UL 1054

STANDARD FOR SAFETY

Special-Use Switches

UL Standard for Safety for Special-Use Switches, UL 1054

Seventh Edition, Dated March 18, 2013

Summary of Topics

Revision pages have been published for UL 1054 to issue a new transmittal page that documents the established withdrawal date for the standard.

THE STANDARDS TECHNICAL PANEL RESPONSIBLE FOR UL 1054 AND UL 61058-1 HAS DETERMINED THAT AS OF JUNE 23, 2015, UL 1054 SHALL BE WITHDRAWN AND SHALL NOT BE USED FOR A PRODUCT'S EVALUATION.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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Standard for Special-Use Switches

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Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover manually operable and mechanical operable special-use switches and replacement switches:

a) That are for use on direct current as well as on alternating current or on alternating current only, and

b) For which the load ratings do not exceed 60 A at 250 V or a lower potential and 30 A or 2 hp at 600 V or a lower potential.

1.2 These requirements cover special-use switches intended for use in devices or appliances which conform with the requirements applicable to such equipment. A special-use switch is intended for factory installation in equipment and is not intended for field installation or field replacement of a similar switch. A vacuum-cleaner-handle switch, a heater switch, a radio or television switch, and a through-cord switch that has more than one on or one off position are examples of special-use switches.

1.3 These requirements cover replacement switches which are intended for field replacement of special-use switches used as part of devices and appliances. Only single or double pole, single or double throw switches are covered. Replacement switches are not for use in safety circuits.

1.4 These requirements do not cover general-use snap switches covered by the Standard for General-Use Snap Switches, UL 20.

1.5 These requirements do not cover through-cord switches with one on and one off position, special-use dimmer switches, or switches constructed so that they can be installed readily in a flush-device box or an outlet-box cover or can otherwise be used in a wiring system that complies with the National Electrical Code, NFPA 70.

2 Glossary

2.1 For the purpose of this standard the following definitions apply.

2.2 ACTUATING MEMBER – The part of the operating mechanism that extends outside the body of the switch and is intended to be exposed to contact by the operator.

2.3 CURRENT-INRUSH FACTOR – The number by which the normal (steady-state) peak current through a tungsten-filament-lamp load is multiplied to obtain the peak value of the inrush current through the load.

2.4 PUSH-IN (SCREWLESS) TERMINAL – A wire terminal that automatically locks a stripped conductor when it is inserted in the terminal.

2.5 SAFETY CIRCUIT – A primary or secondary circuit that is relied upon to reduce the risk of fire, electric shock, or injury to persons, or risk of electrical energy or excessive radiation emission, microwave or X-radiation. Examples include an interlock circuit, a circuit that limits leakage current to accessible parts, a circuit that limits the wattage to a limited-energy circuit, or a phase control or other circuit designed to limit temperatures in the end-use equipment to appropriate levels.

2.6 TELEVISION SWITCH – A switch intended for use as a supply-circuit control switch in a radio or television-receiving appliance.

3 Components

3.1 A component of a product covered by this standard shall comply with the requirements for that component, and shall be used in accordance with its recognized rating and other limitations of use. 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 switches covered by this standard; or

b) Is superseded by a requirement in this standard.

3.2 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3.3 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3.4 In the following text, a requirement that applies only to a switch for a specific use, such as in a heating appliance or in a radio or television-receiving appliance, is so identified by a specific reference in that requirement to the use involved. Absence of such specific reference or use of the term switch indicates that the requirement applies to all switches covered by this standard unless the context indicates otherwise.

4 General Requirements for All Switches

4.1 Requirements under this heading apply to all switches covered by this standard. They are supplemented in subsequent sections with requirements applying exclusively to heater switches, television switches, and special-use dimmer switches.

4.2 A switch shall employ materials that are acceptable for the intended use.

CONSTRUCTION

5 Enclosure

5.1 General

5.1.1 A metal enclosure of a switch (such as the shell of a pendant-type switch) shall not be less than 0.013 in (0.33 mm) thick. Thicker metal shall be employed to provide strength and rigidity if the size or shape of the enclosure requires an increased metal thickness.

5.1.2 A switch intended to be exposed to a specific environment shall comply with the applicable requirements in the Standard for Enclosures for Electrical Equipment, UL 50.

5.2 Lining

5.2.1 All conductive material on the inside surface of a part of the enclosure that is removable for wiring shall be lined completely with insulation not less than 1/32 in (0.8 mm) thick. The thickness of the insulation is to be measured by means of a machinist's micrometer caliper having a flat-ended spindle and a rounded anvil.

Exception: The lining of a switch may be less than 1/32 in (0.8 mm) thick if of a material – other than paper or fiber – that has been shown to be acceptable for the application, and may be omitted if there is a spacing of not less than 1/4 in (6.4 mm) between any uninsulated live part and the metal enclosure.

5.2.2 An insulating lining shall be secured so that it will remain in place under conditions of ordinary service and prevent the enclosure from becoming a live part even if a wire inside the switch should become loose or detached from its position.

6 Thermoplastic Materials

6.1 A thermoplastic material used in a switch shall comply with the requirements in Table 6.1.

Exception: A thermoplastic material with a flammability Class of less than V-2 as required in Table 6.1 used in a switch with material that complies with the applicable 3/4-in flame test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, complies with the requirement.

