# UL 20

0–7629–0596–4

# General-Use Snap Switches

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for General-Use Snap Switches, UL 20

Twelfth Edition, Dated September 22, 2000

The new and/or revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated May 16, 2000. The bulletin(s) is now obsolete and may be discarded.

The following table lists the future effective dates with the corresponding item.

| Future Effective Dates | References |
|---|---|
| June 1, 2005 | Entire Standard |

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.



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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listed, Recognized, Classified, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.



This Standard consists of pages dated as shown in the following checklist:

| Page | Date |
|---|---|
| 1-70 | September 22, 2000 |
| A1-A2 | September 22, 2000 |
| B1-B6 | September 22, 2000 |

**Canadian Standards Association**
**CSA-C22.2 No. 111**
***Third Edition***

**Underwriters Laboratories Inc.**
**UL 20**
***Twelfth Edition***

# General-Use Snap Switches

September 22, 2000

**Commitment for Amendments**

This Standard is issued jointly by Canadian Standards Association and Underwriters Laboratories Incorporated. Amendments to this Standard will be made only after processing according to the Standards writing procedures by both Canadian Standards Association and Underwriters Laboratories Incorporated.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

The Department of Defense (DoD) has adopted UL 20 on December 4, 1981. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

***ISBN 1-55324-251-3***



***ISBN 0-7629-0596-4***

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# Preface

This is the common UL and CSA Standard for General-Use Snap Switches. It is the Third edition of CSA-C22.2 No. 111 and the Twelfth edition of UL 20.

This common Standard has been prepared by CSA International and Underwriters Laboratories Inc., and the manufacturing industry. The efforts and support of NEMA (National Electrical Manufacturers Association) and EFC (Electro-Federation of Canada) are gratefully acknowledged.

This Standard was reviewed by the CSA Subcommittee on Standard C22.2 No. 111 and approved by the Technical Committee on Wiring Products under the jurisdiction of the CSA Strategic Resource Group.

This Standard will be submitted to the American National Standards Institute (ANSI) for publication as as American National Standard.

**Note:** *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.*

### UL Effective Date

As of June 1, 2005, all products Listed, Recognized, or Classified by UL must comply with the requirements in this Standard.

Between September 22, 2000 and June 1, 2005, new product submittals to UL may be evaluated under all the requirements in this Standard or, if requested in writing evaluated under presently effective requirements only. The presently effective requirements are contained in the Eleventh edition of UL 20.

### CSA Effective Date

The effective date for CSA will be announced through CSA Informs or CSA Notification Notice.

### Level of Harmonization

This standard is published as an equivalent standard. An equivalent standard is a standard that is substantially the same in technical content, except as follows. Technical deviations are allowed for Codes and Governmental Regulations and those recognized as being in accordance with NAFTA Article 905, for example because of fundamental, climatic, geographical, technological, or infrastructural factors, scientific justification or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

### Interpretations

The interpretation by the SDO of an equivalent or standard shall be based on the literal text to determine compliance with the standard in accordance with the procedural rules of the SDO. If more than one interpretation of the literal text has been identified, a revision shall be proposed as soon as possible to each of the SDOs to more accurately reflect the intent. (Note: CSA may use an ORD – Other Recognized Document – for this purpose).

# Foreword (CSA)

The Canadian Standards Association, which operates under the name CSA International (CSA), provides certification services for manufacturers who, under license from CSA, wish to use the appropriate registered CSA Marks on certain products of their manufacture to indicate conformity with CSA Standards.

CSA Certification for a number of products is provided in the interest of maintaining agreed-upon standards of quality, performance, interchangeability and/or safety, as appropriate. Where applicable, certification may form the basis for acceptance by inspection authorities responsible for enforcement of regulations. Where feasible, programs will be developed for additional products for which certification is desired by producers, consumers or other interests.

In performing its functions in accordance with its objectives, CSA does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of the Association represent its professional judgement given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed.

Products in substantial accord with this Standard but which exhibit a minor difference or a new feature may be deemed to meet the Standard providing the feature or difference is found acceptable utilizing appropriate CSA Certification and Testing Division Operating Procedures. Products which comply with this Standard shall not be certified if they are found to have additional features which are inconsistent with the intent of this Standard. Products shall not be certifiable if they are discovered to contravene applicable laws or regulations.

Testing techniques, test procedures and instrumentation frequently must be prescribed by the CSA Certification and Testing Division in addition to the technical requirements contained in Standards of CSA. In addition to markings specified in the Standard, the CSA Certification and Testing Division may require special cautions, markings and instructions that are not specified by the Standard.

Some tests required by CSA Standards may be inherently hazardous. The Association neither assumes nor accepts any responsibility for any injury or damage that may occur during or as the result of tests, wherever performed, whether performed in whole or in part by the manufacturer or the Association, and whether or not any equipment, facility or personnel for or in connection with the test is furnished by the manufacturer or the Association.

Manufacturers should note that, in the event of the failure of the CSA Certification and Testing Division to resolve an issue arising from the interpretation of requirements, there is an appeal procedure: the complainant should submit the matter, in writing, to the Secretary of the Canadian Standards Association.

If this Standard is to be used in obtaining CSA Certification please remember, when making application for certification, to request all current Amendments, Bulletins, Notices and Technical Information Letters that may be applicable and for which there may be a nominal charge. For such information or for further information concerning CSA Certification please address your inquiry to Applications and Customer Service, CSA International, 178 Rexdale Boulevard, Toronto, Ontario M9W 1R3.

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# Foreword (UL)

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer’s product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

## 1 Scope

1.1 The requirements of this Standard apply to manually operated, general-use snap switches for connection to copper (Cu) or copper-clad conductors used in accordance with the National Electrical Code(NEC), ANSI/NFPA 70, or the Canadian Electrical Code (CEC), Part 1, and intended for connection to wiring systems recognized by the NEC or the CEC, Part 1. In Canada, requirements for switches for connection to aluminum (Al) conductors used in accordance with the CEC, Part 1, and intended for connection to wiring systems recognized by the CEC, Part 1, are covered in Appendix B.

1.2 This Standard applies to ac/dc rated switches for which the load ratings do not exceed 60 A at 250 V or less, 30 A at 251 V – 600 V, and 2 hp at 125 V – 600 V or less. This Standard also covers ac-only rated switches for which the load ratings do not exceed 30 A at 347 Vac or less.

1.3 This Standard applies to switches constructed to be installed readily in a flush device box or on an outlet-box cover and intended for connection to branch-circuit wiring.

1.4 This Standard applies to pendant and through-cord switches intended for field installation on flexible cord and provided with one "on" and one "off" position.

1.5 This Standard applies to switches intended for surface mounting and provided with a separable base and cover for connection to exposed wiring consisting of nonmetallic sheathed cable or open wiring on insulators (knob and tube).

1.6 This Standard applies to self-contained switches intended for flush mounting without a separate outlet box and for connection to branch-circuit wiring consisting of one or more non-metallic sheathed cables containing copper conductors.

1.7 This Standard applies to ac/dc fixture switches intended to be installed in fixtures to control incandescent lighting or fans for connection to branch-circuit wiring.

1.8 This Standard also applies to single-pole, momentary-contact door switches constructed to be installed readily in a special-purpose device box or on an outlet-box cover for connection to branch-circuit wiring.

1.9 This Standard does not apply to:

a) Clock operated switches specified in the Standard for Clock-Operated Switches, UL 917, and CSA Standard C22.2 No. 177;

b) Dimmer switches specified in the Standard for Solid-State Dimming Controls, UL 1472, and CSA Standard C22.2 No. 184.1;

c) Industrial control equipment specified in the Standard for Industrial Control Equipment, UL 508, and CSA Standard C22.2 No. 14;

d) Solid-state, single-phase motor speed controls specified in the Standard for Solid-State Fan Speed Controls, UL 1917, and CSA Standard C22.2 No. 156;

e) Special-use and ac-only fixture switches specified in the Standard for Special-Use Switches, UL 1054, and CSA Standard C22.2 No. 55; and

f) Switches for use in hazardous locations specified in the Standard for Switches for Use in Hazardous (Classified) Locations, UL 894, and CSA Standard C22.2 No. 159.

1.10 For switches intended for connection to branch-circuit wiring containing aluminum conductors, refer to the Standard for Receptacles and Switches Intended for Use with Aluminum Wire, UL 1567, or to Appendix B.

## 2 Definitions

2.1 The following definitions apply in this Standard:

**Clearances** – through-air spacing.

**Creepage distances (creepage)** – over-surface spacings.

**Door Switch** – a single-pole, momentary contact switch with a push-button actuator, provided with an outlet-box and cover. It is intended for installation in door jambs to control lighting fixtures, typically in a closet.

**Fixture switch** – a switch installed in the enclosure of a fixture such as a luminaire, a fan or the like.

**Flush switch** – a switch provided with a mounting yoke or integral flush device cover plate and intended for installation in or on an outlet box intended to control a branch circuit.

**Pendant switch** – a switch intended to be installed at the end of a flexible cord for use in branch-circuit pendant applications.

**Self-contained switch** – a switch intended for flush mounting without a separate outlet box for connection to one or more nonmetallic sheathed cables containing copper conductors.

**Surface switch** – a switch provided with a separable base and cover primarily intended for branch-circuit installation on exposed wiring consisting of open wiring on insulators or nonmetallic sheathed cable.

**Terminal, insulation displacement** – a terminal having a contacting member that forces the conductor insulation aside and presses against the side of the conductor to make contact.

**Terminal, pin-type** – a terminal having a contact pin that punctures the conductor insulation to contact the current-carrying conductor.

**Terminal, pressure-wire** – a terminal where the conductor is clamped under a pressure plate or saddle by one or more screws or nuts.

**Terminal, push-in** a terminal where the stripped end of a conductor is pushed into the terminal and the clamping pressure is maintained by a spring mechanism, without the use of screws.

**Terminal, set-screw** – a terminal where the clamping pressure is applied by the end of the screw bearing directly on the conductor.

**Terminal, wire-binding screw** – a terminal in which the conductor is bent around the screw and is clamped directly under the head of the screw when it is tightened.

**Through-cord switch** a switch intended to be installed along the length of flexible cord such as for use in power-supply cords or cord sets.

## 3 General

### 3.1 New Product Evaluation

3.1.1 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

### 3.2 Components

3.2.1 Except as indicated in 3.2.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Appendix A for a list of Standards covering components generally used in the products covered by this Standard. A component shall comply with the Canadian Standards Association or the Underwriters Laboratories Inc., standards as appropriate for the country where the product is to be used.

3.2.2 A component need not comply with a specific requirement that:

a) involves a feature or characteristic not needed in the application of the component in the product covered by this Standard; or

b) is superseded by a requirement in this Standard.

3.2.3 A component shall be used in accordance with its ratings for the intended conditions of use.

3.2.4 Specific components are accepted as being incomplete in construction features, or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as temperatures not exceeding specified limits, and shall be used only under those specified conditions for which they have been investigated.

### 3.3 Units of Measurement

3.3.1 If a value for measurement is followed by a value in other units in parenthesis, the second value may be only approximate. The first stated value is the requirement.

### 3.4 Reference Publications

3.4.1 Where reference is made to other publications, such reference shall be considered to refer to the latest edition and all amendments published to that edition up to the time when this Standard was approved.

**UL Standards**

UL 50,
*Enclosures for Electrical Equipment;*

UL 94,
*Tests for Flammability of Plastic Materials for Parts in Devices and Appliances;*

UL 486E,
*Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors;*

UL 508,
*Industrial Control Equipment;*

UL 514A,
*Metallic Outlet Boxes;*

UL 514C,
*Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers;*

UL 746A,
*Polymeric Materials–Short Term Property Evaluations;*

UL 746B,
*Polymeric Materials–Long Term Property Evaluations;*

UL 746C,
*Polymeric Materials – Use in Electrical Equipment Evaluations;*

UL 894,
*Switches for Use in Hazardous (Classified) Locations;*

UL 917,
*Clock-Operated Switches;*

UL 1054,
*Special-Use Switches;*

UL 1472,
*Solid-State Dimming Controls (Bi-National CSA C22.2 No. 184.1-96);*

UL 1567,
*Receptacles and Switches Intended for Use with Aluminum Wire;*

UL 1917,
*Solid-State Fan Speed Controls.*

**CSA Standards**

C22.1-1998,
*Canadia Electrical Code, Part 1;*

CAN/CSA C22.2 No. 0-M91 (R1997),
*General Requirements – Canadian Electrical Code, Part II;*

CAN/CSA C22.2 No. 0.17-92 (R1997),
*Evaluation of Properties of Polymeric Materials;*

C22.2 No. 14-95,
*Industrial Control Equipment;*

C22.2 No. 18-97,
*Outlet Boxes, Conduit Boxes, and Fittings;*

C22.2 No. 42-M1984 (R1996),
*General Use Receptacles, Attachment Plugs, and Similar Wiring Devices;*

C22.2 No. 55-M1986 (R1992),
*Special Use Switches;*

CAN/CSA C22.2 No. 94-M91 (R1997),
*Special Purpose Enclosures;*

C22.2 No. 111-M1986 (R1992),
*General-Use Switches;*

C22.2 No. 156-M1987 (R1993),
*Solid-State Speed Controls;*

C22.2 No. 159-M1987 (R1993),
*Attachment Plugs, Receptacles, and Similar Wiring Devices for Use in Hazardous Locations: Class I, Groups A, B, C, and D; Class II, Group G, in Coal or Coke Dust, and in Gaseous Mines;*

CAN/CSA C22.2 No. 177-92 (R1997),
*Clock-Operated Switches;*

C22.2 No. 184.1-96,
*Solid State Dimming Controls.*

3.4.2 Where reference is made to the following publications not under the jurisdiction of UL or of the CSA Steering Committee on the Canadian Electrical Code, Part II, such reference shall be considered to refer to the edition listed below:

**CGSB Standard (Canadian General Standard Board)**

7-GP-7M-1978,
*Cotton, Absorbent, Sterile, and Nonsterile.*

**ASTM Standard (American Society for Testing and Materials)**

E28-99,
*Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus.*

**National Fire Protection Association (NFPA)**

NFPA 70,
*National Electrical Code.*

## 4 Construction

### 4.1 Enclosure

4.1.1 Switches shall be provided with complete enclosures that house all live parts, except that switches designed to be installed in device boxes or cut-out boxes or intended specifically for use in devices where they will be so enclosed as to prevent the exposure of live parts to accidental contact, need not be provided with such enclosures.

4.1.2 A key-operated switch shall be constructed so that a 0.8 mm (1/32 inch) diameter steel wire can not be inserted into the key slot so as to contact live parts.

4.1.3 A metal enclosure of a switch (such as the cover of a surface-type switch or the shell of a fixture or pendant-type switch) shall be not less than 0.33 mm (0.013 inch) thick. Heavier metal shall be employed to provide strength and rigidity if the switch is rated more than 5 A, 250 V; 10 A, 125 V; or if the size or shape of the enclosure warrants such increased metal thickness.

4.1.4 A nipple (male or female) through which wires may pass shall have not less than five full, clean-cut threads of standard pitch as indicated in Table 1. The wireway provided by the nipple shall be free from burrs, fins, sharp edges, and the like that can damage wiring.

**Table 1**
**Threading for nipples**
**(see Clause 4.1.4)**

| Pipe trade size, inch | Threading per inch |
|---|---|
| 1/8 | 27 threads |
| 1/4 | 18 |
| 3/8 | 18 |
| 1/2 | 14 |
| 3/4 | 14 |

4.1.5 A nipple that is not integral with the body of a switch shall be secured to prevent turning relative to the enclosure, and to provide mechanical strength equivalent to that of a unit piece.

4.1.6 A female nipple in a fixture-type switch shall be provided with a No. 8 - 40 setscrew.

*Exception: The setscrew may be omitted in the nipple of a fixture-type switch if the nipple is of the 1/2 inch or larger pipe size, has a tapered thread, and is intended to be tightened with a wrench.*

4.1.7 A threaded nipple for attachment to rigid metal conduit of the 1/2 inch or larger trade size shall be provided with a positive end stop for the conduit and a bushing, or an equivalent smooth, well-rounded surface, to prevent damage to wiring that enters the switch enclosure from the conduit.

*Exception: Providing a positive end stop and bushing shall not be required for a hole tapped for rigid metal conduit in the wall of an outlet box or equivalent enclosure that is provided with a switch.*

4.1.8 A switch intended to be exposed to a specific environment shall comply with the requirements of the Standard for Enclosures for Electrical Equipment, UL 50 or CSA C22.2. No. 94, Special Purpose Enclosures.

4.1.9 A through-cord switch shall be provided with two distinct holes to accept and pass through the intended flexible cord. If a through-cord type switch is provided with one hole and provisions such as a knock out, the device is considered to be a pendant switch

4.1.10 A door switch shall be provided with an outlet box and cover plate. The outlet box and cover plate shall comply with the performance requirements of either the Standard for Metallic Outlet Boxes, UL 514A, or the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, as appropriate, or Outlet Boxes, Conduit Boxes, and Fittings, C22.2 No. 18.

## 4.2 Lining

4.2.1 If a part of the enclosure of a switch is removable for wiring and is wholly or partly of conductive material, the inside surface of all such conductive material shall be lined completely with insulation not less than 0.71 mm (0.028 inch) thick.

*Exception: The lining of a fixture switch may be less than 0.71 mm (0.028 inch) thick but not less than 0.33 mm (0.013 inch) thick.*

4.2.2 An insulating lining shall be secured so that it will remain in place under conditions of intended service, and shall prevent the enclosure from becoming a live part even if a wire inside the switch should become loose or detached from its termination. The lining of the cover of a surface-type switch shall extend beyond the edge of the cover.

4.2.3 In switches having molded covers protected by a metal armor, the armor may be flush with the cover if the construction of the switch is such that the armor is not likely to make contact with any live parts when the cover is being put in place on the switch.

## 4.3 Bushings and Strain Relief

4.3.1 The cord-inlet hole in a pendant or through-cord switch that has a metal enclosure shall be provided with an insulating bushing or the equivalent. The material of the bushing shall be of porcelain, phenolic, or cold-molded composition, or other insulating material determined to be acceptable for the purpose.

4.3.2 Hard fiber may be provided as the insulating material if the bushing is not less than 1.19 mm (0.047 inch) thick and if it is formed and secured in place so that it will not be affected by conditions of ordinary moisture.

4.3.3 A threaded insulating bushing shall not be used in a threaded nipple to form a pendant switch if the pipe size of the nipple is smaller than 3/8 inch.

4.3.4 A pendant or through-cord switch shall have provision for strain relief so that a pull exerted on the flexible cord cannot be transmitted directly to wiring terminals. If space is provided within the switch enclosure for a strain-relief knot, all parts of the enclosure on which the cord can touch shall be smooth and well-insulated.

4.3.5 A metal cord grip may be provided on a pendant switch intended particularly for use with jacketed flexible cord, such as Type S or SJ, if the diameter of the cord-inlet hole is not less than 7.9 mm (0.31 inch).

