentary flexing of metallic members without permanent deformation is acceptable.

18.12 Bonding Continuity Test

18.12.1 The resistance of a bond shall be determined by calculation from the voltage drop measured between two file marks, each located not more than 1/16 inch (1.6 mm) on opposite sides of the joint with 30 A flowing through the connection. All gaskets shall be in place and fastening devices pulled up tight in the intended manner. The resistance of the joint shall not exceed 0.005 ohms.

18.13 Clamped joint test

18.13.1 A clamped joint between two insulators shall be tested using two samples as follows:

a) On the first sample, the clamped joint shall be opened up to produce a space 3.2 mm (1/8 inch) wide. This may be accomplished by loosening the clamping means or by drilling a 3.2 mm (1/8 in.) diameter hole at the joint between the insulators at a point of minimum spacing between the metal parts on the opposite sides of the joint. The drilled hole shall not decrease spacings between the opposite polarity parts as measured through the crack between the insulators. The 60-Hz dielectric breakdown voltage through this hole shall then be determined by applying a gradually increasing voltage (500 V/second) until breakdown occurs.

b) The second sample, with its clamped joint intact, shall be subjected to a gradually increasing 60-Hz voltage until 110 percent of the breakdown voltage of item (a) has been reached. If the breakdown voltage of item (a) is less than 4 600 V, the voltage to be applied to the second sample shall be further increased to 5 000 V and held for 1 second. There shall be no electrical breakdown of the second sample.

18.14 Close-open test

18.14.1 Pullout switches rated higher than 10 000 amperes short-circuit current shall comply with the Close-Open test requirements in 18.14.

18.14.2 The test conditions shall be as follows:

a) A previously untested sample shall be used.

b) The line terminals of an ac rated switch shall be connected to the power supply circuit and the load terminals of the switch to an inductive load. The connections for a dc rated switch shall be as specified in Clause 18.5.6.2.

c) The test circuit shall be as follows:
   i) For ac rated switches, the power factor of the load shall be 0.45 – 0.50.
   ii) For dc rated switches, testing shall be on a dc circuit with a time constant not less than 0.003 sec. The time constant shall be measured on the oscillogram of the test current where the value is 63.2% of the maximum current.

d) The current shall be 600% of the rated current of the device.

e) A shunting resistance as described in Clause 18.5.6.4 shall be permitted.

f) The open-circuit test voltage shall not be less than 100% of the rated voltage of the device.
g) The closed-circuit test voltage shall not be less than 90% of the rated voltage of the device, or the normal-frequency recovery voltage shall be equal to the rated voltage of the device.

h) A ground fuse as described in Clause 18.5.6.4 shall be used.

i) A polyphase switch or a dc rated switch shall be subjected to 3 operations. A switch intended for use on single-phase ac circuits only shall be subjected to 5 operations.

j) The time between operations is not specified.

k) Servicing the blades and jaws before each operation shall be permitted. Servicing is considered to be filing, lubricating, deburring, and the like. There shall not be any disassembly of the device to accomplish the servicing. Servicing shall not include replacement of any part.

18.14.3
At the conclusion of the test, the switch shall be in operating condition. The ground fuse shall not have opened. Burning or pitting of the contacts shall be considered to be acceptable, but line-to-line breakdown shall be considered to be unacceptable.

18.14.4
Upon completion of the test, the test sample shall not be serviced in any manner before conducting the dielectric voltage-withstand test. After completion of the dielectric voltage-withstand test, servicing the switch prior to the short-circuit withstand test shall be permitted.

18.14.5
The dielectric voltage-withstand test in Clause 18.6 shall be conducted following the close-open test.

18.15  Mold stress relief test

18.15.1
Except for rigid thermosetting materials, conditioning of the equipment as described in Clause 18.15.2 shall not cause softening of the material, as determined by handling, immediately after the conditioning, nor shall there be any shrinkage, warpage, or other distortion, as judged after cooling to room temperature, that results in any of the following:

a) Reduction of spacings between uninsulated live parts of opposite polarity, uninsulated live parts and accessible grounded metal, uninsulated live parts and the enclosure below the minimum acceptable values;

b) Making uninsulated live parts or internal wiring accessible to contact, or defeating the integrity of the enclosure so that unacceptable mechanical protection is not afforded to internal parts of the equipment; and

c) Causing interference with the intended operation or servicing of the equipment.