Table 6.1
Minimum flammability class for a thermoplastic material

Function	Minimum flammability class[a]
Enclosure or support of current-carrying parts	V-2[b]
A functional part other than an enclosure or support of current-carrying parts	HB[b]

[a] The flammability Class is determined at a minimum thickness of 0.8 mm (0.031 in) or the minimum thickness employed in the construction, whichever is greater.

[b] In accordance with the applicable requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

7 Nonmetallic Parts

7.1 A nonmetallic material employed either in the actuation mechanism or for the sole support of a current-carrying part of a switch shall have a Relative Thermal Index (RTI) – electrical, or mechanical without impact acceptable for its intended use. The RTI for a material is to be determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, at the minimum thickness employed in the construction. Also, the switch shall comply with Mold Stress, Section 15.1.

Exception: A mold stress test need not be conducted for a material that is intended to be used at a temperature below 50°C (122°F) or below the generic RTI for the material specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

8 Sealing Compound

8.1 Live screwheads or nuts on the underside of a base constructed for surface mounting shall be:

a) Countersunk not less than 1/8 inch (3.2 mm) in the clear, and covered with a waterproof, insulating sealing compound that has a softening point of 65°C (149°F) or higher; or

b) Spaced not less than 1/2 in (12.7 mm) through air from the mounting surface and staked, upset, or otherwise reliably prevented from loosening.

8.2 The depth or thickness of sealing compound covering a nut or screwhead shall not be less than 1/16 in (1.6 mm) or 1/8 in (3.2 mm) if the underside of the base is not recessed and may contact the surface upon which the switch is mounted.

8.3 Sulfur is not an acceptable sealing material.

8.4 Determination of the softening point of a sealing compound is to be made in accordance with the Test for Softening Point by Ball-and-Ring Apparatus, ASTM E28.

9 Live Parts

9.1 General

9.1.1 A current-carrying part and a wire-binding nut and a screw shall be of metal and shall have the necessary strength, rigidity, and ampacity to comply with the performance requirements.

9.1.2 A current-carrying part shall be:

a) Copper or a copper alloy; or

b) Stainless steel that is resistant to corrosion except for quick-connect terminations, push-in terminals, solder terminals, and parts that are subjected to arcing as shown by the applicable overload and endurance tests.

Exception No. 1: Hermetically sealed switching contacts may be made of corrosion resistant steel alloy.

Exception No. 2: Steel that is protected against corrosion by either zinc plating or the equivalent, may be used for the external buttons or contacts on a mercury-contact switch chamber.

Exception No. 3: Unplated steel may be used for parts wholly within a mercury-contact switch chamber.

Exception No. 4: Sheet steel that is clad on both surfaces with copper if the thickness of copper on each side is at least 10% of the total thickness, and all cut edges are coated with zinc or the equivalent.

Exception No. 5: Sheet steel may be used for terminals of a television-rated switch provided that:

a) All surfaces including cut edges are coated with zinc, tin, or the equivalent;

b) The applicable overload and endurance tests show that the part is not subjected to arcing;

c) The results of the test described in 19.4.1 and 19.4.2 are acceptable; and

d) The terminals are constructed for solder connections only.

9.2 Terminals and leads

9.2.1 A switch shall be provided with wire leads, terminals, or other acceptable means for the connection of conductors.

9.2.2 Means for connection of a switch employing positive screw pressure on a stripped conductor shall be provided with upturned lugs or the equivalent that will retain the wire under the binding-screwhead. Connection by means of soldering, welding, riveting, crimping, or other forms of construction may be used if shown to be acceptable for the purpose by tests. Consideration is to be given to the current involved and the mechanical features of the connecting means.

9.2.3 A wire-binding screw shall thread into metal.

9.2.4 Wire leads used on a switch shall be of a size, type, and length that is acceptable for the intended end use.

9.3 Push-in terminals

9.3.1 A push-in (screwless) terminal shall be:

a) For use with copper conductors only; and

b) For the connection of current-carrying conductors only – not for connection of an equipment-grounding conductor.

9.4 Quick-connect terminals

9.4.1 A quick-connect terminal employed on a switch shall comply with the Standard for Quick-Connect Terminals, UL 310, as applicable, and Table 9.1, or the requirements in 19.3.1 – 19.3.5 and 22.2.1 – 22.2.3.

Table 9.1
Quick-connect terminal dimensions

Nominal tab dimensions		
Width	Thickness	Length
in	in	in
0.250	0.032	0.307
0.205	0.032	0.245
0.205	0.020	0.245
0.187	0.032	0.245
0.187	0.020	0.245
0.125	0.032	0.275
0.125	0.020	0.275
0.110	0.032	0.275
0.110	0.020	0.275

10 Insulating Material

10.1 Fiber, mica, molded composition, or other insulating material shall be judged with reference to the form, size, and purpose of the parts for which it is used, the manner of its assembly, and its location and security in the switch.

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

10.3 Hard rubber shall not be used as insulating material.

10.4 A base or body in or on which live parts are mounted shall be of porcelain, phenolic, cold-molded composition, or other insulating material acceptable for the application.

11 Assembly

11.1 General

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

11.1.2 Uninsulated live parts shall be secured in place so that they will be prevented from turning or shifting in position if such displacement can adversely affect performance or result in a reduction of spacings below the minimum acceptable values specified in Spacings, Section 12.

11.1.3 A screw used for the general assembly of a switch shall, if possible, be prevented from loosening or backing by sealing, staking, or equivalent means.