## 4.4 Bases and Bodies

4.4.1 General

4.4.1.1 A base or body in or on which live parts are mounted shall be of insulating material determined to be acceptable for the particular application. See Clauses 4.6.2 and 4.6.3.

4.4.1.2 A hole for the entrance of wire in a base intended for surface mounting shall be as indicated in Table 2.

**Table 2**
**Holes for entrance of wire**
**(see Clause 4.4.1.2)**

| Switch rating A | Diameter of smallest hole that may be provided mm (inch) |
|---|---|
| 0 – 15 | 5.6 (0.219) |
| 16 – 25 | 6.4 (0.250) |
| 26 – 35 | 7.1 (0.281) |

4.4.1.3 A sub-base for a surface-type switch for use with open wiring shall be constructed so that it will separate the wires leading to the switch not less than 13 mm (1/2 inch) from the surface wired over. A sub-base shall be of insulating material determined to be acceptable for the purpose.

4.4.2 Means for Mounting

4.4.2.1 A base intended for surface mounting shall have two or more holes for mounting screws, and a base with an area of more than 0.016 $m^2$ (25 $inch^2$) shall have three or more holes for mounting screws. A mounting-screw hole shall be countersunk not less than 3 mm (1/8 inch) in the material of the base; and there shall be a spacing over the surface of insulating material, between the head of the screw or washer, and the nearest uninsulated live part, in accordance with 4.8.1.

4.4.2.2 A flush switch shall be provided with means for mounting in a standard flush-device box or on a standard outlet-box cover in accordance with Clause 4.10, Provisions for Grounding. Flush-type switches rated 347 V shall be provided with means for mounting in a specific-use box having tapped holes, spaced on 89.69 mm (3-17/32 inch) centers, that are intended for the mounting of the switch. The mounting screws for a switch that is intended for mounting in a standard flush-device box shall be #6 - 32 and shall be spaced 83.34 mm (3-9/32 inch) apart.

4.4.2.3 A metal yoke, strap, or mounting ears shall not be less than 1.02 mm (0.040 inch) or more than 2.3 mm (0.09 inch) thick. If a nonferrous metal is used, it shall be of sufficient thickness to provide mechanical strength and rigidity not less than that of 1.02 mm (0.040 inch) thick steel. The yoke,strap,or mounting ears may be provided with extension plaster ears, which may be scored so that they can be broken off if not needed.

4.4.2.4 If a yoke, mounting ears, or strap as described in Clause 4.4.2.3 is made of steel, the corrosion protection for a switch for use in a flush-device box or on an outlet-box cover shall be a zinc or equivalent coating not less than 0.0038 mm (0.00015 inch) thick in accordance with the method for determining protection against corrosion in the Standard for Metallic Outlet Boxes, UL 514A, or CAN/CSA C22.2 No. 0, General Requirements - Canadian Electrical Code, Part II, or other coatings determined to be acceptable for the particular application.

4.4.2.5 A nonmetallic yoke, strap, or mounting ears shall be of a material and construction determined to be acceptable for the intended use.

4.4.2.6 A screw provided for use in mounting the switch to an outlet box or other enclosure shall project not more than 22 mm (7/8 inch) beyond the strap or cover and shall have a flat or blunt end. The end of the screw shall have no burrs, fins, or sharp edges that can damage wiring. This does not preclude thread-cleaning slots or grooves in the end of a screw.

4.4.3 Sealing

4.4.3.1 Live screw heads or nuts on the underside of a base intended for surface mounting shall be covered with a waterproof, insulating sealing compound with a softening point of 65°C (149°F) or higher. If such parts are spaced not less than 6 mm (1/4 inch) through-air from the mounting surface and are staked, upset, or otherwise reliably prevented from loosening, sealing compound need not be provided.

4.4.3.2 Sulphur shall not be used as a sealing material.

4.4.3.3 Determination of the softening point of a sealing compound shall be made in accordance with the test method specified in ASTM, E 28-99, Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus.

## 4.5 Current-Carrying Parts

4.5.1 General

4.5.1.1 Current-carrying parts and wire-binding nuts and screws shall be of metal and shall have the strength, rigidity, and ampacity to comply with the requirements outlined in Clauses 4.2 – 4.5.

*Exception No. 1: A switching contact in a general-use ac switch shall not be of copper, copper alloy, steel, or other material that is likely to corrode in service so as to adversely affect the switch performance, particularly the heating.*

*Exception No. 2: A corrosion-resistant (stainless) steel alloy may be used for hermetically sealed switching contacts and for other current-carrying parts not subject to arcing.*

4.5.1.2 Current-carrying parts shall not be permitted to be iron or steel, plain or plated.

*Exception No. 1: Current-carrying parts may be made of sheet steel clad on both surfaces with copper in the thickness ratio of 10 percent copper, 80 percent steel, and 10 percent copper, and with all cut edges coated with zinc, or an equivalent coating if the applicable overload and endurance tests show that the parts are not subject to arcing.*

*Exception No. 2: Steel that is corrosion-resistant (stainless) or steel that is protected against corrosion by zinc plating, or an equivalent coating, may be used for grounding terminals, wire-binding nuts, clamps, and screws.*

4.5.2 Live Parts

4.5.2.1 Uninsulated live parts shall be secured in place so that turning will not adversely affect performance and so that there is no likelihood of a reduction in spacings to values less than the minimum required spacings specified in Table 6. Contact jaws shall be prevented from turning or shifting in position by means other than friction between surfaces.

4.5.2.2 Except for a wiring terminal, an uninsulated live part mounted on insulating material that wiring can touch shall be recessed into the insulating material so that the wiring cannot touch the live part.

4.5.3 Terminals and Leads

4.5.3.1 Switches shall be provided with wire leads or wiring terminals for the connection of conductors that have an ampacity not less than the maximum current rating of the switch. Wire-binding screws shall be as specified in Clause 4.5.3.8.

4.5.3.2 The means for connection of conductors shall be one of the following:

a) Positive binding-screw pressure on a bared conductor plus upturned lugs or the equivalent to retain the wire under the screw head;

b) Soldering, welding, riveting, or crimping; or

c) Other means may be used if shown to be acceptable for the purpose by tests to determine the adequacy of the current-carrying ability and mechanical features of the connecting means. See Clause 4.5.3.3.

4.5.3.3 A push-in (screwless) terminal shall comply with the performance requirements in Push-In Terminal Tests, Clause 5.10, and shall be:

a) For use only with a solid copper conductor,

b) For a current-carrying connection only, not for grounding; and

c) Marked as indicated in Clause 7.2.2.

4.5.3.4 Push-in terminals intended for use on branch circuit wiring shall be designed so that they will permit the use of a solid No. 14 AWG conductor but will reject a No 12 AWG or larger solid conductor. The opening provided for the conductor shall reject a No. 48 drill rod, 1.981 ±0.0076 mm (0.076 ±0.0003 inch) in diameter. The rod shall be applied with 22 N (5 lbf). Openings, other than those intended for wire termination, such as wire release openings, shall not permit electrical contact to be made with a No. 14 AWG conductor.

4.5.3.5 A switch employing ″push-in″ terminations may be provided with a means to release the conductors. Where an opening in the insulating body is provided for such purpose, behind the plane of the mounting means, it shall not permit entry of a No. 14 AWG solid conductor. The wire release means, if provided, shall be subject to the Push-In Terminal Tests, Clause 5.10.

4.5.3.6 A release mechanism shall be located or guarded so that it cannot be unintentionally actuated during installation. The release mechanism may be guarded by recessing, ribs, barriers, or the like.

4.5.3.7 Switches having terminals of a set screw type shall meet the performance requirements for copper conductors AWG sizes 14, 12, and 10 as specified in UL 486E or CSA C22.2 No. 65.

4.5.3.8 The minimum sizes of wire-binding screws used in making electrical connections shall conform to Table 3.

**Table 3**
**Minimum sizes of wire binding screws**
**(see Clause 4.5.3.8, 4.10.6)**

| Rating of switch A | Minimum size of screw | Minimum head diameter | Maximum number of threads per inch |
|---|---|---|---|
| 20 or less | #6 | 0.275 inch | 36 |
| 20 or less | M3.5 | 7.0 mm | – |
| 30 | #8 | 0.315 inch | 32 |
| 30 | M4 | 8.0 mm | – |

4.5.3.9 A terminal plate for a soldering lug or pressure wire connector shall not be less than 0.76 mm (0.030 inch) thick, and the tapped hole shall not have less than two full threads in the metal for a terminal screw.

4.5.3.10 A terminal plate for a wire-binding screw shall be of metal not less than 0.76 mm (0.030 inch) thick, and the tapped hole shall not have less than two full threads in the metal.

4.5.3.11 In a terminal plate formed from stock which has the minimum required thickness, as given in Clauses 4.5.3.9 and 4.5.3.10, the metal may be extruded at the tapped hole for the binding screw to provide two full threads, provided that the thickness of the original metal is not less than the pitch of the thread.

4.5.3.12 With reference to the requirements in Clauses 4.5.3.9 and 4.5.3.10, metal not less than 1.52 mm (0.060 inch) thick may be used for a tapped hole for a screw having 32 threads per inch.

4.5.3.13 A wire-binding screw shall thread into metal.

4.5.3.14 Switches intended for mounting in outlet boxes shall have their terminals located or protected so that they will not be pressed, in normal assembly, against the wiring in the box when the switches are installed.

4.5.3.15 Exposed-back wiring terminals shall not be used on a general-use switch intended for installation in a flush-device box, but may be used on a switch intended specifically for mounting in a box that is to be supported by rigid metal conduit, or on a surface-type switch mounted in or on (integral with) an outlet-box cover.

4.5.3.16 Copper or copper alloy terminal parts that come into contact with branch-circuit conductors, other than the grounding conductor, shall not have a coating of zinc or cadmium.

4.5.3.17 Wire leads provided on a switch shall be insulated conductors of a type suitable for the purpose and not less than 100 mm (4 inch) in length. The ampacity of the leads shall be not less than the maximum current rating of the switch.

*Exception No. 1: If provided, a grounding conductor may be a bare solid copper wire, or if insulated, the insulation shall be green with or without one or more yellow stripes. The length of a grounding lead shall not be less than 150 mm (6 inches).*

*Exception No. 2: The length of the leads is not specified for a fixture switch intended to be incorporated in a wiring harness provided the harness and fixture switch are assembled at the same factory.*

4.5.3.18 The wire leads of a general-use switch shall be made of copper and not be smaller in size than indicated in Table 4.

*Exception: Leads provided for external connection of a pilot light or other signal or sensing circuits in a switch may be No. 18 AWG or larger, regardless of the switch rating.*

**Table 4**
**Minimum sizes of switch leads**
**(see Clause 4.5.3.18, 4.10.7)**

| Current rating of switch A | Copper supply leads AWG | Copper grounding leads AWG |
|---|---|---|
| 0 – 6 | 18 | 18 |
| 6.1 – 10 | 16 | 16 |
| 10.1 – 15 | 14 | 14 |
| 15.1 – 20 | 12 | 12 |
| 20.1 – 30 | 10 | 10 |
| 30.1 – 40 | 8 | 10 |
| 40.1 – 50 | 6 | 10 |
| 50.1 – 60 | 4 | 10 |

4.5.3.19 Pressure cable connectors included in the package of an individually packaged general-use snap switch employing wire leads shall be rated for the intended wire connections of the switch as identified by the switch manufacturer and rated for the size(s) and the number of wires expected to be joined. Switches shall comply with Clause 7.6.8.

4.5.3.20 In a general-use switch rated less than 30A and having provision for the connection of two or more conductors of the circuit (including an identified (grounded) conductor), one set of wiring terminals or leads shall be identified for the identified (grounded) conductor, unless the electrical connection between a pair of terminals intended to be connected to the identified (grounded) conductor is clearly evident, or unless (as in the case of a straight 2-pole switch) it does not make any difference to which set of terminals the identified (grounded) conductor is connected.

4.5.3.21 If identification of wiring terminals is necessary, a terminal for the connection of an identified (grounded) conductor shall be identified by one of the following means:

a) Being covered with a white metallic coating;

b) Being made of metal substantially white in color; or

c) Having the word ″white″ or ″W″ marked on or directly adjacently to the terminal.

Other terminals shall be readily distinguishable. See also Clause 4.5.3.23.

4.5.3.22 The white-colored head of a wire-binding screw that is not readily removable from its terminal plate, and that does not appear to relate to other part, may serve as the terminal identification specified in Clause 4.5.3.21.

4.5.3.23 If the terminal that is plated white to comply with Clause 4.5.3.21 is not visible, the wire-entrance hole for connection to that terminal shall be marked with the word ″white″ or the letter ″W″, or colored white directly adjacent to the hole.

4.5.3.24 The identification of leads shall be in accordance with Table 5.

**Table 5**
**Polarity identification of leads**
**(see Clause 4.5.3.24)**

| Identification obtained by | Acceptable combinations[a] | |
|---|---|---|
| | Identified (Grounded) conductor (unswitched leads) | All other conductors (switched leads) |
| Color of braid[b] | Solid white or natural grey (without tracer)<br><br>Color other than white, natural grey, or green, with tracer in braid | White or natural grey with tracer in braid<br>or<br>Solid color other than white, natural grey, or green (without tracer) |
| Color of insulation[b] | Solid white or natural grey, stripe, white or natural grey, on contrasting color other than green | Solid color other than white, natural grey, or green |
| Color of separator[b] | Solid white or natural grey | Solid color other than white, natural grey, or green |
| Conductor tinning[c] | Tin or other acceptable metal on all strands of the conductor | No tin or other white metal on the strands of the conductor |

[a] A bare solid copper wire, or green wire, with or without one or more yellow stripes, shall be used only as an equipment grounding conductor.

[b] If color of braid, insulation, or separator is used for identification, all conductors shall either be tinned or not tinned.

[c] If conductor tinning is used for identification, all braids and/or insulation shall have the same color and shape.

## 4.6 Insulating Material

4.6.1 Insulating materials shall be judged with reference to the particular form, size, and purpose of the parts for which they are used, the manner of their assembly, and their location and security in the switch.

4.6.2 Insulating material in contact with current-carrying members shall be recognized as suitable for the particular application, and may include certain ceramic, thermoset, thermoplastic, and elastomeric materials.

4.6.3 Vulcanized fiber may be used for insulating washers, separators, and barriers, but not for the sole support of live parts.

4.6.4 A switch intended for use in a flush-device box or on an outlet-box cover shall employ insulating materials described in Clause 4.6.5 that have been investigated and determined to have a comparative tracking index of at least 175 V in accordance with the method for determining the comparative tracking index of solid insulating material under moist conditions, in the Standard for Polymeric Materials - Short Term Property Evaluations, UL 746A (Performance Level Category of 3 or better), or Evaluation of Properties of Polymeric Materials C22.2 No. 0.17.

4.6.5 The insulating materials referred to in Clause 4.6.4 are those used for the sole support of live parts, maintenance of electrical spacings, or the prevention of arcing between live parts.

4.6.6 In Canada, insulating materials in contact with current-carrying members of switches shall have a flammability classification of V-2 or better in accordance with CSA Standard C22.2 No. 0.17, in a thickness of 1.6 mm or in the minimum thickness in contact with that current-carrying member, whichever thickness is greater.

4.6.7 In Canada, as an alternative to the requirement of Clause 4.6.6, a thermosetting material, such as phenolic, melamine, or urea may be used as an insulating material in contact with current-carrying members of switches provided that material has the following characteristics:

a) The flammability classification is HB or better in accordance with CSA Standard C22.2 No. 0.17; and

b) The relative thermal index, mechanical without impact, is a minimum of 100°C in accordance with CSA Standard C22.2 No. 0.17.

## 4.7 Actuating Members

4.7.1 Actuating members may be made of insulating material. If of metal, they shall be either insulated from current-carrying parts or covered, where otherwise exposed to personal contact, with suitable insulating material. See also Clause 4.6.2 with regard to type of insulation required.

4.7.2 An actuating member of other than thermoset insulating material shall comply with Clause 5.11.

## 4.8 Creepage Distances, Clearances, and Distances Through Sealing Compounds

4.8.1 Creepage distances, clearances, and distances through sealing compounds shall not be less than the values shown in Table 6.

4.8.2 For a flush switch, a barrier boss, shoulder, recessing, or similar means may be employed to provide the minimum creepage distances and clearances between any uninsulated live part and the wall of a flush-device box in which the switch may be mounted.

4.8.3 Compliance is checked by measurement.

4.8.4 A flush switch without integral wire leads shall be wired with the following solid copper wires connected to each terminal: No. 14, 12, and 10 AWG sizes for switches having 15 ampere (or less), 20 ampere, and 30 ampere ratings, respectively.

4.8.5 A flush switch shall be mounted in a metal gauge that simulates a flush-device box, as shown in Figure 1.

4.8.6 External switch clearances to the box gauge's walls are to be checked with the switch mounted in any position permitted by the mounting screws and holes.

4.8.7 A dead metal screw head, rivet, or the like shall not be considered exposed to contact by persons after the switch is installed in the intended manner, if the dead metal is located in a hole not more than 7.1 mm (9/32 inch) in diameter and recessed not less than 4.8 mm (3/16 inch) in the clear.

4.8.8 In measuring a creepage distance or clearance, an isolated dead metal part interposed between uninsulated live parts of different polarity, or between an uninsulated live part and an identified (grounded) or exposed dead metal part, reduces the creepage distance or clearance by an amount equal to the dimension of the isolated dead metal part in the direction of the measurement.

4.8.9 In measuring a creepage distance or clearance between non-arcing live parts of different polarity in a pilot or locator switch, the wire lead separation of a current-limited lamp-and-resistor assembly at points on the same side of the current-limiting resistor shall not be considered as reducing the creepage distance or clearance.

4.8.10 An indicating device, such as an ohmmeter, a battery-and-buzzer combination, or the like, shall be used to determine that continuity between the switch terminal(s) and the gauge does not exist with the switch mounted in any position permitted.

## Table 6
## Creepage distances, clearances, and distances through sealing compounds

| Description | mm | inch |
|---|---|---|
| Creepage distances and clearances | | |
| Between non-arcing live parts, with the exception of terminals, of different polarity | | |
| Between non-arcing live parts, with the exception of terminals, and identified (grounded) material | | |
| Between non-arcing live parts, with the exception of terminals, and accessible dead metal parts, with the exception of a recessed screw head, rivet, or the like (see Clause 4.8) | | |
| Between terminals of different polarity | | |
| Between terminals and identified (grounded) metal parts, or dead metal parts likely to be identified (grounded) | | |
| Between terminals and accessible dead metal parts, with the exception of a recessed screw head, rivet, or the like (see Clause 4.8) | | |
| ac/dc switches rated 250V or less | 1.2 | 3/64 |
| ac/dc switches rated greater than 250V to 600V | 3.2 | 1/8 |
| ac-only switches rated 300V ac or less | 1.2 | 3/64 |
| ac-only switches rated greater than 300V ac | 3.2 | 1/8 |
| self-contained switches | 1.6 | 1/16 |
| Clearances | | |
| Between non-arcing live parts and metal flush-device cover plates | | |
| ac/dc switches | 3.2 | 1/8 |
| ac-only switches rated 300V ac or less | 3.2 | 1/8 |
| ac-only switches rated greater than 300V ac | 6.4 | 1/4 |
| Self contained switches | | |
| Between non-arcing live parts and the surface on which the base of a surface switch mounts | 3.2 | 1/8 |
| Distances through insulating sealing compound | | |
| Between non-arcing live parts covered with at least 1.6 mm (1/16 inch) of sealing compound and the surface on which the base of a surface switch mounts | 3.0 | 0.118 |

## 4.9 Assembly

4.9.1 General

4.9.1.1 A switch shall be capable of being readily wired as intended.

4.9.1.2 Sealing, staking, or an equivalent means shall be employed so that screws, upon which the general assembly of a switch depends, cannot loosen or back out.