18.15.2
One complete switch shall be placed in a full-draft circulating-air oven maintained at a uniform temperature at least 10°C higher than the maximum temperature of the material measured during the heating test, but not less than 70°C in any case. The sample shall remain in the oven for 7 hours. After its removal from the oven and return to room temperature, the sample shall be investigated for compliance with Clause 18.15.1.

18.16  Insulating barriers test

18.16.1
The barrier material shall be placed between two metal electrodes. The electrodes shall be cylindrical brass or stainless steel rods 6.4 mm (1/4 in.) in diameter with edges rounded to a 0.8 mm (1/32 in.) radius. The test potential shall be increased to the test value specified in either Clause 14.4 or 14.7, and shall be maintained for 1 second. The result shall be acceptable if there is no dielectric breakdown.
**Figure 1**

Accessibility of live parts

(See Clause 5.16.2.)

![Diagram showing accessibility of live parts]

*Note: All dimensions given are in millimetres.*

---

**Figure 2**

Accessibility of live parts

(See Clause 5.16.3.)

![Diagram showing accessibility of live parts]

*a)* Bare live parts

*b)* Less than 3.2

*Note: All dimensions given are in millimetres.*

---

**Figure 3**

Grounding symbol

![Grounding symbol diagram]
Figure 4
Clamped joints

Parts A, B – Live parts of opposite polarity, or a live part and grounded metal part with spacing through the crack between C and D less than required in Table 2.

Parts C, D – Insulating barriers clamped tightly together so that the dielectric strength between A and B is greater than the equivalent air spacing.

Part E – The clamped joint.
Figure 5
Circuit for withstand and closing tests supply rated voltage 3 phase - 60 Hz

X – Variable tap air-core reactor

R – Variable resistor

SW – Closing switch – may be located as shown or ahead of limiting impedance

F – Enclosure fuse

D – Device under test

Rs – Coaxial shunts for metering current

CL – Current-limiting fuses or circuit breakers used during test

DF – Dummy fuse

Common connection of outer shells of coaxial shunts may be grounded if no other grounds on the circuit.
**Table 1**

Minimum values for insulating materials

<table>
<thead>
<tr>
<th>Test specific</th>
<th>Flammability rating of material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V-0</td>
</tr>
<tr>
<td>Hot wire ignition (HWI)(^a), ignition time in sec. (Appendix A, Ref. No. 3)</td>
<td>7</td>
</tr>
<tr>
<td>High current arc ignition (HAI)(^d), number of arcs (Appendix A, Ref. No. 11)</td>
<td>15</td>
</tr>
<tr>
<td>Comparative tracking index (CTI) under moist conditions(^c), volts (Appendix A, Ref. No. 2)</td>
<td>175(^{a,b})</td>
</tr>
</tbody>
</table>

a) A material having a minimum comparative tracking value of 100 may be used if the voltage involved is 250 volts or less.
b) Not applicable if the over-surface spacing is greater than or equal to 12.7 mm (1/2 inch).
c) Material surface is in contact with or in close proximity (within 0.8 mm (1/32 inch)) to:
   1. Insulated live parts of opposite polarity, or
   2. Insulated live parts and either
      i) metal parts that may be grounded in service, or
      ii) any surface exposed to contact.
d) Material is in contact with or in close proximity to uninsulated live parts 0.8 mm (1/32 inch) for nonarching parts or 12.7 mm (1/2 inch) for arcing parts.
e) Material in contact with or close proximity to uninsulated live parts (within 0.8 mm (1/32 inch)).