11.1.4 When an assembly screw that must be loosened or removed in order to wire or install a switch is tightened with a torque of 6 lbf·in (0.68 N·m), the serviceability of the assembly means shall not be impaired.

11.1.5 The chain of a pull-type mechanism shall not become energized nor shall it cause the mechanism to jam when suddenly and completely released after having been pulled to the full on position or the full off position.

11.2 Actuating members

11.2.1 An actuating member shall have the strength necessary to resist the abuse to which it may be subjected and shall be securely, but not necessarily rigidly, attached to the operating mechanism that it is intended to control, and, if of insulating material, shall comply with the requirements for Effect of Heat on Actuating Members, Section 23.

11.2.2 An actuating member of conductive material shall be insulated from live parts.

12 Spacings

12.1 Spacings through air and over surface between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part that may be grounded or exposed to contact by persons when the device is installed in the intended manner shall not be less than the minimum values specified in Table 12.1.

Exception: This requirement does not apply to a switch that complies with the dielectric voltage-withstand test described in 20.2.

Table 12.1
Spacings

Potential involved	Minimum spacings	
V	in	(mm)
0 – 250	3/64	(1.2)
251 – 600	1/8	(3.2)

12.2 A dead metal part as mentioned in 12.1 includes a metal surface on which the switch is mounted in the intended manner. A dead metal screwhead, rivet, or the like is not to 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 9/32 inch (7.1 mm) in diameter and recessed not less than 3/16 inch (4.8 mm) in the clear.

12.3 In measuring a spacing, an isolated dead metal part interposed between uninsulated live parts of opposite polarity, or between an uninsulated live part and a grounded or exposed dead metal part, is to be considered as reducing the spacing by an amount equal to the dimension of the isolated dead metal part in the direction of the measurement.

PERFORMANCE

13 General

13.1 Unless otherwise specified:

a) Six representative samples of a switch in commercial form shall be tested as described in 13.3 – 23.2.

b) One set of samples shall be used throughout all the tests.

13.2 An additional set of six samples of a switch having a solid-state circuit used for varying power to a load, such as a speed control switch, shall be subjected to the overload, endurance, temperature and dielectric voltage-withstand tests with the solid-state circuit short-circuited.

Exception: This requirement does not apply to a dimmer switch.

13.3 A switch having higher alternating-current ampere ratings than direct-current ratings is to be tested for both ratings with separate samples used for each set of tests. A switch having the same alternating- and direct-current ampere ratings is to be tested on direct current if the direct-current voltage is equal to or greater than the alternating-current voltage rating.

13.4 Other than as noted in 19.1.5, the test sequence is to be:

a) Mold stress – if required;

b) Overload;

c) Endurance;

d) Tungsten-filament-lamp load endurance – if required;

e) Temperature; and

f) Dielectric-voltage withstand.

13.5 Overload and endurance tests at the highest rated voltage may represent tests at a lower voltage of the same frequency if the volt-amperes at the highest voltage is the same or higher than the volt-amperes at the lower voltage. The temperature test is to be conducted at the highest ampere rating that the test represents.

13.6 In addition to the tests mentioned in 12.3, a switch with mercury contacts shall be subjected to the Limited Short-Circuit Test, Section 21.

13.7 A switch having two or more on and off positions of the switch mechanism, such as a 2-circuit, 3-circuit, 3-pole, or series-parallel switch, is to be tested under conditions representing those of actual service, including each position that involves the making and breaking of the maximum current.

13.8 During the testing of a switch, all metal parts of the frame and the enclosure that may be grounded when installed under conditions of actual service or that are exposed to contact by the user are to be connected to ground or to a conductor of the test circuit. See 13.9.

13.9 For the overload and endurance tests, dead metal parts are to be connected through a 15-A or less fuse. The potential rating of the fuse is to be equal to, or greater than, the potential to ground or to the conductor of the test circuit to which dead metal parts of the equipment are to be connected. The circuit is to be connected so that:

a) On direct current, the dead metal parts will be positive with respect to the nearest arcing point in the switch; and

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

Exception: A switch, other than a television switch, rated 240 or 250 V that is not marked as described in 25.4 may be tested with one-half the test potential between live parts and conductive dead metal parts.

13.10 During the overload and endurance tests, a switch is to be mounted and wired so that conditions of actual service will be represented. The switch is to be connected to a load and, other than as noted in 17.5, to a supply circuit having a voltage that is within 5% of the rated voltage of the switch. The test circuit is to have such capacity 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.

13.11 With reference to the requirement in 13.10, it is impracticable to describe the details of connections that are to be made to obtain operating conditions identical with those in actual service because of the different arrangements of terminals. The switch is to be connected in the test circuit so that it will have the same position, relative to the load controlled and the supply mains, that it will have in actual service.

13.12 As a rule, the switch is to be connected in the test circuit between the mains and the load.

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

13.14 Whenever tests are conducted with alternating current, the circuit frequency is to be the same as the rated frequency of the switch. Other than as noted in 13.15 or, if no frequency is specified, 60-Hz alternating current is to be used.

13.15 A switch rated 50 Hz may, if agreeable to those concerned, be tested on a 60-Hz circuit, except that the currents used for the overload and endurance tests are to be 120% of the current that would be used if the switch were tested on a 50-Hz circuit.

13.16 In testing a switch, a cycle of operation includes operation of the switch from the off position through every electrical position of the switch, back to the off position.