4.9.1.3 An assembly screw that must be loosened or removed in order to wire or install a switch shall be capable of being tightened with a torque of 0.68 N-m (6 lbf-in), without impairing the serviceability of the assembly means.

4.9.2 AC/DC Fixture Switch

4.9.2.1 The chain of an ac/dc fixture switch having a pull-type mechanism shall not become energized external to the enclosure, the external non-current-carrying parts of the fixture switch shall not become live, nor shall the chain cause the mechanism to jam when the chain is suddenly and completely released after having been pulled to the full ″on″ position and the full ″off″ position.

4.9.2.2 An AC/DC fixture switch having pull-type switch mechanisms shall have the operating means in the form of:

a) A cord made of suitable insulating material;

b) A chain with a link of suitable insulating material, connected to the metal chain as close as possible to where the chain emerges from the enclosure and that complies with the dielectric and mechanical strength test in Clauses 5.13.2.3 and 5.13.2.4; or

c) A metal chain without an external insulating link, provided that the complete assembly complies with the dielectric voltage-withstand test outlined in Clause 5.8.

4.9.3 Insulating Links

4.9.3.1 An insulating link shall be designed for ready attachment to the conventional metal chain employed in pull-type fixture switch.

4.9.3.2 An insulating link shall be so constructed that there is a distance over the surface of the insulating material of not less than 12.7 mm (1/2 inch).

4.9.4 Pendant and Through-Cord Switch

4.9.4.1 A pendant or through-cord switch provided with pin terminals shall be capable of being assembled to the flexible cord types for which it is intended to be used. The switch shall physically exclude flexible cord types for which it is not intended. A switch intended for use with any group of flexible cords similar in appearance shall be capable of use with all such types unless the cords are distinguishable by marking or are physically excluded by the switch construction. See Clause 7.1.5.

## 4.10 Provision for Grounding

4.10.1 A flush-type switch intended for mounting in a flush-device box shall be constructed so that a metal flush plate will be bonded to an grounded outlet box when installed in the intended manner.

4.10.2 A flush-type switch that is provided with either a grounding terminal or lead shall comply with the requirements described in Clauses 4.5.3.1, 4.5.3.2, and 4.5.3.8 – 4.5.3.19. The construction shall also conductively connect a metal flush device cover plate to the grounding terminal or lead.

4.10.3 Insulating material provided to separate the switch arcing chamber from the metal mounting yoke or metal flush plate shall be permanently secured to the flush switch. The flush plate mounting screws, when in place, shall not touch any part of the switch that is live. Switch assembly parts, such as assembly screws or flush plate screws, if of conductive material, shall not enter the switch arcing chamber or protrude into the outlet box, beyond the back of the switch.

4.10.4 If a device is provided with a grounding terminal, it shall be identified by one of the means identified in Table 7.

4.10.5 A part relied upon to provide the terminal identification required in Table 7 shall not be readily removable. A suitably staked terminal screw shall be considered to comply with this requirement.

4.10.6 The minimum size and the maximum number of threads per inch of a wire-binding screw shall comply with Table 3.

4.10.7 If the device is provided with a grounding lead, it shall be made of copper and not be smaller in size than indicated in Table 4.

## Table 7
## Identification of the grounding terminal

| Identification by | Grounding terminal | All other terminals |
|---|---|---|
| Wire-binding screw | Hexagonal, green-colored nut[a] or slotted screw head[a] | Other than white or green circular screw head |
| Pressure wire terminal visible | Green-colored connector, screw or appendage[a] | Other than white- or green-colored connector |
| Pressure wire teminal concealed | Distinct green-colored area adjacent to wire entrance hole or the word ″green″ or ″ground″, the letters ″G″ or ″GR″[b] or the grounding symbol distinctively marked adjacent to wire entrance hole[d] | Other than white or green area adjacent to wire entrance hole |
| Terminal plate | | Other than white or green metal or plating |
| Insulating enclosure or terminal | The word ″green″ or ″ground″, the letters ″G″ or ″GR″ or the grounding symbol marked on or directly adjacent to terminal[d]<br>or<br>Green-colored terminal | Other than white- or green-colored terminal |
| Color of braid[c] | Solid color green (without tracer) | Solid color other than white, natural grey, or green (without tracer) |
| Color of insulation[c] | A bare solid copper wire, or green wire with or without one or more yellow stripes | Solid color other than white, natural grey, or green |
| Color of separator[c] | Solid color green | Solid color other than white, natural grey, or green |

[a] The screw should not be readily removable; see Clause 4.10.5.

[b] In letters minimum 1.6 mm (1/16 inch) high.

[c] If color of braid, insulation, or separator is used for identification, all conductors shall be either tinned or not tinned.

[d] See Figure 5 – for the grounding symbol.

## 5 Testing

### 5.1 General

5.1.1 A switch shall be investigated by subjecting it to the tests described in Clauses 5.2.1 – 5.2.11. Unless otherwise specified, one set of 6 devices shall be used during this test program. See also Clause 4.5.1.

5.1.2 A switch that has a horsepower rating or ratings in addition to a current rating shall be subjected to overload tests for both horsepower and current ratings, unless it is obvious that one would represent the other. If both overload tests are conducted, each test for a horsepower rating shall be conducted on a separate set of 6 devices.

### 5.2 Test Sequence

5.2.1 The test sequence for a switch shall be as listed in Clauses 5.2.2 – 5.2.11.

5.2.2 AC/DC door switch testing

| | Reference |
|---|---|
| a) Overload | 5.6.1, 5.6.2 |
| b) Endurance No.1 (inductive) | 5.7.1, 5.7.2 |
| c) Endurance No.2 (tungsten) | 5.7.3 |
| d) Temperature | 5.8.1 |
| e) Dielectric | 5.9.1 |
| f) Security of leads | 5.10 |
| g) Pull-out/push-in terminals | 5.11.1, 5.11.2 |
| h) Temperature/push-in terminals | 5.11.3 – 5.11.8 |
| i) Resistance to heat (70°C) | 5.17 |
| j) Effect of heat on actuating members | 5.12 |

5.2.3 AC-only door switch testing

| | Reference |
|---|---|
| a) Overload | 5.6.8 – 5.6.12 |
| b) Endurance (inductive) | 5.7.7 |
| c) Endurance (tungsten) | 5.7.9 |
| d) Temperature | 5.8.1 |
| e) Dielectric | 5.9.1 |
| f) Security of leads | 5.10 |
| g) Pull-out/push-in terminals | 5.11.1, 5.11.2 |
| h) Temperature/push-in terminals | 5.11.3 – 5.11.8 |
| i) Resistance to heat (70°C) | 5.17 |
| j) Effect of heat on actuating members | 5.12 |

5.2.4 AC/DC pendant switch testing

| | Reference |
|---|---|
| a) Overload | 5.6.1, 5.6.2 |
| b) Endurance No. 1 (resistive) | 5.7.1 – 5.7.6 |
| c) Endurance No. 2 (tungsten) | 5.7.3 |
| d) Temperature | 5.8.1 |
| e) Dielectric | 5.9.1 |
| f) Effect of heat on actuating members | 5.12 |
| g) Assembly | 5.4 |

| | |
|---|---|
| h) Temperature (15-day)* | 5.8.2 |
| i) Dielectric* | 5.9.2 |
| j) Strain relief | 5.14 |
| k) Fault current* | 5.15 |
| l) Crushing* | 5.16 |
| m) Resistance to heat (70°C) | 5.17 |

*Pin-type terminals only

5.2.5 AC-only pendant switch testing

| | Reference |
|---|---|
| a) Contact gap (check) | 5.13.1.2 |
| b) Overload | 5.6.8 – 5.6.12 |
| c) Endurance No.1 (resistive) | 5.7.6 |
| d) Endurance No. 2 (inductive) | 5.7.7 |
| e) Endurance No. 3 (tungsten) | 5.7.9 |
| f) Temperature | 5.8.1 |
| g) Contact gap (repeated) | 5.13.1.2 |
| h) Dielectric | 5.9.1 |
| i) Effect of heat on actuating members | 5.12 |
| j) Assembly | 5.4 |
| k) Temperature (15-day)* | 5.8.2 |
| l) Dielectric* | 5.9.2 |
| m) Strain relief | 5.14 |
| n) Fault current* | 5.15 |
| o) Crushing* | 5.16 |
| p) Resistance to heat (70°C) | 5.17 |

*Pin-type terminals only

5.2.6 AC/DC through-cord switch testing

| | Reference |
|---|---|
| a) Overload | 5.6.1, 5.6.2 |
| b) Endurance No. 1 (resistive) | 5.7.1 – 5.7.6 |
| c) Endurance No. 2 (tungsten) | 5.7.3 |
| d) Temperature | 5.8.1 |
| e) Dielectric | 5.9.1 |
| f) Effect of heat on actuating members | 5.12 |
| g) Assembly | 5.4 |
| h) Temperature (15-day)* | 5.8.2 |
| i) Dielectric* | 5.9.2 |
| j) Strain relief | 5.14 |
| k) Fault current* | 5.15 |
| l) Crushing* | 5.16 |
| m) Resistance to heat (70°C) | 5.17 |

*Pin-type terminals only

5.2.7 AC-only through-cord switch testing

| | Reference |
|---|---|
| a) Contact gap (check) | 5.13.1.2 |
| b) Overload | 5.6.8 – 5.6.12 |
| c) Endurance No. 1 (inductive) | 5.7.7 |
| d) Endurance No. 2 (tungsten) | 5.7.9 |
| e) Temperature | 5.8.1 |
| f) Contact gap (repeated) | 5.13.1.2 |
| g) Dielectric | 5.9.1 |
| h) Effect of heat on actuating members | 5.12 |
| i) Assembly | 5.4 |
| j) Temperature (15-day)* | 5.8.2 |
| k) Dielectric* | 5.9.2 |
| l) Strain relief | 5.14 |
| m) Fault current* | 5.15 |
| n) Crushing* | 5.16 |
| o) Resistance to heat (70°C) | 5.17 |

*Pin-type terminals only

5.2.8 AC/DC fixture switch testing

| | Reference |
|---|---|
| a) Overload | 5.6.1, 5.6.2 |
| b) Endurance No. 1 (resistive) | 5.7.1 – 5.7.6 |
| c) Endurance No. 2 (tungsten) | 5.7.3 |
| d) Temperature | 5.8.1 |
| e) Dielectric | 5.9.1 |
| f) Security of Leads | 5.10 |
| g) Pull-out/push-in terminals | 5.11.1, 5.11.2 |
| h) Temperature/push-in terminals | 5.11.3 – 5.11.8 |
| i) Effect of heat on actuating members | 5.12 |
| j) Resistance to heat (70°C) | 5.17 |

5.2.9 AC/DC flush switches and ac/dc surface switch testing

| | Reference |
|---|---|
| a) Overload | 5.6.1, 5.6.2 |
| b) Endurance No. 1 (resistive) | 5.7.1 – 5.7.6 |
| c) Endurance No. 2 (tungsten) | 5.7.3 |
| d) Temperature | 5.8.1 |
| e) Dielectric | 5.9.1 |
| f) Security of leads | 5.10 |
| g) Pull-out/push-in terminals | 5.11.1, 5.11.2 |
| h) Temperature/push-in terminals | 5.11.3 – 5.11.8 |
| i) Effect of heat on actuating members | 5.12 |
| j) Resistance to heat (70°C) | 5.17 |

5.2.10 AC only flush switch testing

| | Reference |
|---|---|
| a) Contact gap | 5.13.1.2 |
| b) Overload | 5.6.8 – 5.6.12 |
| c) Endurance No. 1 (resistive) | 5.7.6 |
| d) Endurance No. 2 (inductive) | 5.7.7 |

| | |
|---|---|
| e) Endurance No. 3 (tungsten) | 5.7.9 |
| f) Temperature | 5.8.1 |
| g) Contact gap (repeated) | 5.13.1.2 |
| h) Dielectric | 5.9.1 |
| i) Security of leads | 5.10 |
| j) Pull-out/push-in terminals | 5.11.1, 5.11.2 |
| k) Temperature/push-in terminals | 5.11.3 – 5.11.8 |
| l) Effect of heat on actuating members | 5.12 |
| m) Resistance to heat (70°C) | 5.17 |

5.2.11 Self-contained switch testing

| | Reference |
|---|---|
| a) Contact gap | 5.13.1.2 |
| b) Overload | 5.6.8 – 5.6.12 |
| c) Endurance No. 1 (resistive) | 5.7.6 |
| d) Endurance No. 2 (inductive) | 5.7.7 |
| e) Endurance No. 3 (tungsten) | 5.7.9 |
| f) Temperature | 5.8.1 |
| g) Contact gap (repeated) | 5.13.1.2 |
| h) Dielectric | 5.9.1 |
| i) Security of leads | 5.10 |
| j) Pull-out/push-in terminals | 5.11.1, 5.11.2 |
| k) Temperature/push-in terminals | 5.11.3 – 5.11.8 |
| l) Effect of heat on actuating members | 5.12 |
| m) Heat cycling and vibration | 8.3.2.1.1 – 8.3.2.4.1 |
| n) Cable pullout | 8.3.3.1, 8.3.3.2 |
| o) Mounting strength | 8.3.5.1.1, 8.3.5.2.1 |
| p) Panel mount | 8.3.5.2.1 |
| q) Mounting bracket | 8.3.5.3.1 |
| r) Field replacement | 8.3.6.1, 8.3.6.2 |
| s) Fault current | 8.3.7.1, 8.3.7.2 |
| t) Knockout | 8.3.8.1, 8.3.8.2 |
| u) Creep | 8.3.9.1, 8.3.9.2 |
| v) Mold stress (90°C) | 8.3.10.1, 8.3.10.2 |
| w) Flammability | 8.3.11.1 – 8.3.11.3 |

5.2.12 For ratings other than those specified for ratings B and D in Table 15, overload and endurance tests conducted at the highest voltage may represent tests at lower voltage of the same frequency if volt-amperes at the high voltage are the same as, or more than, volt-amperes at the lower voltages. Overload and endurance tests at the higher voltage for ratings B and D in Table 15 represent the lower voltage. The temperature test shall be conducted at the highest ampere rating that the test represents.

5.2.13 A switch in which there are two or more ″on″ and ″off″ positions of the switch mechanism shall be tested under conditions representing those of actual service, including the position or positions that involve making and breaking the maximum current.

5.2.14 Each set of contacts of a three-way switch shall be subjected to the required overload test. This may be accomplished by wiring two switches to control a single load as in actual service and operating the switches so that both sets of contacts of both switches are tested.

5.2.15 For three-way switches subjected to the endurance test, each of three devices shall be tested with one set of contacts making and breaking the required test current. Each of three others shall be tested with the other set of contacts making and breaking the circuit.

5.2.16 Each set of contacts of a four-way switch shall be subjected to the required overload test. This may be accomplished by wiring the switch in conjunction with two three-way switches as in actual service and operating the switches so that all four sets of contacts of the four-way switch are tested.

5.2.17 Of the six four-way switches subjected to the endurance test, four shall be connected differently so that their operation for 6000 cycles (10,000 for each test of a general-use ac switch) will result in testing each of the four possible combinations of contacts with respect to making and breaking the required test current. Each set of contacts of the other two switches shall be subjected to 1500 cycles of operation (2500 for each test of a general-use ac switch) making and breaking the required test current, which may be accomplished by wiring and operating each switch as described in Clause 5.2.16.

5.2.18 A general-use ac/dc switch shall be subjected to the overload and endurance tests with direct current and with a noninductive resistance load.

5.2.19 During the overload and endurance tests, all dead metal parts of the switch that are exposed to user contact, including the intended mounting surface, shall be connected through a 15 A fuse to earth ground or to the neutral (identified or grounded) conductor of the test circuit. This shall be accomplished in accordance with Clause 5.2.20. A switch shall be tested with a properly installed metal faceplate or the equivalent.

5.2.20 The fuse shall be of a type and voltage rating intended for branch-circuit protection. The potential rating of the fuse shall be equal to or greater than the maximum potential from the switch to the point at which the dead metal parts and intended mounting surface are connected. The connection shall be such that:

a) On a direct-current circuit, dead metal parts are positive with respect to the nearer arcing point in the switch; and

b) The potential between live parts and conductive dead metal parts is the full test potential.

*Exception: Switches rated 250 V that are not marked as indicated in Clause 7.1.3 may be tested with one-half the test potential between live parts and conductive dead metal parts. The neutral or identified (grounded) conductor of a 125/250 V test circuit shall not be derived from a 2-wire, 250 V circuit by tapping off at the midpoint of resistors in series across the circuit.*

5.2.21 If tests are conducted using alternating current, the circuit frequency shall be the same as the rated frequency of the switch or, if no frequency is indicated, 60 Hz alternating current shall be used. In either case, a lower frequency may be employed if agreeable to those concerned.

*Exception: A switch rated 50 Hz shall be tested on a 60 Hz circuit, except that the currents used for the overload and endurance tests shall be 120 percent of the current that would have been used had this switch been tested in a 50 Hz circuit.*

5.2.22 In testing a switch, a cycle of operation shall include operation of the switch from the ″off″ position through every electrical position of the switch, and back to the ″off″ position.

5.2.23 A switching mechanism shall not be adjust-ed, lubricated, or otherwise conditioned either before or during any test.

*Exception: Switching mechanisms may be lubricated if it is done by the manufacturer during the manufacturing process.*

5.2.24 With reference to Clause 5.2.18, a noninductive load may consist of any convenient combination of carbon-filament lamps or resistors, or both, which will cause the required current to flow through the test circuit, and which will have a power factor of 0.98 – 1.0 at 60 Hz. The power factor may be lower if agreeable to those concerned.

5.2.25 The reactive components of an inductive load for testing a switch for either an ampere or horsepower ac rating shall not be in parallel with other reactances or resistances, except that an air-core reactor in any phase shall be shunted by resistance ($R_{SH}$) in which the power loss is approximately 1 percent of the total power consumption in that phase, calculated in accordance with the following formula:

$$R_{SH} = 100\left(\frac{1}{PF} - PF\right)\frac{E}{I}$$

*in which:*

*PF is the power factor,*

*E is the closed-circuit phase voltage, and*

*I is the phase current.*

Parallel individual loads made up of resistance and inductive-reactance components connected in series may be used if the power factor of the parallel loads are equivalent.