**Table 2**

Machine-screw threads

<table>
<thead>
<tr>
<th>American screws</th>
<th>Metric screws</th>
</tr>
</thead>
<tbody>
<tr>
<td>American National Standard size</td>
<td>Maximum number of threads per inch (per 25.4 mm)</td>
</tr>
<tr>
<td>¼</td>
<td>20</td>
</tr>
<tr>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
</tr>
</tbody>
</table>

**Table 3**

Securing of jaws and contacts

<table>
<thead>
<tr>
<th>Construction</th>
<th>Rating in amperes</th>
<th>Means of securing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slots (See figure 1)</td>
<td>100 or less</td>
<td>Pinning required, soldering not acceptable</td>
</tr>
<tr>
<td>Jaw or contact securely swaged on the underside of the mounting piece</td>
<td>100 or less</td>
<td>Pinning required, soldering not acceptable</td>
</tr>
<tr>
<td>Jaw or contact not securely swaged on the underside</td>
<td>Any</td>
<td>Pinning and soldering required</td>
</tr>
</tbody>
</table>
Table 4

Ampacity of insulated conductors\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Wire size</th>
<th>60°C</th>
<th>75°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Copper</td>
<td>Aluminum</td>
</tr>
<tr>
<td>AWG</td>
<td>mm\textsuperscript{2}</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>2.1</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>3.3</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>5.3</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>8.4</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>13.3</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>21.2</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>26.7</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>33.6</td>
<td>95</td>
</tr>
<tr>
<td>1</td>
<td>42.4</td>
<td>110</td>
</tr>
<tr>
<td>1/0</td>
<td>53.5</td>
<td></td>
</tr>
<tr>
<td>2/0</td>
<td>67.4</td>
<td></td>
</tr>
<tr>
<td>3/0</td>
<td>85.0</td>
<td></td>
</tr>
<tr>
<td>4/0</td>
<td>107.2</td>
<td></td>
</tr>
<tr>
<td>kcmil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>152</td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>203</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>253</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>304</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>355</td>
<td></td>
</tr>
<tr>
<td>750</td>
<td>380</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>405</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>456</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>507</td>
<td></td>
</tr>
<tr>
<td>1250</td>
<td>633</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>760</td>
<td></td>
</tr>
<tr>
<td>1750</td>
<td>887</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1010</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} For a multiple-conductor connector at a terminal, the value shall be multiplied by the number of conductors that the terminal will accommodate (1/0 AWG or larger).

\textsuperscript{b} These values of ampacity apply only if not more than 3 conductors will be field-installed in the conduit. If 4 or more conductors, other than a neutral that carries the unbalanced current, will be installed in a conduit (as may occur because of the number of conduit hubs provided in an outdoor switch, because of the number of wires necessary in certain polyphaser systems, or other reasons) the ampacity of each of those conductors shall be 80 percent of the value given in the Table if 4 - 6 conductors are involved, and 70 percent of that value if 7 - 24 conductors.

\textsuperscript{c} Values in parentheses apply to products for use only in Canada.
Table 5
Minimum spacings<sup>a</sup>

<table>
<thead>
<tr>
<th>Voltage between parts involved</th>
<th>Minimum spacings in mm (inches)</th>
<th>Over surface</th>
<th>Through air</th>
<th>Over surface</th>
<th>Through air</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Between uninsulated live parts of opposite polarity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 130</td>
<td>19 (3/4)</td>
<td>12.5 (1/2)</td>
<td>12.5 (1/2)</td>
<td>12.5 (1/2)</td>
<td>12.5 (1/2)</td>
</tr>
<tr>
<td>131 – 250</td>
<td>31 (1-1/4)</td>
<td>19 (3/4)</td>
<td>12.5 (1/2)</td>
<td>12.5 (1/2)</td>
<td>12.5 (1/2)</td>
</tr>
<tr>
<td>251 - 600</td>
<td>50 (2)</td>
<td>25 (1)</td>
<td>25 (1)</td>
<td>12.5 (1/2)</td>
<td>12.5 (1/2)</td>
</tr>
</tbody>
</table>

<sup>a</sup>The SI units are minimum values and are not a direct conversion from the corresponding values in inches.