13.17 A switching mechanism is not to be adjusted, lubricated, or otherwise conditioned either before or during any of the tests. Switches may be lubricated as a regular practice when they are assembled by the manufacturer.

14 Testing Circuits

14.1 General

14.1.1 An ampere-rated switch shall be subjected to overload and endurance tests with direct current and with a noninductive resistance load. A switch with an ampere rating for use in alternating-current circuits only is to be tested with alternating current and with an inductive load that has a power factor of 0.75 – 0.80.

14.1.2 The noninductive load referred to in 14.1.1 may consist of any convenient combination of carbon-filament lamps or resistors or both that will cause the required current to flow through the test circuit with a power factor of 0.98 – 1.0 on 60-Hz alternating current.

14.1.3 The reactive components of an inductive load for testing a switch for either an ampere or horsepower alternating-current rating are not to be in parallel with other reactances or resistances, except that an air-core reactor in any phase may be shunted by resistance in which the power loss is approximately 1% of the total power consumption in that phase. Parallel individual loads made up of resistance and inductive-reactance components connected in series may be used if the power factors of the paralleled loads are equivalent.

14.2 Tungsten-filament-lamp load

14.2.1 The test circuit, including the generator or other source of supply for testing a switch for tungsten-filament-lamp load rating is to have sufficient capacity to permit a current inrush through the switch and load as follows:

a) For direct current – not less than eight times the normal current, when the circuit is closed on a 20-A load. If a synthetic load is employed, its characteristics are also to be such that the current-inrush factor will not be less than 9 with a 15-A load, 10 with a 10-A load, and 11 with a 5-A load.

b) For alternating current – not less than the value specified in Table 14.1, when the circuit is closed on a load corresponding to a rating equal to or greater than the rating of the switch.

Exception: A direct-current tungsten-filament-lamp load and the supply circuit need not be sufficient for a 20-A load test if a ten-times inrush is available for a 10-A load and testing is limited to ratings that do not exceed 10 A.

Table 14.1
Test currents for tungsten-filament-lamp loads

Switch rating	Overload test		Endurance tests	
	Steady-state current (rms)	Minimum inrush current (peak)	Steady-state current (rms)	Minimum in rush current (peak)
A	A	A	A	A
1	1.5	27	1	18
2	3.0	51	2	35
3	4.5	71	3	51
4	6.0	91	4	65
5	7.5	111	5	78
6	9.0	130	6	92
7	10.5	147	7	105
8	12.0	163	8	117
9	13.5	178	9	130
10	15.0	191	10	141
11	13.75	180	11	153
12	15.0	191	12	163
13	16.25	201	13	173
14	17.5	211	14	183
15	18.75	215	15	191
16	20.0	226	16	199
17	21.25	230	17	207
18	22.5	239	18	214
19	23.75	243	19	220
20	25.0	247	20	226

14.2.2 With reference to the requirements in 14.2.1, the circuit shall be such that the peak value of the inrush current will be reached within 1/200 of a second for 50 Hz and 1/240 of a second for 60 Hz after the circuit is closed.

14.2.3 A synthetic load to simulate a tungsten-filament-lamp load for testing on alternating current shall be investigated as described in 14.2.4 and 14.3.2, and also with respect to conditions that are introduced by use on alternating current.

14.2.4 The acceptability of a test circuit, including the generator or other source of supply, for testing with tungsten-filament lamps is to be determined by means of oscillograph studies. The current-inrush factor of eight mentioned in 14.2.1 is to be based on a normal current flow of 20 A, and testing equipment that has adequate capacity at 20 A is acceptable for testing switches rated at more than 20 A. With reference to a 60-Hz timing wave, the peak value of the inrush current as shown by the oscillograms are to be attained within 1/4 cycle.

14.2.5 The characteristics of a direct-current test circuit are to be judged from 12 or more oscillograms, and testing equipment is acceptable if not less than half the oscillograms show a current-inrush factor equal to, or greater than the minimum acceptable current-inrush factor.

14.2.6 The characteristics of an alternating-current test circuit are to be judged from 12 or more oscillograms. Those that indicate that the absolute value of the current is decreasing – the value in question is approaching the zero point – are to be disregarded. The observed peak values of twelve or more oscillograms taken when the absolute value of the current is increasing should be sufficient to show whether the capacity of the test circuit is adequate to produce the required current-inrush factor.

14.2.7 A tungsten-filament-lamp load used as the load for a switch is to be made up of the smallest possible number of lamps having standard ratings of not more than 500 W. Fewer lamps, each rated more than 500 W, may be used if desired. The operating cycle is to be such that the lamps are off for at least 55 s of each test cycle. If a switch is operated at the rate of 10 cycles per minute, see 13.15, at least ten banks of lamps controlled by a commutator are necessary for each switch under test.

14.3 Synthetic load

14.3.1 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 14.2.6, consideration being given to the provision of higher current-inrush factors with the lower current loads, as required by 14.2.1.

14.3.2 A synthetic load may be used instead of tungsten-filament lamps and may consist of noninductive resistors that 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 is to be calibrated immediately after the capacitor has been charged and discharged in the normal manner. A combination load consisting of tungsten-filament lamps and resistors or capacitors, or both, is considered to be a synthetic load.

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

14.3.4 The characteristics of a synthetic load are to be such that the inrush current will be as specified in 14.2.1 – 14.2.3. The current in the capacitor/resistance load is not to be less than half the required inrush current at 1/60 s and not less than twice the steady-state current at 7/120 s after the circuit is closed. The current in a straight resistance load is to be the full inrush value for a minimum of 15 ms after the circuit is closed.