### 5.3 Tungsten-Filament-Lamp Load Characteristics

5.3.1 The test circuit, including the generator or other source of supply for a switch with a tungsten-filament-lamp load rating for use on direct current, shall provide a current inrush through the switch and load of not less than eight times the normal current when the circuit is closed on a 20 A load, and the circuit shall be such that peak value of the inrush current will be reached within 1/240 of a second after the circuit is closed. If a synthetic load is employed, its characteristics shall, in addition, be such that the current-inrush factor is not less than eight times the rated current of the switch or the peak values indicated in Table 8 when tested to the corresponding current.

*Exception: If the required inrush current is available for a lower current rating with testing limited to such rating, a tungsten-filament-lamp load and the supply circuit need not be sufficient for the 20 A load test described above*

5.3.2 The test circuit, including the generator or other source of supply for a switch with a tungsten-filament-lamp load rating used on alternating current, shall provide a peak current inrush through the switch and load not less than the value given in Table 8 when the circuit is closed on a load corresponding to a rating equal to or greater than the rating of the switch, and the circuit shall be such that the highest value of the inrush current will be reached within 1/240 of a second after the circuit is closed.

*Exception: If the required inrush current is available for a lower current rating with testing limited to such rating, a tungsten-filament-lamp load and the supply circuit need not be sufficient for the 20 A load test described above.*

**Table 8**
**Tungsten-filament-lamp load test ciruit characteristics**

| Steady-state current (rms), amperes | Minimum inrush current (peak), amperes |
|---|---|
| 1 | 18 |
| 2 | 35 |
| 3 | 51 |
| 5 | 78 |
| 10 | 141 |
| 15 | 191 |
| 20 | 226 |

5.3.3 A synthetic load and a combination synthetic and tungsten-filament-lamp load used to simulate a tungsten-filament-lamp load for testing on alternating current shall be investigated as described in Clauses 5.3.4 and 5.3.9, and also with respect to special conditions that are introduced by use on alternating current.

5.3.4 The acceptability of a test circuit, including the generator or other source of supply, for testing with tungsten-filament lamps shall be determined by means of oscillograph studies. If the circuit is tested at a normal (steady-state) current flow of 20 A and inrush currents as indicated in Table 9 are recorded, the test circuit shall be considered to have the capacity for testing switches rated up to and including 60 A. With reference to a 60 Hz timing wave, the peak values of inrush current as shown by oscillograms shall be reached within 1/4 cycle.

5.3.5 The characteristics of a direct-current test circuit shall be determined from a number of oscillograms (12 or more), and testing equipment shall be acceptable if not less than half the oscillograms show at least the minimum current-inrush factor.

5.3.6 The characteristics of an alternating current test circuit shall also be determined from a number of oscillograms (12 or more). Those which indicate that the current is decreasing (that the part of the sinewave in question is approaching the zero point) should be disregarded. Twelve or more oscillograms taken at other points on the sinewave should indicate whether the capacity of the test circuit can produce the minimum required current-inrush factor, based on observed peak values.

5.3.7 If tungsten-filament lamps are used as the load for a switch intended for use with such lamps, the load shall consist of the smallest possible number of lamps having standard ratings. In determining the smallest number of lamps necessary, the maximum lamp size required shall be 500 W. Larger lamps may be used if desired. The operating cycle shall be such that the lamps are off for at least 55 seconds of each test cycle. If a switch is operated at the rate of 10 cycles per minute, at least 10 banks of lamps controlled by a commutator shall be necessary for each switch under test.

5.3.8 A synthetic load may be used instead of tungsten-filament lamps. The synthetic load may consist of noninductive resistors if they are connected and controlled so that a portion of the resistance is shunted during the closing of the switch under test, or if a portion of the load is cut out prior to opening the switch. A synthetic load may also consist of a noninductive resistor or resistors and a capacitor in parallel, in which case the load shall be calibrated immediately after the capacitor has been charged and discharged in the usual manner. A combination load consisting of tungsten-filament lamps and resistors and/or capacitor shall be considered a synthetic load.

5.3.9 The acceptability of a test circuit (including the generator or other source of supply) for testing with a synthetic load shall be determined in a manner similar to that described in Clause 5.3.6, consideration being given to the provision of higher current-inrush factors with the lower current loads, as required in Clause 5.3.1.

5.3.10 A synthetic load shall be calibrated against and shall be equivalent to a tungsten-filament-lamp load in the test circuit. The calibration of a synthetic load shall be checked at intervals to determine that none of the constants of the circuit or load change with time or use.

5.3.11 The characteristics of a synthetic load shall be such that the inrush current will be as specified in Clauses 5.3.1 – 5.3.3. In addition, the current in the capacitor/resistance load or the combination load mentioned in Clause 5.3.8 shall not be less than half the required inrush current at 1/60 second and not less than twice the steady-state current at 7/120 second after the circuit is closed; the current in a straight resistance load shall be the full inrush value for a minimum of 15 milliseconds after the circuit is closed

## 5.4 Assembly Test

5.4.1 A pendant or through-cord switch shall be capable of assembly to the flexible cords with which it is intended to be used without damage to the housing, terminals, or contacts, separation of the device body, or any other damage that may increase the risk of fire or electric shock.

5.4.2 Devices shall be assembled using the maximum and minimum size of each type of flexible cord that the switch can physically accommodate, following the instructions provided by the manufacturer. The switch need not be tested on flexible cord types and sizes that are specifically excluded from use in the installation instructions. See Clause 7.1.5.

5.4.3 A switch intended for use on No. 18 AWG Types SP-1 or SPT-1 flexible cord shall be assembled to No. 18 AWG Type SPT-1 cord with the following dimensions:

a) A cord with a maximum width of 5.21 mm (0.205 inch) and a maximum overall thickness of 2.79 mm (0.110 inch); and

b) A cord with a minimum overall width of 5.33 mm (0.210 inch).

*Exception: Consideration shall be given to the effects of anticipated variations of insulation thickness of other types of flexible cord.*

5.4.4 Each assembly shall be made on a 0.6 m (2 ft) length of flexible cord. A pendant switch shall be assembled at one end of the flexible cord. A through-cord switch shall be assembled in the center of the cord.

5.4.5 The assemblies shall then be subjected to the following tests:

a) Six assemblies using each size and type of flexible cord shall be subjected to the temperature test described in Clause 5.8.2, and then subjected to the dielectric voltage-withstand test in Clause 5.9.2.

b) Twelve assemblies using each size and type of flexible cord shall be subjected to the strain relief test described in Clause 5.14.

c) Six assemblies using each size and type of flexible cord shall be subjected to the fault current test described in Clause 5.15.

d) Six assemblies using each size and type of flexible cord shall be subjected to the crushing test described in Clause 5.16.

### 5.5 Test Conditions

5.5.1 During the overload, and all endurance tests, a switch shall be connected to a load (as described in the applicable test method) and, except as noted in Clauses 5.7.3 and 5.7.9, to a supply circuit, the voltage of which is within 5 percent of the rated voltage of the switch. The capacity of the test circuit shall be such that the potential across the load, measured at or adjacent to the switch, will have the required value when the switch under test is closed in the circuit with the required test current flowing.

5.5.2 A flush switch that is intended for mounting in an outlet box shall be mounted with a metal flush plate or equivalent metal surface in position over the switch.

5.5.3 With reference to the requirement in Clause 5.5.1, it is impracticable to describe the details of connections that must be made in order to obtain all operating conditions because of the different arrangements of terminals of switches of various makes. In any case, however, the connections to a switch in the test circuit shall be such that the load controlled will have the same position, relative to the switch and the supply, that it will have in actual service, except that both 2-circuit and 3-circuit switches may be tested as single-pole devices.

5.5.4 The switch shall be connected in the test circuit between the supply mains and the load.

5.5.5 A lower power factor, a lower frequency, and a greater rate of operation than those specified in the performance clause of these requirements may be employed if agreeable to those concerned and if it is not a less severe condition of test.

### 5.6 Overload Test

5.6.1 After being subjected to the applicable overload test, a general-use ac/dc switch shall be electrically and mechanically operable. At the conclusion of the test, the switch shall be capable of performing its intended function and shall show no wear, loosening of parts, or defects of any other description that will diminish the usefulness and reliability of the switch. The fuse described in Clause 5.2.20 and 5.2.21 shall not open at the conclusion of this test.

5.6.2 A general-use ac/dc switch shall be operated manually by means of its actuating member for 50 cycles at a rate of 6 – 10 cycles per minute, making and breaking the required test current. The rate of speed of operation may be greater than 10 cycles per minute if agreeable to those concerned. If the switch rating is 10 A or less, the test current shall be 150 percent of the rated current. If the switch rating is more than 10 A, the test current shall be 125 percent of the rated current.

5.6.3 A switch rated in horsepower and intended for use in dc circuits only shall be subjected with an overload test for 50 cycles at the rate of 6 – 10 cycles/min with dc and a noninductive load so that the switch makes and breaks an overload current of the value given in Table 9, equal to 10 times the full load current of a motor of the horsepower rating in question.

**Table 9**
**Overload-test currents for dc switches with horsepower ratings**
**(see Clause 5.6.3)**

| Switch rating, hp | 125 V | 250 V | 600 V |
|---|---|---|---|
| 1/10 | 20.0 A | 10.0 A | – |
| 1/8 | 22.0 | 11.0 | – |
| 1/6 | 24.0 | 12.0 | – |
| 1/4 | 30.0 | 15.0 | – |
| 1/3 | 38.0 | 19.0 | – |
| 1/2 | 54.0 | 27.0 | – |
| 3/4 | 74.0 | 37.0 | 16.0 A |
| 1 | 96.0 | 48.0 | 20.0 |
| 1-1/2 | 132.0 | 66.0 | 27.0 |
| 2 | 170.0 | 85.0 | 36.0 |

5.6.4 A switch rated in horsepower for use on ac circuits only shall be subjected to an overload test for 50 cycles at the rate of 6 – 10 cycles/min with ac and an inductive load so that the switch makes and breaks an overload current of the value given in Table 10 or 11, and having a power factor of 0.40 – 0.50, except that a lower power factor may be used with the agreement of those concerned.

5.6.5 A switch rated in horsepower and intended for use on direct as well as alternating current shall comply with the applicable requirements when tested with alternating current as well as direct current, with different devices used for the ac and dc tests.

5.6.6 If a switch has horsepower ratings at more than one voltage, a test shall be conducted at the overload current corresponding to the horsepower rating at the highest voltage. An additional test shall be conducted at the highest overload current value corresponding to a horsepower rating at any lower voltage if that current is more than 135 percent of the overload current involved at the maximum voltage rating. The greater current involved at a lower voltage may necessitate a separate heating test. If more than one test is made, three devices shall be used for each test.

**Table 10**
**Single phase overload-test current for ac switches with horsepower ratings**
**(see Clause 5.6.4)**

| Switch rating in horsepower | 120 Vac | 240 Vac |
|---|---|---|
| 1/10 | 18.0 | 9.0 |
| 1/8 | 22.8 | 11.4 |
| 1/6 | 26.4 | 13.2 |
| 1/4 | 34.8 | 17.4 |
| 1/3 | 43.2 | 21.6 |
| 1/2 | 58.8 | 29.4 |
| 3/4 | 82.8 | 41.4 |
| 1 | 96.0 | 48.0 |
| 1-1/2 | 120.0 | 60.0 |
| 2 | 144.0 | 72.0 |

**Table 11**
**2- and 3-phase overload-test current for ac switches with horsepower ratings**
**(see Clause 5.6.4)**

| Switch rating in horsepower | 120 Vac | | 240 Vac | | 480 Vac | | 600 Vac | |
|---|---|---|---|---|---|---|---|---|
| | Motor Designations | | Motor Designations | | Motor Designations | | Motor Designations | |
| | B, C, D | E | B, C, D | E | B, C, D | E | B, C, D | E |
| 1/2 | 40 | 40 | 20 | 20 | 10 | 10 | 8 | 8 |
| 3/4 | 50 | 50 | 25 | 25 | 12.5 | 12.5 | 10 | 10 |
| 1 | 60 | 60 | 30 | 30 | 15 | 15 | 12 | 12 |
| 1-1/2 | 80 | 80 | 40 | 40 | 20 | 20 | 16 | 16 |
| 2 | 100 | 100 | 50 | 50 | 25 | 25 | 20 | 20 |

5.6.7 An overload test of a switch in a three-phase circuit shall be representative of performance of the switch in a two-phase circuit of the same voltage, for the same horsepower rating.

5.6.8 After being subjected to the overload test described in Clauses 5.6.9 – 5.6.12, a general-use ac switch shall be electrically and mechanically operable. At the conclusion of the test, the switch shall be capable of performing its intended function and shall show no wear, loosening of parts, or defects of any other description which will diminish the usefulness and reliability of the switch.

*Exception: Switches rated 347 V ac shall be subjected to the overload tests in Clauses 5.6.9, 5.6.10 and 5.6.12, except that power factor shall be 0.75 – 0.80. If the rated current of the switch is 15 A, the test current shall be 150% of the rated current. If the rated current of the switch is more than 15 A, the test current shall be 125% of the rated current.*

5.6.9 The test shall consist of 100 cycles of operation at a rate of 6 – 10 cycles per minute, and the on time for each cycle shall be not more than 1 second. The load shall be inductive, with a power factor of 0.40 – 0.50. A load with a lower power factor may be employed if agreeable to all concerned.

5.6.10 A switch with a single voltage rating shall be tested at that voltage, at 4.8 times the rated current.

5.6.11 A switch with multiple voltage ratings and a single current rating shall be tested at the highest rated voltage, at 4.8 times the rated current.

5.6.12 In the case of any switch with multiple current ratings, half the devices shall be tested at the highest voltage, and half shall be tested at the lowest voltage. The test in each case shall be made at 4.8 times the rated current corresponding to the voltage at which the device is being tested.

## 5.7 Endurance Test

5.7.1 After being subjected to the endurance test described in Clause 5.7.2, an ampere-rated general-use ac/dc switch or a combined ampere rated and horse power rated (ac/dc) switch shall be mechanically and electrically operable. At the conclusion of the test, the switch shall be capable of performing its intended function and shall show no wear, loosening of parts, or defects of any other description that will diminish the usefulness and reliability of the switch. Also, the fuse described in Clause 5.2.20 and 5.2.21 shall not open at the conclusion of this test.

5.7.2 A switch shall be operated by means of its actuating member either manually or by a machine for 6000 cycles of operation at a rate of 6 – 10 cycles per minute, making and breaking its rated current. The rate of operation may be greater than 10 cycles per minute, but should not exceed 20 cycles/minute, if agreeable to those concerned.

5.7.3 A general-use ac/dc switch intended for the control of tungsten-filament lamps shall be operated for an additional 6000 cycles following the endurance test specified in Clause 5.7.2, making and breaking a direct-current circuit, with a load of tungsten-filament lamps or a load having equivalent current characteristics, and adjusted so that the normal current flow is the rated current of the switch. The open-circuit potential of the test circuit shall be 120 ±5 V, and the closed-circuit potential at the load with normal current flowing shall be within 5 percent of the open-circuit potential.

5.7.4 Except for 347 V ac-rated switches, an ac-rated switch that has been subjected to the three endurance tests described in Clauses 5.7.5 – 5.7.8, shall be electrically and mechanically operable. At the conclusion of the test, the switch shall be capable of performing its intended function and shall show no wear, loosening of parts, or defects of any other description that will diminish the usefulness and reliability of the switch.

5.7.5 A switch shall be operated by means of its actuating member, either manually or by a suitable machine. It shall be operated at the specified cyclic rate, except that where the rate of operation specified introduces a condition that could not occur in normal use, the switch may be operated at a reduced rate.

5.7.6 The first test shall consist of 10,000 cycles of operation, controlling rated current at maximum rated voltage, at a rate of operation of 18 – 24 cycles per minute. The load shall be noninductive, with a power factor of 0.98 – 1.0 at 60 Hz. The power factor may be lower if agreeable to those concerned.

*Exception: An ac only through-cord switch shall not be required to comply.*

5.7.7 The second test shall consist of 10,000 cycles of operation, at a rate of operation of 18 – 24 cycles per minute, controlling rated current at maximum rated voltage. The load shall be inductive, with a power factor of 0.75 – 0.80.

*Exception: For ac-only through-cord switch or ac-only door switch rated in amperes, the number of cycles shall be 6000.*

5.7.8 An ac switch rated 347 V ac or an ac switch marked as specified in Clause 7.6.10 shall be subjected to the endurance tests in Clauses 5.7.6 and 5.7.7, except that the number of cycles in Clause 5.7.7 shall be 20,000.

5.7.9 The third test shall consist of 10,000 cycles of operation, controlling a tungsten-lamp (or equivalent) load with rated current at 120 V, at a rate of operation of 6 – 10 cycles per minute. The open-circuit potential of the test circuit shall be 120 ±5 V, and the closed-circuit potential at the load with normal (steady-state) current flowing shall be within 5 percent of the open-circuit potential.

*Exception: For an ac-only door switch or ac-only through-cord switch, the number of cycles shall be 6000.*

## 5.8 Temperature Test

5.8.1 General

5.8.1.1 A switch shall carry continuously the maximum rated current for which it was tested, in any ″on″ position, without showing greater rise in temperature than 30°C (54°F) on the wiring terminals; on a device with wire leads, the temperature shall be measured 6 – 12 mm (0.24 – 0.47 inch) from the surface of the enclosure of the wire leads of switches provided with leads. See Clause 5.2.12.

5.8.1.2 The temperature test described in Clause 5.8.1.1 may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

5.8.1.3 A switch having one or more push-in (screwless) terminals shall also comply with Clause 5.11.3.

5.8.1.4 As indicated in Clause 5.2, the temperature test shall always follow the endurance test. If there is any question regarding the ability of a switch to pass the temperature test before the blades and contacts have been worked in, the test may also be conducted following the overload test and prior to the endurance test.

5.8.1.5 To determine whether a switch complies with the requirements in Clause 5.8.1.1, the switch shall carry its maximum rated current continuously until constant temperatures are attained on the plates of wiring terminals or on wire leads used instead of wiring terminals. Unless the switch is provided with attached leads, connections to the switch shall be made with fixture or building wire in lengths not less than 305 mm (12 inches) having 0.76 mm (30 mils) or greater average thickness of thermoplastic insulation rated for 60°C (140°F) and of the size indicated in Table 12. The temperature test shall be conducted in open air at any convenient voltage, using either alternating or direct current.

**Table 12**
**Wire size for temperature test**

| Test current, A | Wire size, AWG |
|---|---|
| 0.0 – 6 | 18 |
| 6.1 – 10 | 16 |
| 10.1 – 15 | 14 |
| 15.1 – 20 | 12 |
| 20.1 – 30 | 10 |
| 30.1 – 45 | 8* |
| 45.1 – 60 | 6* |

*In Canada, compact wire shall be used.

5.8.1.6 Temperature readings shall be obtained by using thermocouples consisting of No. 28 – 32 AWG iron and constantan wires. Measurements shall be made on the terminals outside the switch enclosure but adjacent thereto. If a switch has wire leads, the measurements shall be made on the copper conductors at the point of entrance of the leads to the switch. A temperature shall be considered to be constant when three successive readings, taken at 5-minute intervals, indicate no change.