Table 6
Conduit bushings

<table>
<thead>
<tr>
<th>Trade size designators</th>
<th>Overall diameter, mm</th>
<th>Height, mm</th>
<th>Overall diameter, inches</th>
<th>Height, inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>25.4</td>
<td>9.5</td>
<td>(1)</td>
<td>(3/8)</td>
</tr>
<tr>
<td>3/4</td>
<td>31.4</td>
<td>10.7</td>
<td>(1-15/64)</td>
<td>(27/64)</td>
</tr>
<tr>
<td>1</td>
<td>40.5</td>
<td>13.1</td>
<td>(1-19/32)</td>
<td>(33/64)</td>
</tr>
<tr>
<td>1-1/4</td>
<td>49.2</td>
<td>14.3</td>
<td>(1-15/16)</td>
<td>(9/16)</td>
</tr>
<tr>
<td>1-1/2</td>
<td>56.0</td>
<td>15.1</td>
<td>(2-13/64)</td>
<td>(19/32)</td>
</tr>
<tr>
<td>2</td>
<td>68.7</td>
<td>15.9</td>
<td>(2-45/64)</td>
<td>(5/8)</td>
</tr>
<tr>
<td>2-1/2</td>
<td>81.8</td>
<td>19.1</td>
<td>(3-7/32)</td>
<td>(3/4)</td>
</tr>
<tr>
<td>3</td>
<td>98.4</td>
<td>20.6</td>
<td>(3-7/8)</td>
<td>(13/16)</td>
</tr>
<tr>
<td>3-1/2</td>
<td>112.7</td>
<td>23.8</td>
<td>(4-7/16)</td>
<td>(15/16)</td>
</tr>
<tr>
<td>4</td>
<td>126.2</td>
<td>25.4</td>
<td>(4-31/32)</td>
<td>(1)</td>
</tr>
<tr>
<td>4-1/2</td>
<td>140.9</td>
<td>27.0</td>
<td>(5-35/64)</td>
<td>(1-1/16)</td>
</tr>
<tr>
<td>5</td>
<td>158.0</td>
<td>30.2</td>
<td>(6-7/32)</td>
<td>(1-3/16)</td>
</tr>
<tr>
<td>6</td>
<td>183.4</td>
<td>31.8</td>
<td>(7-7/32)</td>
<td>(1-1/4)</td>
</tr>
</tbody>
</table>

Table 7
AWG size (mm²) of wire to be used in spacings evaluation of 30 A switches

<table>
<thead>
<tr>
<th>Terminal acceptable for use with</th>
<th>For use as service equipment</th>
<th>Not for use as service equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AWG</td>
<td>mm²</td>
</tr>
<tr>
<td>Copper only</td>
<td>8</td>
<td>8.367</td>
</tr>
<tr>
<td>Copper/aluminum</td>
<td>6</td>
<td>13.30</td>
</tr>
</tbody>
</table>
Table 8
Minimum values for insulating barriers used in place of spacing in conjunction with minimum air space of 0.33 mm (0.013 inch)

<table>
<thead>
<tr>
<th>Test specified†</th>
<th>Flammability rating of material ‡</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V-0 or VTM-0</td>
<td>V-1 or VTM-1</td>
<td>V-2 or VTM-2</td>
<td>HB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot wire ignition (HWI), ignition time in sec. (Appendix A, Ref. No. 3)</td>
<td>7</td>
<td>15</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High current arc, ignition (HAI), number of arcs (Appendix A, Ref. No. 11)</td>
<td>15</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparative tracking index (CTI) under moist conditions, Volts (Appendix A, Ref. No. 2)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

‡ Not applicable if the over-surface spacing is greater than or equal to 12.7 mm (1/2 inch)  
§ Material surface is in contact with or in close proximity (within 0.8 mm (1/32 inch)) to:  
  1) Uninsulated live parts of opposite polarity, or  
  2) Uninsulated live parts and either  
     i) metal parts that may be grounded in service, or  
     ii) any surface exposed to contact.  
§ Material is in contact with or in close proximity to uninsulated live parts 0.8 mm (1/32 inch) for non-arcing parts or 12.7 mm (1/2 inch) for arcing parts.  
§ Material is in contact with or in close proximity to uninsulated live parts (within 0.8 mm (1/32 inch)).  
† These flammability ratings are derived from Appendix A, Ref. No. 5  
†† See Appendix A, Ref. No. 11, for these specified tests.