15 Tests on Nonmetallic Parts

15.1 Mold stress

15.1.1 With reference to Nonmetallic Parts, Section 7, a nonmetallic parts is to be subjected to the test as specified in 15.1.2. There shall be no distortion of a nonmetallic part employed either in the actuation mechanism or for the sole support of a current-carrying part of the switch or switch parts that would adversely affect the performance of the switch.

15.1.2 The switch is to be conditioned in an air-circulating oven for 300 h. The temperature of the oven is to be the temperature that the switch is intended to attain in the end-use application as specified by the manufacturer. The maximum temperature shall not exceed the temperature index rating of the material – electrical or mechanical, generally without impact.

15.1.3 The samples subjected to the mold-stress test are then to be used for the remaining electrical tests after being allowed to cool to room temperature.

15.2 Diaphragms

15.2.1 If the deterioration of a diaphragm, seal or similar part of a switch intended for use with laundry and dishwasher equipment or the like, would result in a risk of fire or electric shock, the part shall be resistant to deterioration from the vapors or liquids likely to come in contact with it as determined by investigation.

15.2.2 The test procedure to determine whether a part complies with the requirement in 15.2.1 depends upon such factors as the material of which it is made, its size, shape, and application in the appliance. Among the considerations the evaluation is to include, but need not be limited to, are:

a) Visual inspection for cracks, deformation, and the like after artificial aging; and

b) Comparison of hardness, tensile strength, and elongation before and after artificial aging.

15.2.3 With reference to the requirements in 15.2.1 and 15.2.2, a diaphragm made of a noncomposite material or materials is acceptable if its hardness, tensile strength and elongation, before and after air oven aging tests, are in accordance with the requirements specified in the Standard for Gaskets and Seals, UL 157. The maximum service temperature specified in UL 157 corresponds to the temperature rating of the switch.

15.2.4 Materials exposed to powdered laundry detergents and bleach shall be subjected to the exposure test conditions in the Standard for Gaskets and Seals, UL 157.

16 Overload Test

16.1 A switch shall be subjected to the applicable overload test specified in Table 16.1. There shall be no electrical or mechanical malfunction of the switch, and the fuse that is connected to dead metal parts – see 13.9 – shall not open.

Table 16.1
Overload test

Table 16.1 revised May 6, 2013

Switch rating	Test current	Load
0 – 10 A	150% of rating	
More than 10 A	125% of rating	
Horsepower:		
DC	See Table 16.2.	Non-inductive
AC	See Table 16.3.	Inductive, 0.4 – 0.5 power factor

16.2 For the overload tests, a switch is to be operated by means of its actuating member for 50 cycles of operation, making and breaking the specified current at a rate of 6 – 10 cycles per minute.

16.3 A switch rated in horsepower and intended for use on direct current as well as alternating current is to be tested with alternating current and direct current, with different samples used for the alternating- and direct-current tests.

16.4 For a switch that has horsepower ratings at more than one voltage the test sequence shall be completed according to the conditions as follows:

a) If 135% of the overload current at the higher voltage is less than or equal to the overload current at the lower voltage, test both ratings, 3 samples higher voltage, 3 samples lower voltage, temperature test at the higher full load current. Example: 240 Vac 3/4 hp (41.4 A × 1.35) = 55.8 A, this is less than 120 Vac 1/2 hp overload current 58.8 A. Test 3 specimens at 120 V and 3 specimens at 240 V.

b) If 135% of the overload current at the higher voltage is greater than the overload current at the lower voltage, test all samples at the higher voltage rating, temperature test at the higher full load current. Example: 240 Vac 1 hp (48 A × 1.35) = 64.8 A, this is greater than 120 Vac 1/2 hp overload current 58.8 A. Test 6 specimens at 240 V.

16.5 An overload test of a switch in a 3-phase circuit is representative of performance of the switch on a 2-phase circuit of the same voltage for the same horsepower rating.

16.6 A switch that has a horsepower rating and a current rating is to be tested for both horsepower and current ratings unless it is obvious that one overload test would represent the other. If both overload tests are conducted, each test for a horsepower rating is to be conducted on a separate set of samples.

16.7 Other than as noted in 16.8, each set of contacts of a switch is to be subjected to the required overload test.

16.8 For a switch that has multiple sets of identical contacts that are actuated in an identical manner, representative sets of contacts are to be selected for testing.

16.9 If a switch can be left in other than a full off or a full contact position, it shall perform acceptably in the overload test when operated so that the switching contacts are moved from the full contact to an intermediate position sufficient only to interrupt the circuit.