5.8.2 Pendant and Through-Cord Switches with Pin terminals

5.8.2.1 The temperature rise of a switch with pin terminals shall be not more than 30°C (54°F) when tested as described in Clauses 5.8.2.2 and 5.8.2.3.

5.8.2.2 The assemblies specified in Clause 5.4.5 shall be connected in a series circuit and subjected to a test current equal to the ampacity of the flexible cord size and type used in the assemblies. Thermocouples shall be attached to the bared copper conductors as close as possible to the point where the flexible cord enters the switch. All switch contacts shall be in the closed (″on″) position.

*Exception: The switch may be tested at its rated current if the current rating of the switch is less that the ampacity of the flexible cord*

5.8.2.3 The test shall continue for 15 days without interruption. The temperatures of each assembly shall be measured at the end of each working day.

## 5.9 Dielectric Voltage-Withstand Test

5.9.1 General

5.9.1.1 A switch shall withstand without breakdown a 50 – 60 Hz essentially sinusoidal potential applied as described in Clauses 5.9.1.2 and 5.9.1.3 for 1 minute between live parts of opposite polarity and between live parts and dead metal parts, with the switch at the maximum operating temperature reached in intended use. The test potential shall be as indicated in Table 13.

5.9.1.2 To determine that a switch complies with the requirements in Clause 5.9.1.1, the switch shall be tested by means of a 500 VA or larger capacity transformer whose output voltage is essentially sinusoidal and can be varied. The applied potential shall be increased from zero until the required test level is reached, and shall be held at that level for 1 minute. The increase in the applied potential shall be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

5.9.1.3 Compliance of switches with the foregoing requirements shall be determined by means of a suitable transformer of not less than 500 VA capacity, the output voltage of which can be regulated, except that the capacity may be less than 500 VA if there is a meter of not more than 2 percent error connected across the secondary terminals to directly measure the applied voltage. Starting from zero, the applied voltage shall be increased gradually and at a uniform rate until the required test value is reached or until breakdown occurs.

**Table 13**
**Dielectric strength test voltages**

| Switch rating, V | Test voltage, V |
|---|---|
| 120 – 300 V ac | 1500 |
| 301 – 600 V ac | 2 x rated + 1000 |
| 125 – 250 V ac/dc | 1000 |
| 251 – 600 V ac/dc | 2 x rated + 1000 |

5.9.2 Pendant and Through-Cord Switches with Pin Terminals

5.9.2.1 Immediately following the temperature test of Clause 5.8.2, the assembly of a cord and switch employing pin terminals shall be capable of withstanding, without breakdown, for a period of 1 minute, the application of a 60 Hz essentially sinusoidal potential of 1250 V between the two conductors of the flexible cord. For this test, three assemblies shall be selected from each set of those used for the temperature test, Clause 5.8.2.

5.9.2.2 The test potential shall be supplied from a 500 VA or larger capacity testing transformer whose output is essentially sinusoidal and can be varied. The applied potential shall be increased from zero until the required test voltage is reached, and shall be held at that voltage for a period of 1 minute. The increase in the applied potential shall be at a uniform rate and as rapid as is consistent with its value being correctly indicated by the voltmeter.

## 5.10 Security of Switch Leads Test

5.10.1 The connection of a lead wire to a switch shall be capable of withstanding without damage or disconnection from the terminal the application of a straight pull of 90 N (20 lbf) for a period of 1 min. The pull shall be applied gradually and in the direction most likely to cause failure.

## 5.11 Push-In Terminal Tests

5.11.1 A push-in (screwless) terminal shall withstand, without pull-out or breakage of the conductor, the application of a straight pull, applied for 1 minute and as further described in Clause 5.11.2.

5.11.2 No. 14 AWG conductors shall be connected to both terminals of one circuit in each of six devices in accordance with the manufacturer’s instructions. Each conductor shall be subjected to a gradual increasing pull maintained at 90 N (20 lbf) for 1 minute. Untested devices may be used for this test.

5.11.3 A push-in (screwless) terminal shall perform with a temperature rise of the attached conductor that shall not exceed 30°C (54°F), based on an ambient temperature of 25°C (77°F), with the terminal connection carrying maximum rated current of the switch.

5.11.4 Separate sets of six previously unused switches shall be assembled with solid copper wire, using No. 14 AWG. Internal components of the switches, including the switching mechanism, may be short-circuited by means of a soldered shunt.

5.11.5 The terminals of a switch employing a release mechanism shall be subjected to a conditioning regimen consisting of nine insertions and withdrawals of a conductor of the size and type to be used for the test. A tenth insertion of a newly stripped, previously unused length of wire shall be made and left in place for the test.

5.11.6 With the devices connected as described in Clauses 5.11.4 and 5.11.5, a current of 15A shall be passed through the assemblies.

5.11.7 The assemblies shall be continued under test for 30 days without interruption. Temperature values shall be measured at the end of each working day.

5.11.8 The test described in Clauses 5.11.4 – 5.11.7 may be conducted in conjunction with the temperature test, Clause 5.8.

## 5.12 Effect of Heat on Actuating Members Test

5.12.1 An actuating member of insulating material, other than thermoset material, shall not soften or become damaged when caused to operate the mechanism after being exposed to a temperature of 65 ±3°C (149 ±5°F).

5.12.2 To determine whether or not an actuating member complies with the requirement in Clause 5.12.1, the switch shall be subjected to a temperature of 65 ±3°C (149 ±5°F) until the insulating material under consideration is thoroughly heated (usually 1 hour in a constant-temperature oven). The actuating member shall then be operated manually (not controlling a load) and shall not be adversely affected to the extent that it is appreciably deformed or fails to operate the mechanism for 25 cycles of make and break. In conducting this test, the actuating member shall be operated with no more force or greater impact than would be the case in service. The test shall be conducted immediately after removal of each individual device from the oven.

## 5.13 Switching Mechanism Test

5.13.1 General

5.13.1.1 The switching contacts of a general-use switch for use on direct current as well as alternating current shall be such that the switching mechanism will trip free from the actuating member when the switch is operated – that is, the switch shall make and break the circuit with a quick snap by a blade or blades whose rate of motion, while the switch is actually making or breaking the circuit, cannot be affected by manipulation of the actuating member.

5.13.1.2 When the actuating force is removed from the actuating member of a general-use ac snap switch, the contacts shall:

a) With the actuator in the ″on″ position, make contact with sufficient pressure to comply with the temperature test, Clause 5.8; and

b) With the actuator in any position other than ″on″, be separated by a distance sufficient to withstand a 60 Hz essentially sinusoidal potential of 1500 V rms applied between them for 1 minute without breakdown.

5.13.1.3 The applied potential test mentioned in Clause 5.13.1.2(b) shall be made prior to the overload test, and shall be repeated at the conclusion of the heating test.

5.13.1.4 A three-way and a four-way switch shall be constructed so that they cannot be left in a position in which the circuits corresponding to both operating positions of the actuating member are on simultaneously.

5.13.2 AC/DC fixture switch with pull chain

5.13.2.1 General

5.13.2.1.1 The chain of 3 fixture switches are to be pulled to the ″off″ position and then released. This test shall be repeated a total of 5 times for each fixture switch. The chain shall not become energized and the mechanism shall not jam.

5.13.2.2 Dielectric Strength – Chain Mechanism Without External Insulating Link

5.13.2.2.1 Specimens of the switch shall be subjected to an ac voltage as outlined in Clause 5.9.

5.13.2.3 Dielectric Strength – Chain Mechanism with Insulating Link

5.13.2.3.1 An insulating link shall withstand without breakdown for a period of 1 minute the application of a 60 Hz essentially sinusoidal potential of 1500 V between metal chains attached to both ends, after the link has been exposed to a saturated moist atmosphere for a period of 48 hours.

5.13.2.3.2 Prior to testing, the insulating links shall be conditioned by exposure for 48 hours in a saturated moist atmosphere at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). The devices shall be suspended over water in a small, flat-bottomed vessel with a tight-fitting cover - the water to be about 12.7 mm (1/2 inch) deep and the devices to clear the water by 25.4 mm (1 inch) or more. The closed vessel containing the water and the suspended devices shall be placed in a controlled- temperature cabinet, with a free circulation of air around the vessel, and the temperature of the air within the cabinet shall be maintained at the value specified.

5.13.2.4 Mechanical Strength of Insulating Links Test

5.13.2.4.1 An insulating link shall withstand for a period of 1 minute a direct pull of 178 N (40 lbf) applied between the chain attachments at either end, except that, in the case of a factory-assembled link that is not detachable from the chain, the link shall not break before the chain breaks when the complete assembly is subjected to a direct pull of not more than 178 N (40 lbf) between the chains at either end.

5.13.2.4.2 Equipment for the mechanical-strength test shall consist of a pair of special connectors for the attachment of the two ends of an insulating link. Each connector shall consist of a 3.96 mm (0.156 inch) diameter steel rod with one end formed into a hook (for convenience in attaching it to a testing machine) and the other end machined to provide a sphere 3.25 mm (0.128 inch) in diameter (approximately the same as the ball section of the conventional chain). The steel between the sphere and the rod proper shall have a rectangular, 0.76 by 1.65 mm (0.03 by 0.065 inch), cross-section – the smaller dimension corresponding to the diameter of the dumbbell section of the chain. A connector shall be attached to each end of an insulating link, the assembly connected in a testing machine, and the load applied slowly and gradually until the force is 178 N (40 lbf). The load shall then to be held constant for 1 minute or until failure occurs.

## 5.14 Strain-Relief Test

5.14.1 When tested in accordance with this Clause, a pendant or through-cord switch shall not exhibit any:

a) Damage to the flexible cord insulation, nor any displacement of the flexible cord, cord conductors, or insulation exceeding 0.79 mm (1/32 inch);

b) Breakage of the switch that may effect the enclosure of live parts or the strain relief; or

c) Other damage that may increase the risk of fire or electrical shock.

5.14.2 The assemblies specified in Clause 5.4.5 shall be subjected to this test. Six of each type of assembly shall be tested as-received. In addition, if the device employs pin-type terminals, six shall be tested after conditioning in a full-draft circulating-air oven for 30 days at 67.0°C (153.0°F).

5.14.3 Each switch shall be securely supported by the body in a manner that will not restrict the motion of the flexible cord. The force specified in Table 14 shall be applied for one minute between the free ends of the flexible cord with the switch in between in the case of a through-cord switch and between the switch and the free end of the flexible cord in the case of a pendent type switch.

**Table 14**
**Strain-relief test values**

| Flexible cord size | Pull force, lbf (N) |
|---|---|
| Smaller than 18 AWG | 20 (89) |
| 18 AWG | 30 (133) |

## 5.15 Fault Current Test

5.15.1 When tested as described in this Clause, a pendant or through-cord switch that employs pin terminals shall not experience ignition of the switch enclosure, the flexible cord insulation, or a surrounding fire indicator. The switch contacts need not be able to function at the completion of this test.

5.15.2 The assemblies specified in Clause 5.4.5 shall be subjected to this test as follows:

a) Two of each assembly type as-received;

b) Two of each assembly type after being subjected to a 67N (15 lbf) pull force applied for one minute to the flexible cord along the major axis of the cord and perpendicular to the plane where the cord enters the switch; and

c) Two of each assembly type after being conditioned in an oven at 67°C (153°F) for 30 days.

5.15.3 Each assembly shall be connected into a circuit capable of drawing 1000 A when the system is short-circuited at the supply terminals. A standard, nonrenewable 20 A cartridge fuse or a thermal-type circuit breaker (calibrated and determined to meet the calibration requirements for circuit breakers) shall be connected in series with the assembly. The two conductors of the flexible cord shall be twisted together and soldered at one end. The switch contacts shall be in the closed (″on″) position before the fault current is applied.

### 5.16 Crushing Test

5.16.1 When tested as described in this Clause, a pendant or through-cord switch shall be capable of withstanding for a period of one minute a crushing force of 333 N (75 lbf) applied at right angles to the major axis of the body without complete permanent collapse, without damage to the switching mechanism, and without exposure of bare live parts to contact by the probe shown in Figure 2.

5.16.2 A device shall be laid flat on a slab of wood, such as maple, 12.7 mm (1/2 inch) thick, resting on a smooth steel plate suitably supported in a horizontal position. A round steel rod 19.1 mm (0.75 inch) in diameter shall be placed on the switch body at right angles to the longitudinal axis of the switch and midway between the points of contact of the ends of the switch body with its supporting surface, except that modifications shall be made where necessary so that the force is not applied to an actuating member. By means of weights, levers, or other suitable means, forces gradually increasing up to the required values shall be applied to the rod in a direction normal to the surface of the wood slab.

### 5.17 Resistance to Heat Test

5.17.1 As a result of oven conditioning, devices employing thermoplastic materials shall not have a change in any dimension greater than 10 percent nor any warpage creating an opening greater than 0.79 mm (1/32 inch) in any butt joint forming the enclosure of each device. Each device shall remain capable of functioning as intended.

5.17.2 The unwired devices shall be placed in a circulating air oven for 7 hours at 70°C (158°F). The devices shall be removed from the oven and allowed to cool to room temperature before determining compliance.

## 6 Ratings

6.1 Switches shall be rated in amperes and volts. In addition, they may be rated in horsepower.

6.2 The ampere rating of switches shall be one of the ratings given in Table 8. If ampere ratings are given at two voltages, the switch shall have both ratings and shall be capable of performing successfully at both ratings in accordance with the requirements of this Standard. If only one ampere rating is given, the switch shall have only that rating.

6.3 An ampere rating on a general-use switch marked for appliance use in addition to its standard rating shall be considered a special use rating. A switch with a special use rating shall be judged on the basis of its compliance with the requirements in this Standard, insofar as they apply, and further appropriate tests in accordance with the applicable requirements in the Standard for Special Use Switches, CSA C22.2 No. 55, or UL 1054.

6.4 A general-use ac/dc switch may have an additional ″T″ rating at 125 V if it has been tested as required for a switch intended for the control of tungsten-filament lamps operating on direct current with acceptable results.

6.5 For two-circuit and three-circuit switches (including fan-motor and double-throw switches), the ampere rating of the switch shall not be greater than the minimum rating of any single pair of contacts in the switch, unless the ampere rating of each pair of contacts is indicated on the switch.

6.6 The marked horsepower rating of a general-use ac/dc or ac-only switch shall be 1/10, 1/8, 1/6, 1/4, 1/3, 1/2, 3/4, 1, 1-1/2, 2 hp, or an appropriate combination of such values at different voltages.

6.7 The marked horsepower rating of a general-use ac/dc switch at any single voltage indicates that the switch is acceptable for that horsepower rating or less at that voltage only. If the switch is to be considered acceptable for any horsepower rating at another voltage, that horsepower and voltage rating shall also be marked on the switch.

6.8 Instead of the horsepower ratings in Clause 6.6, switches may be rated in full load current and locked rotor current not to exceed the horsepower rating permitted in this Standard for the equivalent ampere and voltage ratings of the switch.

6.9 An ac-only pendant switch shall be rated at 10, 15, 20, or 30 A at 120 V ac.

6.10 An ac-only door switch shall be rated either 3, 6, 10, or 15A at 120 V AC or in wattage as described in Clause 6.11.

6.11 An ac-only door switch if rated in wattage shall be rated minimum 300 W at 120 Vac only and marked as described in Clause 7.6.9.

6.12 An ac-only through-cord switch shall be rated at 1, 3, 6, 10 or 15A at 120V ac.

## 7 Markings

### 7.1 General

7.1.1 A general-use switch shall be permanently and legibly marked with the following:

a) The name, tradename, trademark, or other recognized symbol of the organization responsible for the product can be identified;

b) The electrical ratings; and

c) The catalog number or some suitable equivalent shall appear on the switch where practicable, or the smallest unit of package.

7.1.2 A general-use switch provided with No. 6 wire-binding terminal screw having heads less than 7.0 mm (0.276 inch) in diameter shall be marked, where readily visible during installation, No. 12 AWG maximum or the equivalent.

7.1.3 An AC/DC switch rated 250 V that has been tested with full potential to ground in accordance with Clause 5.2.21(b) shall be marked with the voltage rating 250 V(double underline).

7.1.4 The voltage rating of ac/dc switches rated 250 V that have been tested in accordance with the Exception to Clause 5.2.21(b) shall neither be underlined nor shall the switch be marked to indicate that they have been tested at full potential to ground.

7.1.5 A pendant or through-cord switch intended for assembly on flexible cord shall be provided with the following information, on the device or on its individual unit shipping carton:

a) The intended types of flexible cord, (such as Types S, SJ, SJT, HPN, SPT, and the like). The cord identification may refer to the generic names for each family of cords (such as Hard Service Cord, Vacuum Cleaner Cord, Parallel Cord, and the like), if all types of cords identified in the family can be utilized with the device;

b) The conductor size or sizes;

c) The total number of conductors; and

d) The overall cord diameter range, if the device is intended to be utilized within a limited range of the cord diameters available for a cord type.

*Exception: If the switches are to be shipped for OEM assembly with more than one unit to a carton, the information may be provided on a stuffer sheet or on the smallest shipping carton.*

7.1.6 The markings mentioned in Clause 7.1.5 may be combined in an abbreviated format (such as wire sizes 18/3 SV to 14/3 SJ, 0.230–0.450 inch diameter). The conductor sizes, total number of conductors, and overall diameters may be included individually or as a range with the appropriate cord types. Optionally, a wiring gauge in the form of die-punched holes or printed outlines may be included on the smallest unit carton.

7.1.7 In addition to the markings otherwise required, a pendant or through-cord switch that is made with pin-type (screwless) terminals intended for assembly on a flexible cord shall be provided with an instruction card. The switch shall be attached to the card in such fashion that it cannot be accidentally removed or torn free from the device during shipment, distribution, or normal handling. A blister package or an equivalent means of securing the material to the device may be used. Friction alone shall not be used for attaching the wiring device to an instruction card. The card shall be marked with:

a) Instructions for assembling the device to the cord. Details shall be provided, which may include pictorial representation, to enable proper assembly by an inexperienced person.

b) The word ″CAUTION″ and the following or the equivalent: ″To reduce the risk of fire or electric shock, do not strip wires - Cut off end of cord cleanly,″ and any other specific instructions concerning cord preparation.

c) Instructions concerning the cord type or types to be used. A description shall be provided of any type of cord that may not be physically excluded but which is not intended to be used (for example, ″Not for use with Type TPT extra-flexible cord such as used on electric shavers″). There are some cord groups that are not distinguishable by marking and, where one of these cords is recommended, all must be capable of proper use or be physically excluded. Refer to Clause 4.9.4.1.

d) Electrical rating (in volts and amperes or watts, as applicable) corresponding to the ampacity of the cord, if the current rating of the switch is greater than or equal to the ampacity of the cord. If more than one size or type of cord is intended to be used, the electrical rating shall be as indicated for each type cord. Any cord ampacity rating included in these instructions shall not be in excess of the switch rating.

