UL 429

STANDARD FOR SAFETY

Electrically Operated Valves

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UL Standard for Safety for Electrically Operated Valves, UL 429

Seventh Edition, Dated November 6, 2013

Summary of Topics

This revision of UL 429 dated March 19, 2021 includes the addition of Class 120 Insulation Systems and Smaller Conductor Sizes for Class 2 Devices; 14.1.3, 14.2.1, and Table 26.1

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.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated January 29, 2021.

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Standard for Electrically Operated Valves

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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 https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover electrically operated general purpose and safety valves rated 600 volts or less and intended for the control of fluids, such as air, gases, oils, refrigerants, steam, water, and the like. Electrically operated valves, other than automotive fuel valves, covered by these requirements are intended to be used in other than hazardous locations as defined by the National Electrical Code, NFPA 70.

1.2 These requirements also cover electrically operated valves intended to be factory installed on or in certain appliances as operating or safety controls.

1.3 These requirements do not cover automatic valves for gas appliances that are covered by the requirements in the Standard for Automatic Valves for Gas Appliances, ANSI Z21.21/CSA 6.5.

1.4 These requirements do not cover valves employing electrical parts, including coils, switch contacts and resistance elements, located in the flammable gas containing compartment of a valve. Valves constructed as such shall comply with the requirements in the Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations, UL 913.

1.5 When the valve assembly includes a pressure or flow regulator, its regulating ability is not covered by requirements in this standard.

1.6 When a mechanically actuated indicator is provided to indicate whether the valve is open or closed, its visibility from any distance is not covered by requirements in this standard.

1.7 In addition to the requirements in this standard, valves intended for fire protection service are required to comply with the Outline of Investigation for Electrically Operated Valves for Fire Protection Service, SU 429A.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a valve covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the valves covered by this standard.

2.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

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2.2 Units of measurement

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

2.2.2 Unless indicated otherwise all voltage and current values mentioned in this standard are root-mean-square (rms).

2.3 Undated references

2.3.1 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.

2.4 Automotive-fuel valve

2.4.1 An automotive fuel valve shall comply with the requirements applicable to safety valves and as noted in 14.1.3, 14.2.6 and 58.4.

2.5 Marine valve

2.5.1 A valve used for marine service shall additionally comply with the requirements in Supplement SA.

3 Glossary

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

3.2 AUTOMOTIVE-FUEL VALVE – An electrically operated valve rated for use with a direct current (DC) circuit and intended for use as a fuel-line shutoff valve on mobile equipment.

3.3 ELECTRICAL CIRCUITS –

a) Class 2 Circuit – A circuit involving a potential of not more than 42.4 volts peak supplied by:

1) An isolating source that complies with the requirements in the Standard for Class 2 Power Units, UL 1310, or the requirements in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3

2) A dry cell battery having output characteristics no greater than those of an inherently limited Class 2 transformer; or

3) A combination of a rechargeable battery and a fixed impedance or regulating network that complies with the applicable performance requirements for an inherently limited Class 2 transformer.

b) High-Voltage Circuit – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a Class 2 circuit.

c) Safety-Control Circuit – A circuit involving one or more safety controls.

3.4 FLAMMABLE AND COMBUSTIBLE FLUID – A gas or liquid considered to be flammable or combustible, such as acetylene, petroleum base hydraulic oil, fuel oil, gasoline, kerosene, or similar petroleum product, liquefied petroleum gas (LP-Gas), manufactured or natural fuel gas, anhydrous ammonia, or hydrogen.

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3.5 GENERAL PURPOSE VALVE – Either a normally open or normally closed valve intended to control the flow of a fluid, but not depended upon to act as a safety valve.

3.6 HAZARDOUS FLUID – A gas or liquid considered to be highly corrosive or toxic, for example, a strong acid or alkali, ammonia, or perchlorethylene. Refrigerants designated other than Class A1 per the Standard for Designation and Safety Classification of Refrigerants, ASHRAE 34 are considered hazardous. Highly Corrosive and Highly Toxic are defined using the Globally Harmonized System of Classification and Labeling Chemicals (GHS) as shown below:

1. Highly Corrosive – Skin Corrosion – Category 1,

2. Highly Toxic Fluid - Any of the following:

   a. Acute Toxicity – Category 1 and 2,

   b. Reproductive Toxicity – Category 1,

   c. Target Organ Toxicity: Single or Repeated Exposure – Category 1.