Table 16.2
Test current for dc switches

Switch rating	Full-load current, A			Overload current, A		
hp	125 V	250 V	600 V	125 V	250 V	600 V
1/10	2.0	1.0	–	20	10	–
1/8	2.2	1.1	–	22	11	–
1/6	2.4	1.2	–	24	12	–
1/4	3.0	1.5	–	30	15	–
1/3	3.8	1.8	–	38	19	–
1/2	5.4	2.7	–	54	27	–
3/4	7.4	3.7	1.6	74	37	16
1	9.6	4.8	2.0	96	48	20
1-1/2	13.2	6.6	2.7	132	66	27
2	17.0	8.5	3.6	170	85	36

Table 16.3
Overload-test current for a-c switches

Switch rating in hp	Test current, A								
	120 – 125 V			240 – 250 V			480 V		600 V	
	Single-phase	Two-phase four-wire	Three phase	Single-phase	Two-phase four-wire	Three phase	Two-phase four-wire	Three phase	Two-phase four-wire	Three phase
1/10	18	–	–	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	40.0	40.0	29.4	20.0	20.0	10.0	10.0	8.0	8.0
3/4	82.8	50.0	50.0	41.4	25.0	25.0	12.5	12.5	10.0	10.0
1	96.0	60.0	60.0	48.0	30.0	30.0	15.0	15.0	12.0	12.0
1-1/2	120.0	80.0	80.0	60.0	40.0	40.0	20.0	20.0	16.0	16.0
2	144.0	100.0	100.0	72.0	50.0	50.0	25.0	25.0	20.0	20.0

17 Endurance Test

17.1 A switch rated in amperes or horsepower shall be subjected to the tests described in 17.2 – 17.4. There shall be no electrical or mechanical malfunction of the switch and the fuse that is connected to dead metal parts – see 13.9 – shall not open. At the conclusion of the test, the switch shall be capable of performing its normal function and there shall be no loosening of parts or any other defect that will diminish appreciably the usefulness and reliability of the switch.

17.2 A switch is to be operated by means of its actuating member either manually or by an acceptable machine for 6000 cycles of making and breaking its rated current at a rate of 6 – 10 cycles per minute.

17.3 If an additional rating in horsepower is desired for an ampere-rated alternating-current switch, (such as a heater switch) that has been tested for overload and endurance at unity power factor, an additional endurance test with an inductive load may be waived if the current rating of the switch is not less than twice the full-load motor current corresponding to the horsepower rating. However, the switch is to be subjected to the horsepower overload test in accordance with Table 16.1.

17.4 For a switch rated in horsepower only, the endurance test-current is to be the applicable value of full-load current specified in Table 16.2 or Table 17.1.

17.5 A switch intended for the control of a tungsten-filament lamp is to be operated for an additional 6000 cycles, following the endurance test making and breaking a 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.

17.6 The open-circuit potential of the test circuit described in 17.5 is to be 120 ±5 V, and the closed-circuit potential at the load with normal current flowing is to be within 5% of the open-circuit potential. A direct-current supply is to be used with a T-rated switch – see 24.3. An alternating-current supply is to be used with an L-rated switch – see 24.4.

Table 17.1
Full-load currents for a-c motors rated in horsepower

hp	Full-load current, A									
	120 – 125 V			240 – 250 V			480 V		600 V	
	Single-phase	Two-phase four-wire	Three phase	Single-phase	Two-phase four-wire	Three phase	Two-phase four-wire	Three phase	Two-phase four wire	Three phase
1/10	3.0	–	–	1.5	–	–	–	–	–	–
1/8	3.8	–	–	1.9	–	–	–	–	–	–
1/6	4.4	–	–	2.2	–	–	–	–	–	–
1/4	5.8	–	–	2.9	–	–	–	–	–	–
1/3	7.2	–	–	3.6	–	–	–	–	–	–
1/2	9.8	4.0	4.4	4.9	2.0	2.2	1.0	1.1	0.8	0.9
3/4	13.8	4.8	6.4	6.9	2.4	3.2	1.2	1.6	1.0	1.3
1	16.0	6.4	8.4	8.0	3.2	4.2	1.6	2.1	1.3	1.7
1-1/2	20.0	9.0	12.0	10.0	4.5	6.0	2.3	3.0	1.8	2.4
2	24.0	11.8	13.6	12.0	5.9	6.8	3.0	3.4	2.4	2.7

18 Continuity Test

18.1 Immediately following the endurance test, one sample of a switch having contacts for separate circuits shall be subjected to a continuity test as described in 18.2. There shall be no electrical continuity between the contacts.

18.2 The actuating member of the switch is to be placed in any position that does not require an external retaining force to be maintained. The switch is then to be subjected for 1 min to a 50 – 60 Hz essentially sinusoidal potential between the contacts for the separate circuits. The applied potential is to be equal to the maximum rated voltage of the switch.

19 Temperature Test

19.1 General

19.1.1 The temperature rise on the wiring terminals or on the wire leads used instead of wiring terminals shall not be more than 30°C (54°F) while a switch is continuously carrying the maximum rated current. The current for the temperature test of a switch rated in horsepower only shall be the same as that specified for the Endurance Test, Section 17.

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

19.1.3 During the temperature test, the switch is to be on a flat, horizontal nonconductive surface. Switches that are intended to be mounted immediately adjacent to each other are to be tested while mounted in that manner. If the test fixture used to hold the switch during the endurance test does not affect the temperature of the switch, the fixture may be used for the temperature test.

19.1.4 A switch that does not have a quick-make and -break mechanism and has two or more on contact positions shall comply with the requirement in 19.1.1 with the mechanism in any on position in which it can be left.

19.1.5 As indicated in 13.4, the temperature test is always required following 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 be conducted following the overload test and prior to the endurance test.

19.1.6 The switch is to carry its maximum applicable current continuously (see 13.3) until constant temperatures are attained on the plates of wiring terminals or on wire leads used instead of wiring terminals. Connections to a switch not provided with attached leads are to be made with leads not less than 1 ft (300 mm) long having 1/32-in (0.8-mm) thick thermoplastic insulation and of the size specified in Table 19.1. The temperature test may be conducted at any convenient voltage, using either alternating or direct current.