Table 9
(Only applicable up to 350 hp)  
Endurance-test currents in amperes for alternating-current switches

<table>
<thead>
<tr>
<th>Switch rating in kW</th>
<th>Switch rating in hp</th>
<th>120 V †</th>
<th>240 V</th>
<th>480 V</th>
<th>600 V</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1Φ</td>
<td>2Φ</td>
<td>3Φ</td>
<td>1Φ</td>
<td>2Φ</td>
<td>3Φ</td>
<td>1Φ</td>
<td>2Φ</td>
<td>3Φ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-Wire</td>
<td>4-Wire</td>
<td>4-Wire</td>
<td>4-Wire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9
(Only applicable up to 350 hp)
Endurance-test currents in amperes for alternating-current switches

<table>
<thead>
<tr>
<th>Switch rating in kW</th>
<th>hp</th>
<th>120 V&lt;sup&gt;a&lt;/sup&gt;</th>
<th>240 V</th>
<th>480 V</th>
<th>600 V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1Φ</td>
<td>2Φ</td>
<td>3Φ</td>
<td>1Φ</td>
</tr>
<tr>
<td>186.5</td>
<td>250</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>223.8</td>
<td>300</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>261.1</td>
<td>350</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>298.4</td>
<td>400</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>335.7</td>
<td>450</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>373.0</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup> For 127 V ratings, the test is conducted at rated voltage with the currents in this column.

Table 10
Endurance-test currents in amperes for direct-current switches

<table>
<thead>
<tr>
<th>Switch rating in kW</th>
<th>hp</th>
<th>125 V</th>
<th>250 V</th>
<th>600 V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.746</td>
<td>1</td>
<td>9.4</td>
<td>4.7</td>
<td>1.8</td>
</tr>
<tr>
<td>1.119</td>
<td>1-1/2</td>
<td>13.2</td>
<td>6.6</td>
<td>2.6</td>
</tr>
<tr>
<td>1.462</td>
<td>2</td>
<td>17</td>
<td>8.5</td>
<td>3.4</td>
</tr>
<tr>
<td>2.238</td>
<td>3</td>
<td>25</td>
<td>12.2</td>
<td>5.0</td>
</tr>
<tr>
<td>3.73</td>
<td>5</td>
<td>40</td>
<td>20</td>
<td>8.3</td>
</tr>
<tr>
<td>5.60</td>
<td>7-1/2</td>
<td>58</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>7.46</td>
<td>10</td>
<td>76</td>
<td>38</td>
<td>16</td>
</tr>
<tr>
<td>11.19</td>
<td>15</td>
<td>112</td>
<td>55</td>
<td>23</td>
</tr>
<tr>
<td>14.92</td>
<td>20</td>
<td>148</td>
<td>72</td>
<td>31</td>
</tr>
<tr>
<td>18.65</td>
<td>25</td>
<td>-</td>
<td>89</td>
<td>89</td>
</tr>
<tr>
<td>22.38</td>
<td>30</td>
<td>-</td>
<td>106</td>
<td>46</td>
</tr>
<tr>
<td>29.84</td>
<td>40</td>
<td>-</td>
<td>140</td>
<td>61</td>
</tr>
<tr>
<td>37.30</td>
<td>50</td>
<td>-</td>
<td>173</td>
<td>75</td>
</tr>
</tbody>
</table>
### Table 11
(Only applicable up to 350 hp)
Power ratings of fused switches