*Exception: Pendant or through-cord switches employing pin-type (screwless) terminals that are packed for OEM assembly and that are not field-wireable need not be provided with individual instruction cards. The above required information may be provided on the smallest unit shipping carton, which shall be additionally marked "For OEM Assembly On Flexible Cords Only."*

### 7.2 Supplementary Markings

7.2.1 In addition to the ratings given in Table 15, a general-use ac switch may be marked with a supplementary rating as follows: "For motor loads of (A) full load amps. max. and not more than (B) or equivalent." The values of (A) and (B) to be inserted in the above statement shall be in accordance with Table 16. The marking shall appear on the switch, on a tag attached to the switch, on the smallest unit carton, or on a sheet packaged with each switch.

**Table 15**
**Switch ampere ratings for various voltages**
**(see Clause 5.2.12, 7.2.1)**

| AC-only rating | | | AC/DC rating | | | |
|---|---|---|---|---|---|---|
| | | | Ampere rating, A voltage, dc | | | |
| Ampere rating A | Voltage ac, V | Maximum full load motor current A | Rating designation | 125 V | 250 V | 600 V |
| 15 | 120 | 12 | A | – | – | 1 |
| 20 | 120 | 16 | B[c] | 3[d] | 1[d] | – |
| 30 | 120 | 24 | C | – | – | 2 |
| 15 | 120 – 277[b] | 12 | D[c] | 5[d] | 2[d] | – |
| 20 | 120 – 277[b] | 16 | E | – | – | 3 |
| 30 | 120 – 277[b] | 24 | F | 5[d] or 6[d] | 3[d] | – |
| 20/15 | 120 – 277[b] | 16/12 | G | – | 5 | 3 |
| 30/15 | 120 – 277[b] | 24/12 | H | – | – | 5 |
| 30/20 | 120 – 277[b] | 24/16 | I | – | 5[d] | – |
| 15 | 347 | [e]Not applicable | J | 10[d] | 5[d] | – |
| 20 | 347 | [e]Not applicable | K | – | 10 | 5 |
| 30 | 347 | [e]Not applicable | L | – | – | 10 |
| | | | M | – | 10[d] | – |
| | | | N | 20[d] | 10[d] | – |
| | | | O | – | 20 | 10 |
| | | | P | – | – | 20 |
| | | | Q | – | 20[d] | – |
| | | | R | 30[d] | 20 | – |
| | | | S | 40[d] | 20[d] | – |
| | | | T | – | 30 | 20 |
| | | | U | – | – | 30 |
| | | | V | – | 30[d] | – |

Table 15 Continued on Next Page

**Table 15 Continued**

| AC-only rating | | | AC/DC rating | | | |
|---|---|---|---|---|---|---|
| | | | Ampere rating, A voltage, dc | | | |
| Ampere rating A | Voltage ac, V | Maximum full load motor current A | Rating designation | 125 V | 250 V | 600 V |
| | | | W | 60[d] | 30[d] | – |
| | | | X | – | 60 | – |

[a] These ratings are inherent in the switches.

[b] Switches rated 120 – 277 V ac are acceptable for use on motor circuits up to the ampere ratings shown, at any voltage between 120 and 277 V ac.

[c] Ratings B and D apply only to 3-way, 4-way, 2-circuit, 3-circuit, or fixture switches.

[d] The current rating indicated may be used as the current rating for an additional “T” rating, at 125 V.

[e] Not intended for motor leads.

**Table 16**
**Values for marking in supplementary rating**
**(see Clause 7.2.1)**

| Switch rating | | Supplementary rating | |
|---|---|---|---|
| Amperes | Volts | A | B |
| 15 | 120 | 12 | 1/2 hp |
| 15 | 120 – 277 | 12 | 1/2 hp, 120 V; 2 hp, 240 V |
| 20 | 120 | 16 | 1 hp |
| 20 | 120 – 277 | 16 | 1 hp, 120 V; 2 hp, 240 V |
| 30 | 120 | 24 | 2 hp |
| 30 | 120 – 277 | 24 | 2 hp |

7.2.2 A switch having push-in (screwless) terminals shall be marked:

a) Where readily visible during installation, with instructions for connecting acceptably sized wire;

b) Where readily visible during wiring and rewiring, with instructions for disconnecting a wire from the terminal;

c) To specify use with ″No. 14 AWG solid copper wire only″; and

d) Where readily visible during installation, with instruction to strip the insulation from conductors a specific length.

7.2.3 A general-use switch that is intended for the control of more than a single circuit shall be marked to indicate the number of circuits that may be accommodated. In addition, a circuit diagram showing the intended multiple connections shall be provided either on the switch, the smallest carton in which the switch is packaged, on the card in the case of a blister pack, or on a stuffer sheet packaged with the switch.

## 7.3 Location

7.3.1 The marking specified in Clause 7.1.1 (for general-use switches) shall be located so that it will be readily visible after the switch is installed. Plaster ears (whether separate pieces or integral with the mounting means) and fiber linings shall not carry the identifying marking or the electrical rating of the switch, unless such marking or rating, or both, also appear elsewhere on the switch.

7.3.2 The marking may be applied as follows:

a) On the sub-plate or mounting yoke for flush type switches; or

b) On the inside of the plate or cover for a switch that has an integral flush plate or outlet-box cover of insulating material; or

c) On the inside of the plate or cover for surface type switches having a detachable cover of porcelain or other insulating material; and

d) For the manufacturer’s trademark, on the push buttons or on the rotary or toggle handles of the switches.

## 7.4 Tungsten

7.4.1 An ac/dc switch intended for the control of tungsten-filament lamps shall be marked with the letter ″T,″ located to indicate that it applies only to the rating at 125 V.

7.4.2 An ac/dc switch acceptable for the control of tungsten-filament lamps on alternating-current circuits only shall be marked with the letter ″L″, located to indicate that it applies to the rating for 120 or 125 volts ac.

## 7.5 AC-Only Identification

7.5.1 A general-use switch that is intended for use only on alternating-current circuits shall be identified as such by means of the letters ″AC″ or ″~″ or frequency marking (for example, ″60 hertz″) or a phase marking, which shall be a part of the electrical ratings.

## 7.6 Switch Termination Restrictions

7.6.1 A switch rated 20 A or less that is not marked ″CO/ALR″ and that has provisions for mounting to a standard outlet box shall be marked as indicated in Clause 7.6.2. This requirement applies only to devices for installation in a fixed wiring system (branch circuit).

7.6.2 The switch, individual package label, or instruction sheet shall be marked with one of the following, or its equivalent:

a) ″Notice - Use only copper or copper-clad wire with this device;″

b) ″Notice - Connect only copper or copper-clad wire to this device;″

c) ″Notice - Use only devices marked CO/ALR with aluminum wire″; or

d) ″Caution - Use with copper wire only.″

*Exception: If the device itself carries the marking, one of the abbreviated markings in Clause 7.6.4 may be used.*

7.6.3 The marking in Clause 7.6.2 shall be located as follows:

a) For individually packaged devices, the marking shall appear on the device, a stuffer sheet, a removable label or tag attached to each device, or the device carton.

b) For OEM-shipped devices, the marking shall be on the device. For the purpose of this requirement, ″OEM-shipped″ is defined as any carton having more than one device, except for individual packages containing two devices intended for sale directly to the user.

7.6.4 If the marking required in Clause 7.6.1 appears on the device, one of the abbreviated markings shown below may be used to indicate that the switch is for use with either copper or copper-clad wire. The marking shall be legible, with letters at least 1.6 mm (1/16 inch) high.

a) ″Use copper wire only″;

b) ″Cu wire only″;

c) ″Use copper or copper-clad wire only″; or

d) ″Cu and Cu-clad wire only″; and

e) The symbol shown in Figure 3.

7.6.5 When molded, the circles and bar of the marking described in Figure 3 shall be formed by lines that have twice the width and thickness of the lines used for the letters ″CU″ and ″AL″ within the circles.

7.6.6 Other methods of marking, (i.e., die stamping, labeling, or other contrasting method) may be used, provided an equivalent prominence is achieved.

7.6.7 In all cases, this marking shall have greater prominence than any other marking, unless the other marking is also a required caution marking, in which case they shall have equal prominence.

7.6.8 An individually packaged general-use snap switch as described in Clause 4.5.3.19 shall be provided with instructions for the proper use of the pressure cable connectors furnished with the product. These instructions shall include:

a) The proper insulation strip length;

b) The wire sizes and combinations intended to be joined for proper application of the switch;

c) The phrase ″Suitable for dry locations only,″ or the equivalent, if an AL-CU wire connector is provided; and

d) The phrase ″Suitable for use with copper wire only,″ or the equivalent, if a copper wire connector is provided.

These instructions shall appear directly on the package or on a sheet to be included in the package.

7.6.9 An AC-only door switch, if rated in wattage, shall be marked where visible after installation with the words ″For use with incandescent lighting only″.

7.6.10 An AC switch rated 347V, or a three-position or momentary contact ac switch not intended for the control of incandescent luminaries, shall be clearly marked with the following or equivalent wording:

″CAUTION: NOT FOR CONTROL OF INCANDESCENT LUMINARIES″ and

″ATTENTION: PAS POUR LA COMMANDE DE LUMINARIES A INCANDESCENCE″ or, alternatively, with the symbol shown in Figure 4.

7.6.11 When molded, the circle and bar of the marking described in Figure 4 shall be formed by lines that have twice the width and thickness of the lines used for the lightbulb within the circle.

7.6.12 Other methods of marking, i.e., die stamping, labeling, or other contrasting method, may be used provided an equivalent prominence is achieved.

7.6.13 In all cases this marking shall have greater prominence than any other marking, unless the other marking is also a required caution marking, in which case they shall have equal prominence.

## 8 Self-Contained Switches for Use Without a Separate Outlet Box

### 8.1 General

8.1.1 The requirements in 8.2 – 8.4 are applicable to self-contained general-use switches rated 15 A and 20 A, 125 V and 250 V, for flush mounting without a separate outlet-box and for connection to one or more nonmetallic sheathed cables containing copper conductors. They are for use in accordance with the National Electrical Code or CEC Part 1 and primarily used in mobile homes, recreational vehicles, manufactured buildings, and on-site frame construction.

### 8.2 Construction

8.2.1 General

8.2.1.1 Self-contained switches shall comply with the applicable construction requirements of this Standard as modified by the requirements in 8.2.2 – 8.2.7.

8.2.2 Spacings

8.2.2.1 The spacings maintained between live parts of opposite polarity and between live parts and identified (grounded) metal parts shall be at least 1.6 mm (1/16 inch) through air and 3.2 mm (1/8 inch) over surfaces.

8.2.3 Insulation Material

8.2.3.1 The material used for the support, insulation, and overall enclosure of live parts and cable from which any part of the cable covering has been removed shall be either one of the materials in Table 17 or another insulating material determined to be acceptable by means of an investigation which shall include the following requirements:

a) The material shall have a temperature index of at least 80°C (176°F) at the thickness used, or the equivalent.

b) The enclosure material shall have a high-ampere arc ignition (HAI) index of at least 30 arcs and a hot wire ignition (HWI) index of at least 15 seconds.

c) The enclosure material shall have a minimum V-2 flammability classification or comply with the requirements of the specimen flammability test, Clause 8.3.11.

**Table 17**
**Insulating materials**

| Material: Generic name | |
|---|---|
| Molded Phenolic[a] | Molded Alkyd[a] |
| Molded Melamine[a] | Molded Epoxy[a,b] |
| Molded Melamine-Phenolic[a] | Molded Diallyl Phthalate[a] |
| Urea Formaldehyde[a] | Molded Polyester[a,b] |

[a] Includes materials having filler systems of fibrous (other than synthetic organic) types, but excludes fiber reinforcement systems using resins which are applied in a liquid form.

[b] Includes heat- and pressure-molded types only, not those intended for casting or pouring.

8.2.4 Enclosure

8.2.4.1 All current-carrying parts and that part of the cable from which any part of the covering has been removed shall be fully enclosed in the insulating body. This does not preclude cable openings to be filled in use or assembly joints designed to butt.

8.2.4.2 The overall insulating enclosure shall be at least 2.54 mm (0.100 inch) thick or a thickness determined to be acceptable for the material when used as the enclosure of an outlet box.

*Exception: Knockouts to be removed for the installation of cable may have a reduced thickness, but shall comply with the knockouts test, Clause 8.3.8.*

8.2.5 Mounting Means

8.2.5.1 A self-contained switch shall be provided with a means for mounting to walls or to frame construction brackets.

8.2.5.2 Brackets for mounting a self-contained switch shall not have holes located such that a standard flush device may be readily mounted to the bracket.

8.2.5.3 Self-contained switches shall be constructed so that they cannot readily be mounted in a standard flush-device box using the two threaded openings in the box provided for mounting conventional flush devices.

8.2.5.4 A self-contained device intended for flush installation may be provided with a mounting bracket for fastening the device to a structural member in the walls of the frame construction. The mounting bracket shall either be constructed integral with the device or packaged with the device along with the installation instructions.

8.2.6 Frame-Construction Mounting Brackets

8.2.6.1 Mounting brackets used to fasten self-contained switches to studs or joists of frame construction shall comply with all of the following provisions:

a) The support or mounting means shall be outside the enclosed interior of the insulating body of the self-contained switch.

b) Ferrous material other than stainless steel shall be protected against corrosion with a zinc coating having a minimum thickness of 0.013 mm (0.0005 inch) or its equivalent. Cut edges and tapped openings need not be protected.

c) A means shall be provided for the temporary retention of the nonmetallic sheathed cable at the bracket so that the cable will be accessible during installation of the self-contained switch. Clips or open hooks integral with the bracket may be used.

8.2.6.2 The mounting bracket used shall also comply with the mounting strength test, Clause 8.3.5.

8.2.7 Field Replacement

8.2.7.1 Switches marketed as replacement devices shall be capable of installation without the use of special tools.

8.2.7.2 Those switches which require replacement with specific devices of similar construction shall be marked to include the information indicated in Clause 8.4.1.2.

## 8.3 Performance Testing

8.3.1 General

8.3.1.1 The performance tests described in Clauses 8.3.2 – 8.3.11 are in addition to the applicable tests specified elsewhere in this Standard. Among the tests applicable to self-contained switches are the overload, endurance, temperature, and dielectric voltage-withstand tests described in Clauses 5.6, 5.7, 5.8, and 5.9, respectively.

8.3.1.2 For self-contained switches employing insulation displacement terminals, the temperature test, Clause 5.8, shall be performed after the cable pullout test, Clause 8.3.3.

8.3.2 Heat cycling and vibration test

8.3.2.1 General

8.3.2.1.1 Following the heat cycling and vibration tests described in this Clause, each switch shall:

a) Comply with the thermal stability criteria described in Clause 8.3.2.4.1; and

b) Not have a temperature rise of more than 100°C (180°F).

*Exception: Self-contained switches for connection only to copper wire employing crimp, screw-terminal, or pressure-wire connector constructions need not be tested for heat cycling or vibration.*

8.3.2.1.2 Ten self-contained switches rated 15 A shall be assembled onto a two-conductor No. 14 AWG nonmetallic sheathed cable with ground and copper conductors. Ten devices rated 20 A shall be assembled onto a two-conductor No. 12 AWG nonmetallic sheathed cable with ground and copper conductors. For a non-identified (non-grounded) 3-way switch, the ground conductor shall be assembled as indicated in the installation instructions.

8.3.2.1.3 The switches shall be connected with 610 to 686 mm (24 to 27 inches) of cable between each device and wired in series so that the test current passes through the connection point of the entering conductor, the device internal structure, and the exiting conductor. See Clauses 8.3.2.2.2 and 8.3.2.2.3 for a description of splice and nonsplice connection. See Clauses 8.3.2.3.1 – 8.3.2.3.6 for devices to be subjected to the vibration test.

8.3.2.2 Heat Cycling Test

8.3.2.2.1 Each heating cycle shall consist of 1-1/2 hours ″on″ time and 1/2 hour ″off″ time, with a total of 500 cycles on each device. The test current shall be 53 A for those devices being tested with No. 12 AWG cable and 40 A for those devices being tested with No. 14 AWG cable.

8.3.2.2.2 The temperature rises shall be measured using thermocouples placed on the internal wire termination structure, as close as practicable to the wire termination point. If the construction of the device is such that splicing connections are intended (see manufacturer’s instructions), all devices shall be so wired, using the minimum number of possible connection points for each wire (a splicing connector is where the incoming wires terminate in the device and a second set of conductors originate in the same device).

8.3.2.2.3 If a splicing connection is not intended, modified devices may be necessary so that unrelated variables will not influence the test results. For example, the line and neutral wire terminations may have to be jumped by a No. 14 AWG copper wire soldered in place or No. 12 AWG copper wire for devices tested with No. 12 (3.3 mm$^2$) wire, or an equivalent means. Modifications shall not provide any increase in overall thermal or electrical conductivity, mechanical strength, and so forth, beyond that of the basic unmodified device construction.

8.3.2.2.4 The temperature of the conductors shall be recorded at the following intervals, which may be approximate:

a) Beginning with the 25th cycle and every 25 cycles thereafter for a total of five measurements (125 cycles);

b) Continuing with the 40th cycle and every 40 cycles thereafter for a total of three measurements (120 cycles); and

c) Continuing with the 80th cycle and every 80 cycles thereafter for a total of three measurements (240 cycles).

This yields a total of 11 data points for each device tested. Temperature measurements shall be accomplished by using thermocouples with a temperature-indicating instrument. See Clause 5.8.1.6 for thermocouple details.

8.3.2.3 Vibration Test

8.3.2.3.1 Following approximately 125 cycles of heat cycling (as described in Clauses 8.3.2.2.1 – 8.3.2.2.4), six devices from each group of ten (for a total of 12 devices) shall be disconnected from their circuit and subjected to vibration conditioning.

8.3.2.3.2 Five of each six devices shall be mounted (prior to the start of the heat cycling test) to a special test rack constructed of cast-iron angles not smaller than 3.2 by 31.8 by 31.8 mm (1/8 by 1-1/4 by 1-1/4 inch) welded to form a rigid assembly. Mounting holes shall be provided for attachment to the vibration platform. Insulating strips or clamps shall be provided to secure the wires between devices at 152 – 203 mm (6 – 8 inches) from the point at which they exit the device, and located in the same plane as the mounting means for the device.

8.3.2.3.3 The devices shall be rigidly mounted to the fixture by their mounting means. Equivalent methods of mounting such as bolting or clamping the devices to the frame may be used.

8.3.2.3.4 The sixth device of each group shall be mounted by its normal mounting means in the center of a 533 mm square (21 inch square) piece of panel board having the minimum intended thickness for use with the device. The panel board shall then be bolted to a test rack similar to that described in previous paragraphs, but sized so that the panel board is supported around its periphery [approximately 52 mm (21 inches) on each side]. Clearance holes through the test rack shall be provided for the test wires opposite where they exit the device. No additional support for the test wire shall be provided.