Table 19.1
Wire size for temperature test

Test current	Wire	Size
A	AWG	(mm^2)
0.0 – 6	18	(0.82)
6.1 – 10	16	(1.3)
10.1 – 15	14	(2.1)
15.1 – 20	12	(3.3)
20.1 – 30	10	(5.3)
30.1 – 45	8	(8.4)
45.1 – 60	6	(13.3)

19.1.7 Temperatures are to be measured using thermocouples consisting of Nos. 28 – 32 AWG (0.08 – 0.03 mm^2) iron and constantan wires. Measurements are to be made on the terminals adjacent to the switch enclosure. If a switch has wire leads, the measurements are to be made on the copper conductors at the point of entrance of the lead to the switch. A temperature is considered to be constant when three successive readings, taken at 5-min intervals, indicate no change.

19.2 Push-in terminals

19.2.1 A switch with push-in terminals shall be tested as described in 19.2.2. The temperature rise on the conductor attached to a push-in (screwless) terminal shall not exceed 30°C (54°F) based on an ambient temperature of 10 – 40°C (50 – 104°F) with the terminal connection carrying maximum rated current of the switch for 30 days without interruption.

19.2.2 Six previously unused samples are to be assembled with copper wire. The size and type of conductor and the method used to install it are to be in accordance with the manufacturer's instructions. Internal components of the switches, including the switching mechanism, may be short-circuited by means of a shunt. Temperatures are to be measured each working day.

19.3 Quick-connect terminals

19.3.1 A switch with quick-connect terminals shall be tested as described in 19.3.2. The temperature rise of a quick-connect tab and connector in combination shall not be more than 30°C (54°F). See 9.4.1.

19.3.2 The switch is to be tested as described in 19.2.2 except that the temperature of the tab is to be measured until constant temperatures are attained while connected to an appropriate female connector.

19.3.3 After the continuous heating test, a connector shall perform acceptably in a 500-cycle heating test as described in 19.3.4.

19.3.4 The switch is to be operated for 500 cycles – each cycle consisting of 45 min on and 15 min off. A current equal to twice the maximum rated current of the switch is to be passed through the terminal during each on period. The final on period may be longer than 45 min if necessary for the connector to attain thermal equilibrium – however, the on period is not to be prolonged longer than is necessary for temperatures to become constant. The temperature rise is to be determined at the end of the 24th on period and again at the end of the 500th on period. The temperature after the 500th on period shall not be more than 15°C (27°F) higher than the temperature reading after the 24th on period and the temperature rise is to not be more than 85°C (153°F).

19.3.5 For the tests described in 19.3.1 – 19.3.4, internal components of the switch, including the switching mechanism, may be short-circuited by means of a shunt.

19.4 Steel terminals

19.4.1 A switch having steel terminals shall be compared to a switch of the same construction having copper terminals. When tested as described in 19.4.2, the switch having steel terminals shall function in the intended manner, and comply with the requirements in 19.1.1 – 19.1.7 for at least as long as the switch having copper terminals functions in the intended manner or complies with the requirements in 19.1.1 – 19.1.7.

19.4.2 Samples of switches of the same construction having:

a) Steel terminals as mentioned in Exception No. 5 of 9.1.2; and

b) Copper terminals, are to be placed in a controlled atmosphere maintained at 60°C (140°F) at a relative humidity of 98 ±2%

The switches are to be investigated to determine whether they comply with the requirements in 19.4.1 at intervals of approximately 168 h. The test is to be continued until ultimate results are obtained, which will usually be within 2,160 h.

20 Dielectric Voltage-Withstand Test

20.1 A switch shall withstand for 1 min, without breakdown, a 50 – 60 Hz essentially sinusoidal potential applied as described in 20.2 – 20.5. The potential is to be applied between live parts of opposite polarity and between live parts and dead metal parts, with the switch at the maximum operating temperature reached in normal use. The test potential is to be in accordance with Table 20.1.

Table 20.1
Test potentials for the dielectric voltage-withstand test

Switch rating	Location of the test potential application	
	Between live parts of opposite polarity	Between live parts and dead metal parts
	V	V
250 V or less	1000	1000
More than 250 V or 1/2 hp	1500	2 V[a] + 1000

[a] V is the voltage rating of the switch.

20.2 As an alternative to the test described in 20.1, a switch that does not have the minimum spacings required by 12.1 shall withstand without breakdown for 1 min the application of a 50 – 60 Hz essentially sinusoidal potential of twice the rated voltage plus 1000 V, with the switch mounted as described in 20.4. The test potential shall be applied between live parts of opposite polarity, and between live parts and dead metal parts.

20.3 The test specified in 20.2 is to be conducted immediately following conditioning of the switch for 48 h in a moist-air chamber at a temperature of 32 ±1°C (90 ±2°F) and a relative humidity of 95 – 100%.

20.4 A switch that is to be tested as described in 20.2 is to be mounted in its intended manner on flat sheet metal not less than 1/16 in (1.6 mm) thick, so that the most severe normal conditions of spacing exist. However, screws or other mounting means are to be the smallest that are commercially obtainable and that are adequate for securing the switch in place as in actual service.

20.5 The test specified in 20.1 or 20.2 is to be conducted using a testing transformer, the output voltage of which is essentially sinusoidal and can be varied. Starting at zero, the applied potential is to be increased gradually until the required test level is reached, and is to be held at that level for 1 min. The increase in the applied potential is to be at a substantially uniform rate as rapid as is consistent with its value being correctly indicated by a voltmeter.