<table>
<thead>
<tr>
<th>Fuse-holder, amps</th>
<th>Switch rating in volts</th>
<th>Power ratings, kilowatts (horsepower)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2-pole single-phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>30</td>
<td>120 AC</td>
<td>0.373 (1/2)</td>
</tr>
<tr>
<td></td>
<td>127 AC</td>
<td>(1-1/2)</td>
</tr>
<tr>
<td>60</td>
<td>120 AC</td>
<td>1.119</td>
</tr>
<tr>
<td></td>
<td>127 AC</td>
<td>(1-1/2)</td>
</tr>
<tr>
<td>30</td>
<td>125 DC</td>
<td>1.492 (2)</td>
</tr>
<tr>
<td>60</td>
<td>125 DC</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>240 AC</td>
<td>1.119</td>
</tr>
<tr>
<td></td>
<td>(1-1/2)</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>240 AC</td>
<td>2.238 (3)</td>
</tr>
<tr>
<td></td>
<td>480 AC</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>240 AC</td>
<td>5.60 (7-1/2)</td>
</tr>
<tr>
<td>200</td>
<td>240 AC</td>
<td>11.19 (15)</td>
</tr>
<tr>
<td>400</td>
<td>240 AC</td>
<td>18.65 (25)</td>
</tr>
<tr>
<td>600</td>
<td>240 AC</td>
<td>37.30 (50)</td>
</tr>
<tr>
<td>800</td>
<td>240 AC</td>
<td>74.60 (100)</td>
</tr>
<tr>
<td>30</td>
<td>250 DC</td>
<td>3.73 (5)</td>
</tr>
<tr>
<td>60</td>
<td>250 DC</td>
<td>7.46 (10)</td>
</tr>
<tr>
<td>100</td>
<td>250 DC</td>
<td>14.92 (20)</td>
</tr>
<tr>
<td>200</td>
<td>250 DC</td>
<td>29.84 (40)</td>
</tr>
<tr>
<td>400</td>
<td>250 DC</td>
<td>57.68 (80)</td>
</tr>
<tr>
<td>30</td>
<td>480 AC</td>
<td>2.238 (3)</td>
</tr>
<tr>
<td>60</td>
<td>480 AC</td>
<td>3.73 (5)</td>
</tr>
<tr>
<td>100</td>
<td>480 AC</td>
<td>7.46 (10)</td>
</tr>
<tr>
<td>200</td>
<td>480 AC</td>
<td>14.92 (20)</td>
</tr>
<tr>
<td>400</td>
<td>480 AC</td>
<td>29.84 (40)</td>
</tr>
<tr>
<td>600</td>
<td>480 AC</td>
<td>57.68 (80)</td>
</tr>
<tr>
<td>800</td>
<td>480 AC</td>
<td>74.60 (100)</td>
</tr>
<tr>
<td>30</td>
<td>600 AC</td>
<td>2.238 (3)</td>
</tr>
<tr>
<td>60</td>
<td>600 AC</td>
<td>3.73 (5)</td>
</tr>
<tr>
<td>100</td>
<td>600 AC</td>
<td>7.46 (10)</td>
</tr>
<tr>
<td>200</td>
<td>600 AC</td>
<td>22.38 (30)</td>
</tr>
<tr>
<td>400</td>
<td>600 AC</td>
<td>44.76 (60)</td>
</tr>
<tr>
<td>600</td>
<td>600 AC</td>
<td>89.52 (120)</td>
</tr>
<tr>
<td>800</td>
<td>600 AC</td>
<td>179.04 (240)</td>
</tr>
<tr>
<td>30</td>
<td>600 DC</td>
<td>7.46 (10)</td>
</tr>
<tr>
<td>60</td>
<td>600 DC</td>
<td>18.65 (25)</td>
</tr>
<tr>
<td>100</td>
<td>600 DC</td>
<td>37.30 (50)</td>
</tr>
<tr>
<td>200</td>
<td>600 DC</td>
<td>74.60 (100)</td>
</tr>
</tbody>
</table>

* See 9.2.7.1.
Table 12
Short-circuit current rating, rms

<table>
<thead>
<tr>
<th>Symmetrical amperes</th>
<th>25000</th>
<th>65000&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7500&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>85000&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>10000</td>
<td>35000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100000</td>
</tr>
<tr>
<td>14000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>125000&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>18000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50000&lt;sup&gt;a&lt;/sup&gt;</td>
<td>150000&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>22000&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>200000</td>
</tr>
</tbody>
</table>

<sup>a</sup>These short-circuit ratings shall only be employed when circuit breakers are specified.