8.3.2.3.5 Each device shall then be subjected to the following vibration conditioning:

a) Simple harmonic motion of amplitude 0.75 mm (0.03 inch) [1.5 mm (0.06 inch) peak-to-peak] with the frequency varied uniformly between 10 and 55 and back to 10 cycles per second in one minute; and

b) Vibration applied for two hours in each of three mutually perpendicular directions for a total of 6 hours of testing.

8.3.2.3.6 At the conclusion of the vibration test described in Clauses 8.3.2.3.1 – 8.3.2.3.5, all test devices shall be reconnected to their respective circuits to complete the remaining 375 cycles of the heat cycling test (for a total of 500 cycles).

8.3.2.4 Calculations

8.3.2.4.1 The thermal stability shall be evaluated as follows: for each thermocouple location, find the average temperature rise for all 11 data points obtained (from Clause 8.3.2.2.4) and find the deviation of each of the 11 data points from the calculated average. None of the 11 data points shall deviate above the average temperature by more than 10°C (18°F). There shall not be a temperature rise greater than 100°C (180°F) above the room ambient temperature on any device during the heat cycling test.

8.3.3 Cable Pullout Test

8.3.3.1 After being subjected to the cable pullout test described in Clause 8.3.3.2, there shall not be:

a) Any visible indication of conductor pullout;

b) Damage to the cable insulation; and

c) Any loosening of the assembly that would enable the cable to be removed by flexing or bending following the removal of the test force.

8.3.3.2 Six switches rated 15 A shall be installed onto two-conductor No. 14 AWG copper cable with ground, and six switches rated 20 A installed onto No. 12 AWG copper cable with ground. The cable installation shall be in accordance with the manufacturer’s instructions. Wiring terminals having a screw-actuated clamping means shall be fully tightened and then loosened one full turn before application of the test force. Each cable shall then be subjected to a 267 N (60 lbf) applied perpendicular to the plane of the cable entrance (along the wire) for five minutes. Devices shall be rigidly supported by their mounting means during testing. For a non-identified (non-grounded) 3-way switch, the ground conductor shall be assembled as indicated in the installation instructions.

8.3.4 Conductor Pullout Test

8.3.4.1 Following the test pull described in Clause 8.3.4.2, no conductor shall be displaced from its connection(s).

8.3.4.2 Three devices of a device rated 15 A shall be installed with a single copper conductor No. 14 AWG (Type TW) connected to each terminal. Three devices rated 20 A shall be similarly installed, but with a single No. 12 AWG copper Type TW conductor connected to each terminal. Each conductor shall be subjected to a pull of 89.0 N (20 lbf) gradually applied perpendicular to the plane of the wire entrance hole (along the wire) and sustained for 1 minute. Any parts necessary for proper installation of wire in the termination shall be used.

8.3.5 Mounting Strength Test

8.3.5.1 General

8.3.5.1.1 Following the test in Clause 8.3.5.4.1, each switch shall not experience:

a) A permanent displacement of more than 3.2 mm (1/8 inch) from the plane of the wall; or

b) Any damage that might adversely affect the intended function of the device.

8.3.5.2 Switches Mounted Directly in Panels

8.3.5.2.1 Six devices of a self-contained switch that is intended to be directly mounted in paneling shall be installed in a test wall made using paneling of the minimum thickness for which the device is intended. The paneling shall be supported (typically with a stud) 152 mm (6 inches) from one edge of the opening in which the device is to be installed. Each of the switches shall then be tested as described in Clause 8.3.5.4.1.

8.3.5.3 Switches Supported by Mounting Brackets

8.3.5.3.1 Six devices of a self-contained switch that is intended to be supported from a frame construction mounting bracket shall be installed and tested as described in Clause 8.3.5.4.1

8.3.5.4 Testing

8.3.5.4.1 Testing shall be accomplished as follows:

a) A 222 N (50 lbf) shall be applied for a period of 5 minutes to each of two devices in a direction perpendicular to the face of the mounting surface along the center line of the switch, tending to push it into the mounting opening,

b) A 222 N (50 lbf) shall be applied to two previously untested switches as described in (a) above, but in the opposite direction (tending to pull the switch out of the opening),

c) A 267 N (60 lbf) shall be applied to the nonmetallic sheathed cable of each of two previously untested devices in a downward direction from where the cables exit.

8.3.6 Field Replacement with Conventional Outlet Box and Switch

8.3.6.1 A self-contained switch that is intended to be replaced in the field with a conventional outlet box and switch shall be installed on a typical wall panel of the minimum thickness intended in accordance with the manufacturer's instructions. The self-contained switch shall then be removed from the wall. A conventional outlet box and switch shall then be installed.

8.3.6.2 Installation of the conventional outlet box and switch shall be readily accomplished by using wall support tabs furnished with the box or ″old work″ brackets. The opening in the wall around the replacement outlet box shall be such that it is entirely covered when a standard-sized, not oversized, flush plate is installed.

8.3.7 Fault Current Withstand Test

8.3.7.1 When subjected to the fault current withstand test described in this Clause:

a) There shall not be any damage to the cable that could render it incapable of being used in the installation of a similar self-contained replacement-type switch, or a conventional outlet box and switch; and

b) The circuit breaker or fuse shall operate in each case.

8.3.7.2 Typical installations of the self-contained switch shall be made in the intended manner, using the maximum and minimum cables (conductor sizes). The switch contacts shall be bypassed by a short length of the same size conductor soldered, welded, or otherwise secured in place. Each installed device shall be connected using 1.22 m (4 feet) of the maximum size wire to a 60 Hz power supply capable of delivering 1000 A at 120 V when the system is short-circuited at the test terminals. The test circuit shall have a thermal-type circuit breaker or an inverse-time molded-case-type circuit- breaker connected in one unidentified (ungrounded) line between the test terminals and the switch. The breaker rating shall correspond to the rating of the wire used in the test. Each of three devices shall be tested by applying the test current to the device by means of a suitable switching device. This procedure shall then be repeated on the same devices using a 200 A, 120 V, circuit.

8.3.8 Knockouts Test

8.3.8.1 Knockouts shall remain intact when subjected to a 44.5 N (10 lbf) for one minute applied perpendicular to the plane of the knockout. The force shall be applied by means of a mandrel, with a 6.4 mm (1/4 inch) diameter flat end, at the point considered most likely to displace the knockout.

8.3.8.2 Knockouts shall be readily removable without breakage of the insulating body of the enclosure or sharp edges becoming present. Knockouts shall be displaced by means of a screwdriver or by using other conventional tools.

8.3.9 Creep Test

8.3.9.1 Self-contained switches shall be capable of withstanding the cable pullout test, Clause 8.3.3, following the oven conditioning described in Clause 8.3.9.2.

8.3.9.2 Six devices of a self-contained switch employing thermoplastic material shall be assembled as a splice installation onto nonmetallic sheathed cable of the maximum AWG size conductor intended for use. Each device shall then be conditioned in an circulating-air oven for 300 hours at 90°C (194°F).

8.3.10 Mold Stress Test

8.3.10.1 Following the aging conditioning described in Clause 8.3.10.2, there shall not be:

a) Change in any overall dimension greater than 10 percent; and

b) An opening larger than 0.8 mm (1/32 inch) at any joint once the device has cooled to room temperature.

8.3.10.2 Six devices of self-contained switches employing thermoplastic material, unassembled and without the cable installed, shall be conditioned in a circulating-air oven for a period of 7 hours at 90°C (194°F). Upon cooling to room temperature, the openings shall be measured after installation on cable as intended.

8.3.11 Specimen Flammability Test

8.3.11.1 Insulating materials of a self-contained switch other than the materials specified in Table 17 shall be subjected to this test. A total of fifteen specimens for each material shall be tested as follows:

a) Five in an as-received state tested under the conditions described in Clause 8.3.11.2;

b) Five following seven days of conditioning in an circulating-air oven at 90.0 ±1.0°C (194.0 ±1.8°F), tested under the condition described in Clause 8.3.11.2; and

c) Five in an as-received state-tested under the conditions described in Clause 8.3.11.3.

8.3.11.2 When tested as described for V-2 material in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94 or CSA C22.2 No. 0.17, each 127 by 12.7 mm (5.0 by 0.50 inch) specimen shall not burn with:

a) Flaming combustion for more than 30 seconds after each withdrawal of the test flame;

b) Flaming or glowing combustion up to the holding clamp; and

c) Glowing ember for more than 50 seconds after the second withdrawal of the test flame.

8.3.11.3 When tested as described for 94HB material in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94 or CSA C22.2 No. 0.17, each 127 by 12.7 mm (5.0 by 0.50 inch) specimen shall cease to burn before the flame reaches the reference mark located 102 mm (4.0 inches) from its free end.

## 8.4 Markings and Instructions

### 8.4.1 General

8.4.1.1 Each self-contained switch shall be plainly marked where readily visible after installation with:

a) The manufacturer's name, trademark, or trade name;

b) A distinctive catalog number or the equivalent; and

c) The electrical rating

8.4.1.2 Each self-contained switch that is not capable of being replaced with a conventional outlet box and switch shall be marked with:

a) The type of switch necessary for replacement purposes; and

b) Instructions for disassembly prior to replacement.

Switches intended for replacement with similar devices without the use of special tools shall be specifically marked to indicate this.

8.4.1.3 The following information shall be provided on the outer surface of the smallest unit package or on a tag or stuffer sheet (or its equivalent) or included therein:

a) Manufacturer's name and complete address;

b) Catalog number or its equivalent;

c) Intended conductor material, cable type, and cable size;

d) Limitations of use – for example, "mobile homes"; and

e) Necessary installation instructions such as:

    1) wall or ceiling limitations (material, thicknesses, and the like);

    2) cable preparation (required slack, tools, and the like);

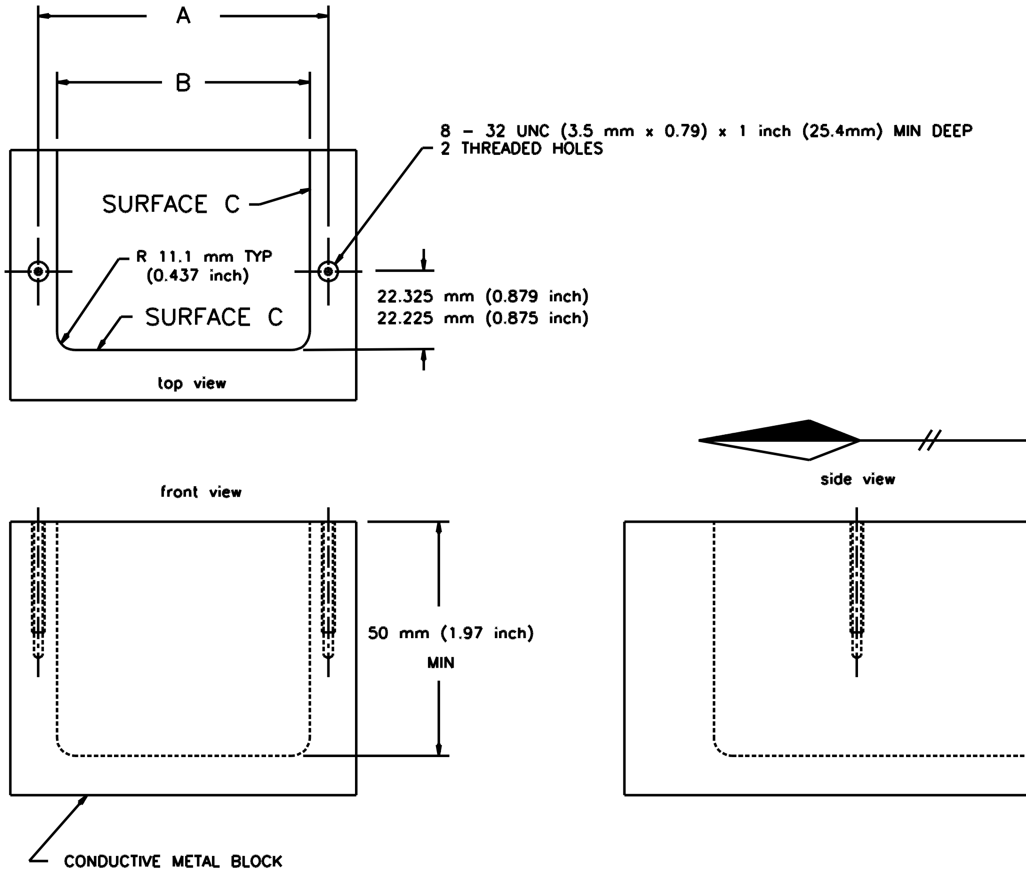
    3) selection of wiring materials; and

    4) bracket references and the like.

8.4.1.4 With regard to Clause 8.4.1.3, the installation instructions shall specifically state that the maximum slit length of nonmetallic sheathed cable being prepared for installation on a self-contained switch shall be 54 mm (2.125 inch).

## Figures

**Figure 1**
**Test fixture for flush device clearance to flush-device box**
(see Clause 4.8.5)




| Dimensions | Flush devices | | | |
|---|---|---|---|---|
| | all except 347 V ac switches | | 347 V ac switches | |
| | mm | (inch) | mm | (inch) |
| A | 83.44 mm<br>83.24 mm | (3.285) max<br>(3.277) min | 96.92 mm<br>96.72 mm | (3.816) max<br>(3.808) min |
| B | 71.625 mm<br>71.425 mm | (2.820) max<br>(2.812) min | 85.10 mm<br>84.90 mm | (3.530) max<br>(3.342) min |

Notes When determining the clearance of live parts of the device to Surface C:

(a) thread the device's mounting screws through the slot in the device's mounting yoke into the holes in the metal block. Do not tighten the device to the block;

(b) position the device shown by the arrow until the slot in the device's mounting yoke contacts the mounting screw;

(c) perform the continuity test, and;

(d) if the device is asymmetrical, repeat steps (a) – (c) with the device reoriented 180° within its proper mounting.

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**Figure 2**
**Accessibility probe**
(see Clause 5.16.1)

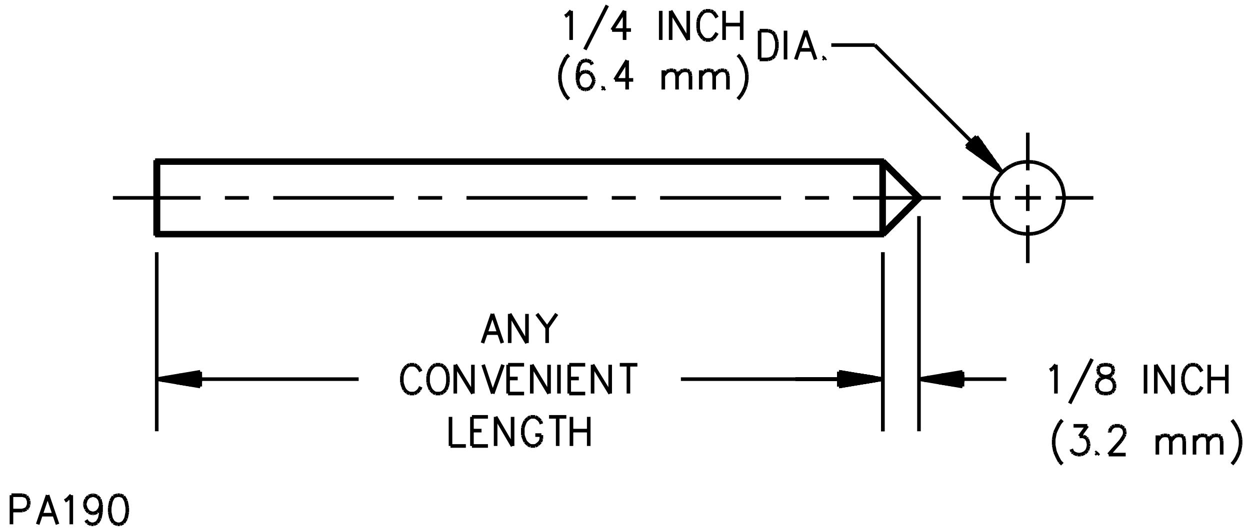
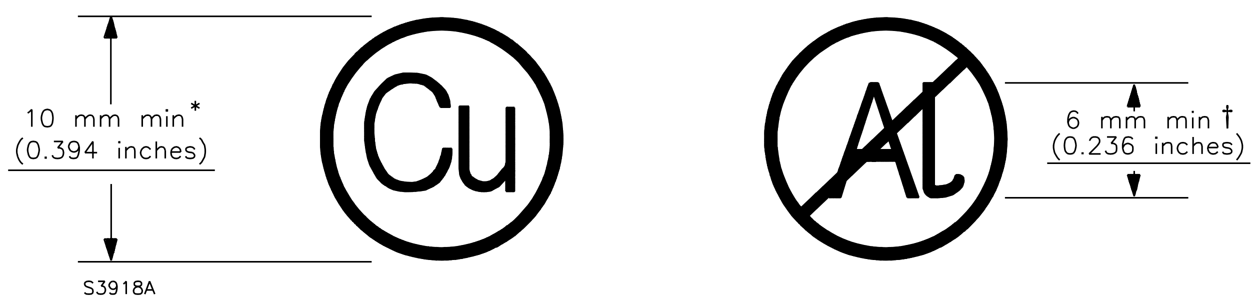
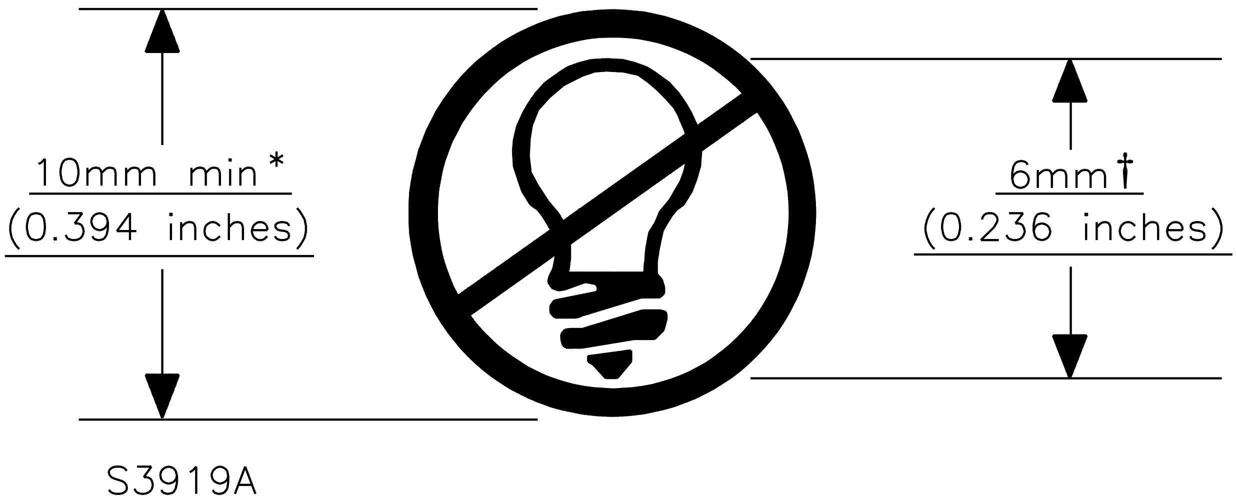



**Figure 3**
**For use with copper only**
(see Clause 7.6.4, 7.6.5)



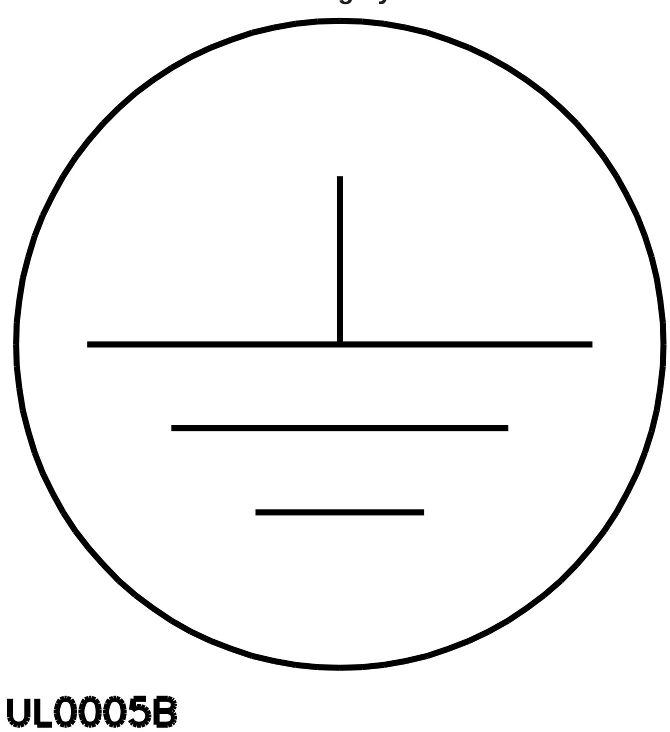

*4 mm (0.157 inch) if marked on the device †2.4 mm (0.094 inch) if marked on the device

**Figure 4**
**Marking for 347V ac or three-position or momentary contact ac switches not intended for control of incandescent luminaries**
(see Clause 7.6.10, 7.6.11)




*4 mm (0.157 inch) if marked on the device †2.4 mm (0.094 inch) if marked on the device

**Figure 5**
**Grounding symbol**



# Appendix A

## Standards for Components

### A1 Component Standards

A1.1 CSA and UL Standards listed below are used for the evaluation of components and features of products covered by this Standard.