20.6 Other than as noted in 20.7, the transformer for dielectric voltage-withstand testing is to have a capacity of not less than 500 VA and an output or secondary potential of not less than the applicable value specified in 20.1 and 20.2.

20.7 The capacity of a transformer used for the test may be less than 500 VA if there is a meter of not more than 2% error connected across the secondary terminals to directly measure the applied potential.

21 Limited Short-Circuit Test

21.1 A switch having mercury contacts shall be tested in series with a standard, nonrenewable, cartridge fuse in a direct-current circuit of rated voltage. For an ampere rated switch, a 30-A fuse shall be used for a switch rated 30 A or less and a 60-A fuse shall be used for a switch rated 31 – 60 A. For a switch having a horsepower rating, the capacity of the fuse shall not be less than four times the full-load motor current corresponding to the switch rating, but shall not be less than 30 A. The test circuit shall be capable of delivering 3500 A when the system is short-circuited at the testing terminals.

Exception: Alternating current may be employed if the device is intended and marked for use on alternating current only. The power factor for the alternating-current test is to be 0.98 – 1.0.

21.2 There shall be no ignition of the cotton or the insulation on the circuit conductors or emission of flame or molten metal – mercury excepted – from the enclosure housing the switch. Wiring attached to the switch, except leads to the mercury contacts, shall not be damaged. Successive operations shall be conducted by alternately closing the short circuit on the switch by means of an acceptable switching device, and closing the switch on the short circuit.

21.3 Each of three sample switches that have not previously been tested is to be mounted in an enclosure of the material, dimensions, and other characteristics recommended by the manufacturer. Any exposed dead metal part including the enclosure and a metal surface on which the switch is mounted in the intended manner is to be grounded, and cotton is to be placed around each opening in the enclosure. Each switch is to be subjected to three operations with sufficient time between successive operations on any one sample to permit cooling to room temperature, unless the tube is damaged to the degree that it opens the circuit permanently before completion of the third operation. A switch need not be operable after the test.

22 Pull Test

22.1 Push-in terminals

22.1.1 A push-in terminal shall withstand without pull-out or breakage of the conductor or any strand of the conductor, the application of a straight pull as described in 22.1.2.

22.1.2 Conductors of the intended size, solid, stranded, or solder-dipped stranded, are to be connected to both terminals of one circuit in each of six samples in accordance with the manufacturer's instructions. The pull on each conductor is to be increased gradually until it reaches 5 lbf (22 N) and it is to be maintained at that value for 1 min. Previously untested samples may be used for this test.

22.2 Quick-connect terminals

22.2.1 The force required to insert and withdraw the tab and connector of a quick-connect terminal shall comply with the values specified in Table 22.1 for the number of insertions and withdrawals specified in that table.

Table 22.1
Insertion and withdrawal forces

	Force	
	lbf	(N)
First insertion:		
Maximum individual	18	(80)
First withdrawal:		
Maximum individual	20	(89)
Minimum		
Average	5	(22)
Individual	3	(13)
Sixth withdrawal		
Minimum:		
Average	3	(13)
Individual	2	(8.9)

22.2.2 Six unused tabs and connectors assembled in the intended manner to lengths of wire of the proper size are to be tested. See 9.4.1.

22.2.3 Force measurements are to be made using a testing device capable of holding the reading and providing accurate alignment with slow and steady engagement and withdrawal of the tab and connector.

23 Effect of Heat on Actuating Members

23.1 An actuating member of insulating material shall be tested as specified in 23.2. The actuating member shall:

a) Not soften or be damaged by the exposure;

b) Operate the mechanism in the normal manner following such exposure; and

c) Not be adversely affected to the extent that it is appreciably deformed or fails to operate the mechanism.

23.2 The switch assembly is to be subjected to a temperature of 65°C (149°F) for a time long enough to determine that the insulating material under consideration is thoroughly heated – usually 1 h in a constant-temperature oven will be sufficient. The actuating member is then to be operated manually – not controlling a load – as in actual service of 25 cycles of make and break. In conducting this test the actuating member is to be operated with no more force or greater impact than would be the case in normal service. The test is to be conducted immediately after removal of each individual sample from the oven.

RATING

24 General

24.1 The potential rating of a switch shall be any one or combination of the following values: A value, or values, less than 50 V, 50, 75, 125, 250, or 600 V.

Exception: An alternating-current potential rating may also be 120, 240, 277, or 480 V.

24.2 A switch shall have a horsepower or a current rating, or both, for each voltage rating.

24.3 A switch that has been tested as required for a switch intended for the control of tungsten-filament lamps operating on direct current with acceptable results may have an additional T rating at 125 V.

24.4 A switch that has been tested as required for a switch intended for the control of tungsten-filament lamps operating on alternating current with acceptable results may have an additional L rating at 120 or 125 V.

24.5 For two- and three-circuit switches, including fan-motor and double-throw switches, the ampere rating applies to the maximum current carried using any combination of circuits.

24.6 The horsepower rating of a switch shall be 1/10, 1/8, 1/6, 1/4, 1/3, 1/2, 3/4, 1, 1-1/2, or 2 hp or an appropriate combination of such values at different voltages, except that the rating – not more than 2 hp – may be determined from the results of test performance at one or more of the established voltages mentioned in 24.1.