Table 13
Fused pullout switches

<table>
<thead>
<tr>
<th>Test</th>
<th>Test sequence</th>
<th>Class H or K fuse</th>
<th>Class J,R,G,T, or CC fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>A</td>
<td>Sec. 20</td>
<td>Sec. 20</td>
</tr>
<tr>
<td>Heating with Fuses</td>
<td>B</td>
<td>Sec. 21</td>
<td>Sec. 21</td>
</tr>
<tr>
<td>Overload Cycling Heating</td>
<td>C</td>
<td>Sec. 22</td>
<td>Sec. 22</td>
</tr>
<tr>
<td>Overload</td>
<td>D</td>
<td>Sec. 23</td>
<td>Sec. 23</td>
</tr>
<tr>
<td>Endurance</td>
<td>D</td>
<td>Sec. 24</td>
<td>Sec. 24</td>
</tr>
<tr>
<td>Dielectric Voltage-Withstand</td>
<td>D</td>
<td>Sec. 25</td>
<td>Sec. 25</td>
</tr>
<tr>
<td>Close-Open</td>
<td>E</td>
<td>-</td>
<td>Sec. 35</td>
</tr>
<tr>
<td>Dielectric Voltage-Withstand</td>
<td>E</td>
<td>-</td>
<td>Sec. 36</td>
</tr>
<tr>
<td>Short-Circuit Withstand</td>
<td>E</td>
<td>-</td>
<td>Sec. 37</td>
</tr>
<tr>
<td>Low-Level Dielectric Voltage-W</td>
<td>E</td>
<td>-</td>
<td>Sec. 38&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Withstand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closing</td>
<td>F</td>
<td>-</td>
<td>Sec. 39</td>
</tr>
<tr>
<td>Low-Level Dielectric Voltage-W</td>
<td>F</td>
<td>-</td>
<td>Sec. 40</td>
</tr>
<tr>
<td>Strength of Insulating Base</td>
<td>G</td>
<td>Sec. 31</td>
<td>Sec. 31</td>
</tr>
<tr>
<td>and Support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonding Continuity</td>
<td>H</td>
<td>Sec. 32</td>
<td>Sec. 32</td>
</tr>
<tr>
<td>Clamped Joint</td>
<td>I</td>
<td>Sec. 32</td>
<td>Sec. 33</td>
</tr>
</tbody>
</table>

<sup>a</sup>If the same sample is used for the Short-Circuit Withstand and Closing Tests, the Low-Level Dielectric Voltage Withstand Test is not to be conducted following the Short-Circuit Withstand Test.

**Note:** The letter in the “Test Sequence” columns indicate the test sequences that are to be performed on an individual sample. All tests identified with the same letter shall be performed on a single previously untested sample, except that a sample that was subjected to previous tests may be reconditioned and used if agreeable to those concerned.
Table 14
Unfused pullout switches

<table>
<thead>
<tr>
<th>Test</th>
<th>Test sequence</th>
<th>Class H or K fuse</th>
<th>Class J,R,G,T, or CC fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>A</td>
<td>Sec. 20</td>
<td>Sec. 20</td>
</tr>
<tr>
<td>Overload</td>
<td>D</td>
<td>Sec. 23</td>
<td>Sec. 23</td>
</tr>
<tr>
<td>Endurance</td>
<td>D</td>
<td>Sec. 24</td>
<td>Sec. 24</td>
</tr>
<tr>
<td>Dielectric Voltage-Withstand</td>
<td>D</td>
<td>Sec. 25</td>
<td>Sec. 25</td>
</tr>
<tr>
<td>Close-Open</td>
<td>E</td>
<td>-</td>
<td>Sec. 35</td>
</tr>
<tr>
<td>Dielectric Voltage-Withstand</td>
<td>E</td>
<td>-</td>
<td>Sec. 36</td>
</tr>
<tr>
<td>Short-Circuit Withstand</td>
<td>E</td>
<td>Sec. 26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Sec. 37</td>
</tr>
<tr>
<td>Low-Level Dielectric Voltage-Withstand</td>
<td>E</td>
<td>Sec. 27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Sec. 38&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Closing</td>
<td>F</td>
<td>Sec. 28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Sec. 39</td>
</tr>
<tr>
<td>Low-Level Dielectric Voltage-Withstand</td>
<td>F</td>
<td>Sec. 29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Sec. 40</td>
</tr>
<tr>
<td>Strength of Insulating Base and Support</td>
<td>G</td>
<td>Sec. 31</td>
<td>Sec. 31</td>
</tr>
<tr>
<td>Bonding Continuity</td>
<td>H</td>
<td>Sec. 32</td>
<td>Sec. 32</td>
</tr>
<tr>
<td>Clamped Joint</td>
<td>I</td>
<td>Sec. 33</td>
<td>Sec. 33</td>
</tr>
</tbody>
</table>

<sup>a</sup> Tests only applicable to switches where the maximum rating of the specified overcurrent protective device exceeds the current rating of the switch.