**CSA Standards**

C22.1–1998, *Canadian Electrical Code, Part 1;*

CAN/CSA C22.2 No. 0-M91 (R1997), *General Requirements – Canadian Electrical Code, Part II*

CAN/CSA C22.2 No. 0.17-92 (R1997), *Evaluation of Properties of Polymeric Materials;*

C22.2 No. 14-95, *Industrial Control Equipment;*

C22.2 No. 18-97, *Outlet Boxes, Conduit Boxes, and Fittings;*

C22.2 No. 42-M1984 (R1996), *General Use Receptacles, Attachment Plugs, and Similar Wiring Devices;*

C22.2 No. 55-M1986 (R1992), *Special Use Switches;*

CAN/CSA C22.2 No. 94-M91 (R1997), *Special Purpose Enclosures;*

C22.2 No. 111-M1986 (R1992), *General Use Switches;*

C22.2 No. 156-M1987 (R1993), *Solid-State Speed Controls;*

C22.2 No. 159-M1987 (R1993), *Attachment Plugs, Receptacles, and Similar Wiring Devices for Use in Hazardous Locations: Class I, Groups A, B, D, and D; Class II, Group G, in Coal or Coke Dust, and in Gaseous Mines;*

CAN/CSA C22.2 No. 177-92 (R1997), *Clock-Operated Switches;*

C22.2 No. 184.1-96, *Solid State Dimming Controls*.

**UL Standards**

UL 50, *Enclosures for Electrical Equipment;*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances;*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors;*

UL 508, *Industrial Control Equipment;*

UL 514A, *Metallic Outlet Boxes;*

UL 514C, *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers;*

UL 746A, *Polymeric Materials – Short Term Property Evaluations;*

UL 746B, *Polymeric Materials – Long Term Property Evaluations;*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations;*

UL 894, *Switches for Use in Hazardous (Classified) Locations;*

UL 917, *Clock-Operated Switches;*

UL 1054, *Special-Use Switches;*

UL 1472, *Solid-State Dimming Controls (Bi-National CSA C22.2 No. 184.1-96);*

UL 1567, *Receptacles and Switches Intended for Use with Aluminum;*

UL 1917, *Solid-State Fan Speed Controls.*

## Appendix B

## Canadian Requirements for CO/ALR Switches

### B1 General

B1.1 This Appendix specifies the Canadian requirements for switches intended for connection to branch-circuit wiring containing aluminum conductors. The U.S. requirements for switches intended for use with aluminum conductors are specified in UL 1567.

B1.2 In addition to all other tests required for switches by this Standard, the tests described in Sections B2 to B5 shall be applied to binding screw type terminals provided on switches rated 20 A or less and intended for use with solid-conductor building wire as specified in Clause B1.4. Clauses B1.3 to B1.16 shall also apply. Additional tests or requirements may be necessary if features of construction or intended use that have not been anticipated by these requirements are present.

B1.3 Unless otherwise restricted, such as by suitable markings, a switch rated 15 A shall be tested when connected with No. 12 AWG wire and a switch rated 20 A shall be tested when connected with No. 10 AWG wire.

B1.4 The test wire shall be thermoplastic insulated building wire, Type TW or TWH, and the conductor shall be aluminum conductor material (ACM) having the following characteristics:

a) Ultimate tensile strength, 103 138 MPa; and

b) Elongation, 10 percent min.

B1.5 In order to evaluate adequately a particular switch construction, it may be necessary to provide switches so modified that unrelated variables will not influence the results of the tests. This anticipates the need to weld, clamp closed, or otherwise bypass internal current-carrying parts of switches by bonding parts or adding parts by welding, soldering, or other equivalent means. Where such modifications are made, the resultant assembly shall not provide any increase in overall thermal or electrical conductivity, mechanical strength, etc, beyond that of the basic, unmodified device construction. The need for such modifications shall be determined by preliminary testing or evaluation, or both, of a particular switch construction.

B1.6 The switches shall be mounted on the special test frames described for each test. The switches shall be fastened by their mounting yokes to the special test frames and shall be mounted with the major axis of the switch in the vertical position.

B1.7 Those tests which require monitoring of temperatures generated by current flow through the device shall be conducted in a draft-free location where the ambient temperature is maintained at approximately 25°C.

B1.8 The switches shall be connected in a series circuit using the appropriate gauge and interconnecting-lead length of test wire as specified for each test. The series test circuit shall be connected to an adjustable source of low voltage, well regulated 60 Hz ac current using lengths of wires having an ampacity of at least the test circuit current.

B1.9 The test wires shall be connected to the switch in a manner to allow the switch to perform its normal function. The test circuit shall be completed by modification of the switch as described in Clause B1.5.

B1.10 The end of the test wire to be connected to the switch binding screws shall be formed in a plane to have a 180° bend with the inside diameter of the bend equal to approximately 0.5 mm more than the nominal diameter of the switch terminal screw. The end of the conductor shall not project from under the head of the screw more than one-half the diameter of the test conductor.

B1.11 A special, wire-forming jig for each terminal screw size No. 6 and No. 8 (M3.5 and 4) shall be used in order to facilitate wiring in a reproducible fashion. If the switch terminal construction does not properly accommodate a loop formed by the use of the special jig (due to insulating barriers around the terminal, etc), the parallel ends of the loop may be squeezed together after installation on the device if such action will allow the looped conductor to seat properly. No additional modification of the jig-formed conductor loop is anticipated.

B1.12 The insulation of the test wire shall be removed in order to expose approximately 6 mm of wire beyond that required to make connection to the switch, with the exception that if the switch incorporates provisions (such as ″wire guides″ or channel) intended to minimize the transmission of wire bending forces to the terminal, the length of exposed wire beyond that necessary to make connections to the device shall be selected so as to result in the least favorable test condition.

B1.13 A wire guide intended to accept an insulated wire may be tested with the wire insulation stripped back beyond the wire guide. A wire guide intended to accept uninsulated wire in the No. 12 and No. 10 AWG wire range and required to be tested with No. 12 AWG wire may be tested without removing the wire insulation in the area of the wire guide if the wire guide will reasonably receive the insulated wire.

B1.14 Where possible all test wire connections on switches with binding screw terminations shall be made with the looped end of the wire, with the direction of wire wrap corresponding to the direction of terminal screw tightening.

B1.15 Where the construction of the switch terminal precludes installation in accordance with ClauseB4.1 or where examination of the switch indicates a likelihood that the wire will not be so installed, the test wires shall be terminated with the direction of wrap opposite to the direction of terminal screw tightening.

B1.16 Each switch terminal screw shall be tightened by application of the value of torque specified. Application of the proper value of torque shall be ensured by the use of the tool specified. Unless otherwise specified, there shall be no subsequent checking of the torque or other tightening of the screws.

B1.17 Temperatures shall be measured using No. 30 AWG Type J thermocouples and a suitable indicating instrument. The thermocouples shall be placed on the metal of the terminal as close to the wire connection as is practical. When the terminal is recessed or otherwise inaccessible, the thermocouple shall be located either on the metal directly connected to the terminal or on the wire close to its entry into the switch, whichever point has the highest temperature. A preliminary trial heat test may be necessary.

B1.18 All temperature measurements shall be made after thermal equilibrium has been achieved. This will generally occur 2-3/4 h into the full current part of the heat cycle. The ambient temperature shall be measured in the immediate vicinity of the switch under test.

## B2 Heat Cycling with Wire Disturbance

B2.1 The switches shall be mounted on special metal brackets that are in turn secured to a supporting framework. (See Clause B1.6 for additional mounting details.) The metal brackets and supporting framework shall be constructed so as to

a) Allow easy access to the switch terminals;

b) Allow unrestricted motion of test conductors for the wire distrubance cycles; and

c) Minimize the effects of heat generated by equipment or adjacent switches under tests.

B2.2 Switches rated 20 A shall be tested when connected to No. 10 AWG test wires and carrying a current of 53 + 0, − 1 A, at the cycle rate specified in Clause B2.6.

B2.3 Switches rated 15 A shall be tested when connected to No. 12 AWG test wires and carrying a current of 40 + 0, − 1 A, at the cycle rate specified in Clause B2.6.

B2.4 The test wire length between terminals shall be at least 610 mm but not more than 685 mm and shall project straight back, in the horizontal plane, from the switch terminals.

B2.5 The switch terminals under test shall be tightened by the application of a 0.68 N m torque. A variable torque driver provided with a dial indicator shall be used to tighten the switch terminals. See Clause B1.16.

B2.6 A test cycle shall consist of full current for 3-1/2 h followed by a 1/2 h period during which no current flows. The test shall be continued until all switches have been subjected to 500 test cycles or until a single failure occurs. Terminal temperature shall be recorded commencing with the 25th cycle and approximately every 25 cycles thereafter for a total of five data point measurements (approximately 125 cycles). The test wires shall be disturbed after the 25th and 125th cycle, as detailed in Clause B2.7. The temperature shall be recorded at the first heat cycle following each of the wire disturbance cycles. These data point measurements shall replace or supplement the measurements made at approximately the 25th and 125th cycles. Then data point measurements shall be taken approximately every 40 cycles for a total of three measurements (approximately 120 cycles); and, finally, approximately every 80 cycles for a total of three data point measurements (approximately 240 cycles).

B2.7 The wire disturbance cycle shall consist of the following:

a) The test wire connected to each switch terminal shall be grasped approximately 100 mm from the terminal and the wire moved as described in Items (b), (c), and (d). Care shall be exercised so that during movement of the test wires no tensile or twisting forces are applied to the wire and adjacent test specimens are not disturbed.

b) The test wire shall be moved firmly and with a smooth motion downward from the horizontal plane through an arc of approximately 90° so that the wire assumes a vertical orientation.

c) Then the test wire shall be moved upward so that the wire returns to the horizontal position.

d) Items (b) and (c) are to be repeated so that each connection to the switch under test is in turn subjected to two successive movements.

The actual point in the heat cycle test at which the wire disturbance cycles are to be performed may vary about the points noted so as to conform with normal working hours. The wire disturbance cycle shall be performed during the 1/2 h period when no current is flowing.

B2.8 All switches shall complete 500 cycles of the heat cycle test with wire disturbance test and shall exhibit connection stability as determined by the application of the following criteria:

a) At any point in the test there shall be no temperature measurement in excess of 125°C, ie, 100°C maximum rise, based on an ambient temperature of, or corrected to, 25°C.

b) At the completion of the 500th cycle, the stability factor, ΔT, shall be determined for each of the eleven data points for each of the connections monitored. The stability factor is defined as the maximum temperature rise of any one data point above the average temperature rise of all eleven data points for a particular connection. The data points are those discussed in Clause B2.6.

For all points monitored, the ΔT shall be less than or equal to 10°C.

**B3 Heat Cycling with Vibration**

B3.1 The switches shall be mounted directly to the test frame. See Clause B1.6 for additional mounting details. The test frame shall be constructed so as to allow easy assembly to the vibration platform without disturbing the switches already under test.

B3.2 Switches rated 15 A shall be tested when connected to No. 12 AWG test wires. Switches rated 20 A shall be tested when connected to No. 10 AWG test wires.

B3.3 The switches shall be connected as described in Section B2 except that the test wires shall be bent upward into a smooth arc and secured to the test frame above the switches. The radius of the bend of the lead wires shall be such that the wires leave the switch terminals in a generally horizontal plane and do not project rearward from the switch more than approximately 38 mm.

B3.4 The test sequence shall consist of heat cycle conditioning, vibration, and heat cycle testing. The heat cycle conditioning and testing phases shall be conducted as described in Section B2 except as follows:

a) The wire disturbance cycle shall not be included.

b) The test current shall be 40 + 0, − 1 A for 15 A switches and 53 + 0, − 1 A for 20 A switches. The cycle shall consist of full current for 3-1/2 h followed by a 1/2 h period during which no current flows.

c) The heat cycle conditioning phase shall be terminated and the specimens subjected to vibration when the monitored temperatures appear to be reasonably stable. The specimens shall complete at least 15 conditioning cycles prior to being subjected to vibration.

*Note: In general, it may not be necessary to conduct the heat cycle conditioning phase beyond 50 cycles unless successive temperature readings indicate a temperature deviation of more than 5°C between readings.*

d) The heat cycle testing phase shall be started as soon as possible after the vibration phase and shall be continued until all devices have been subjected to 200 test cycles or until a single failure occurs. Terminal temperatures shall be recorded commencing with the first cycle after the vibration sequence and approximately every 20 cycles thereafter for a total of eleven measurements, including the 200th cycle.

e) During the vibration phase the test specimens shall be disconnected from the heat cycling circuit and the test carriage shall be mounted on a free-floating vibration platform. The specimens shall be subjected to the following vibration sequence:

(i) simple harmonic motion of amplitude 0.76 mm (1.5 mm peak to peak) with the frequency varied uniformly from 10 to 55 Hz and back to 10 Hz in 1 min; and

(ii) the vibrating motion shall be applied for 1 h in each of three mutually perpendicular directions for a total of 3 h of testing. After vibration, the test specimens shall be reconnected to the heat cycle circuit in order to complete the heat cycle test described above.

B3.5 All specimens shall complete 200 cycles of the heat cycle test phase of the heat cycle with vibration test and shall exhibit stability as determined by the application of the criteria described in Clause B2.8.

## B4 Environmental

B4.1 Switches shall be mounted and wired as described in Section B2. The test sequence shall be as follows:

a) The switches shall be connected to the test circuit and caused to carry full rated current until thermal equilibrium is obtained as determined by three successive temperature readings taken a minimum of 3 min apart.

b) The switches shall be conditioned thermally as follows:

(i) a circulating air oven shall be preheated to 150 ±1°C and the oven controls set to maintain that temperature; the switches shall be placed in the oven for 30 min;

(ii) as rapidly as possible following the completion of the 30 min high temperature conditioning, but in no case more than 5 min, the switches shall be placed in a pre-cooled cold chamber set to maintain a temperature of 30 ±1°C, and shall remain there for 30 min;

(iii) as rapidly as possible following the completion of the 30 min low temperature conditioning, but in no case more than 5 min, the switches shall be returned to the oven and the sequence repeated for six more conditioning cycles, ie, a total of 7 cycles; then the switches shall be subjected to the humidity conditioning sequence.

c) The switches shall be conditioned for humidity as follows:

(i) the test chamber shall be set to maintain a temperature of 75 ±1°C and a relative humidity of 95 ±3% and the switches shall remain in the chamber for 4 h;

(ii) the test chamber shall be reset to maintain a relative humidity of 40 ±3%, the temperature remaining at 75 ±1°C; the switches shall remain in the chamber for 16 h;

(iii) the test chamber shall be reset to maintain a temperature of 30 ±1°C and a relative humidity of 60 ±3%; the switches shall be in the chamber for 4 h;

(iv) the humidity conditioning sequence consisting of Items (i), (ii), and (iii) shall be repeated for a total of 5 cycles.

*Note: For humidity conditioning the interval between Items (i), (ii), and (iii) is not to exceed 4 h; the interval between cycles consisting of Items (i), (ii), and (iii) may be varied to suit normal working hours.*

d) Deterioration of the connections shall be determined by repeating the measurements described in Clause B4.1(a).

B4.2 The maximum temperature rise while carrying rated current shall not exceed 30°C, based on an ambient of 25°C.

**B5 Stripping Torque**

B5.1 The switches shall be secured by means of a suitable fixture, eg, by being clamped between the jaws of a vise, so as to allow unrestricted access to the switch terminal screws. Care shall be exercised so as to ensure that the switch body is not subject to more than the minimum clamping force necessary to physically restrain the device from moving during this test. The switches shall be secured so as to minimize the application of any forces tending to weaken or strengthen the switch body in the area of the terminal under test.

B5.2 Each switch terminal shall be wired with No. 14 AWG solid copper wire using approximately a 3/4 wrap of wire about the terminal screw. (See Clause B1.11.)

B5.3 Torque shall be applied to each test terminal in turn as described in Clause B1.16.

B5.4 The stripping torque test shall begin with the application of a 1.36 N m torque and increase in 0.22 N m increments until the torque necessary to ″strip out″ the switch terminal under test is determined. This routine shall be followed for at least the first 10 terminals under test. The initial test torque may then be increased above 1.36 N m in order to minimize test time, but in no case is the initial test torque to exceed a value 0.68 N m less than the average stripping torque of the first 10 terminations tested.

B5.5 A suitable pre-set type torque drive shall be used for this test.

B5.6 Switch terminals tested shall withstand the application of at least a 1.81 N m torque without any damage to the switch terminal or the switch body. Due to the variable dimensions of screw head slots, screw head diameters, etc, some damage to the screw head may result from the application of a 1.81 N m torque. However, there shall be no impairment of the switch function, ie, it shall be possible to loosen the screw and reapply the torque to 1.81 N m without any unusual care being necessary.