<sup>b</sup> If the same sample is used for the Short-Circuit Withstand and Closing Tests, the Low-Level Dielectric Voltage Withstand Test is not to be conducted following the Short-Circuit Withstand Test.

**Note:** The letters in the “Test Sequence” columns indicate the test sequences that are to be performed on an individual sample. All tests identified with the same letter shall be performed on a single previously untested sample, except that a sample that was subjected to previous tests may be reconditioned and used if agreeable to those concerned.
Table 15
Maximum acceptable temperature rises

<table>
<thead>
<tr>
<th>Material and components</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Terminals for field-installed conductors:</td>
<td></td>
</tr>
<tr>
<td>1. Unfused switches</td>
<td>50</td>
</tr>
<tr>
<td>2. Fused switches for use with 60°C wire and tested with dummy fuses</td>
<td>30</td>
</tr>
<tr>
<td>3. Fused switches for use with 75°C wire and tested with dummy fuses a</td>
<td>45</td>
</tr>
<tr>
<td>4. Class T fused switches rated 100 A or less for use with 60°C wire</td>
<td>50</td>
</tr>
<tr>
<td>5. Class T fused switches rated 100 A or less for use with 75°C wire a</td>
<td>65</td>
</tr>
<tr>
<td>6. Class J, Class C (rated more than 200 A), Class T (rated more than 100 A), and Class L fused switches</td>
<td>60</td>
</tr>
<tr>
<td>B. All other current-carrying parts:</td>
<td></td>
</tr>
<tr>
<td>1. Unfused switches</td>
<td>50</td>
</tr>
<tr>
<td>2. Fused switches for use with 60°C wire and tested with dummy fuses</td>
<td>30</td>
</tr>
<tr>
<td>3. Fused switches for use with 75°C wire and tested with dummy fuses a</td>
<td>50</td>
</tr>
<tr>
<td>4. Class T, Class J, Class C (rated more than 200 A), and Class L fused switches</td>
<td>85</td>
</tr>
<tr>
<td>C. Other materials and components:</td>
<td></td>
</tr>
<tr>
<td>1. Wire insulation or insulating tubing</td>
<td>35</td>
</tr>
<tr>
<td>2. Electrical tape</td>
<td>55</td>
</tr>
<tr>
<td>3. Varnished cloth insulation</td>
<td>60</td>
</tr>
<tr>
<td>4. Fiber used as electrical insulation</td>
<td>65</td>
</tr>
<tr>
<td>5. Sealing compound</td>
<td>50</td>
</tr>
<tr>
<td>6. Phenolic composition used as electrical insulation or as a part whose failure would result in an undesired condition</td>
<td>125</td>
</tr>
<tr>
<td>7. Other insulating materials.</td>
<td>b</td>
</tr>
</tbody>
</table>

a Applicable to a connector for copper wire. Also applicable to a connector for aluminum wire or an aluminum-bodied connector, if the connector has a temperature rating of 90°C.
b Rated temperature limit of material minus test ambient temperature.

Table 16
Adjusted temperature rise

<table>
<thead>
<tr>
<th>Switch rating, amperes</th>
<th>Temperature rise above room</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-100</td>
<td>30°C (54°F) plus T a</td>
</tr>
<tr>
<td>101-200</td>
<td>40°C (72°F) plus T a</td>
</tr>
</tbody>
</table>

a T is the temperature rise obtained in the Heating Test, Section 20.

Table 17
Endurance test cycles
Table 24.1 revised July 28, 2005

<table>
<thead>
<tr>
<th>Switch rating in amperes</th>
<th>Number of cycles of operation per minute a</th>
<th>Number of cycles of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With current</td>
<td>Without current</td>
</tr>
<tr>
<td>100 or less</td>
<td>6</td>
<td>6000</td>
</tr>
<tr>
<td>200</td>
<td>5</td>
<td>60000</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>1000</td>
</tr>
</tbody>
</table>

a The indicated number of cycles of operation per minute applies only to that part of the test made with current. When no current is used, the switch may be operated at any convenient speed.