3.7 HYDRAULIC FLUID POWER SYSTEM – A system that transmits and controls power by use of a pressurized hydraulic fluid within an enclosed circuit.

3.8 INTERLOCK – A switch or control intended to verify the physical state of a required condition, such as proof of closure (that is, supervise the closing of a safety valve) and to furnish that verification to a safety-control circuit by means of a switch contact closure.

3.9 MAXIMUM OPERATING PRESSURE DIFFERENTIAL – The maximum difference between the pressure at an inlet port and the pressure at an outlet port against which an electrically operated valve is intended to operate.

3.10 MAXIMUM RATED PRESSURE – The maximum pressure to which the valve assembly may be subjected as specified by the manufacturer.

3.11 MINIMUM OPERATING PRESSURE DIFFERENTIAL – The minimum difference between the pressure at an inlet port and the pressure at an outlet port required for operation of the valve.

3.12 RAINPROOF ENCLOSURE – An enclosure that prevents rain from interfering with the intended operation of apparatus within the enclosure.

3.13 RAINTIGHT ENCLOSURE – An enclosure that, when exposed to a beating rain, does not permit water to enter the enclosure.

3.14 SAFETY VALVE – A normally closed valve intended to be actuated by a safety control or by an emergency device to prevent the delivery of a fluid that can result in risk of fire.

3.15 SWITCH – A contact device actuated by the valve mechanism and intended to control electrical loads that are internal or external to the valve.

a) Safety Switch – A switch that opens and closes a safety-control circuit, or one intended for use as an interlock in a safety-control circuit.

b) Nonsafety Switch – A switch not associated with a safety-control circuit.

3.16 WATERTIGHT ENCLOSURE – An enclosure that, when subjected to the application of a hose stream as described in the Hosedown Test, Section 43, does not permit water to enter the enclosure.

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CONSTRUCTION

4 General

4.1 Valves shall be constructed so that they comply with the rules for installation and use of such equipment as given in the National Electrical Code, NFPA 70.

5 Assembly

5.1 All valves

5.1.1 A valve shall include all the components necessary for its intended function and installation. The components shall be constructed for assembly as a unit.

5.1.2 Two or more subassemblies intended to be assembled in the field as a unit shall be capable of being joined together without requiring any of the subassemblies to be cut, drilled, welded, or otherwise altered.

5.1.3 If two or more valves or actuating devices, or both, are intended to be used together as one unit, the entire assembly is to be considered and tested as one valve.

5.1.4 The construction of a valve shall be such that parts can be reassembled after being dismantled to the extent needed for servicing.

5.1.5 A screwed cap or cover that constitutes a fluid-confining part and that is intended to be removed for servicing a valve may be hand-removable if:

a) The valve is intended for use with nonflammable or nonhazardous fluids only,

b) Leakage becomes apparent to the user before such part is completely disengaged, and

c) The part can be retightened with the valve under rated pressure so as to prevent further leakage.

Otherwise, such parts shall require the use of a tool for removal.

5.1.6 A seat disc shall be attached to its poppet or holder or be otherwise assembled to prevent it from becoming dislocated under service conditions. The disc may be secured by crimping, staking, or the equivalent, or by means of a chemical bond achieved by vulcanization in a controlled molding process. Cement or adhesive shall not be used as the sole means for securing a disc.

5.1.7 Valves intended for oxygen service shall be free of oil, grease, and other foreign substances that are not compatible with oxygen. Thread sealing compounds and lubricants shall be compatible with oxygen.

5.2 Safety valves

5.2.1 A safety valve shall not depend on an external source of energy, such as electricity, pneumatic or hydraulic pressure to function as a safety shutoff.

5.2.2 A safety valve shall close independently of the energy supplied by the medium flowing. However, the medium flowing is permitted to be used to exert supplementary closing forces on the valve seat.

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5.2.3 A safety valve shall not be equipped with a bypass or with a means to prevent it from closing completely. This requirement does not apply to a feature provided to permit a takeoff to recirculate fluid or to supply a pilot or other individually controlled outlet.

5.2.4 An automatic shutoff mechanism shall be guarded to prevent unintended obstruction of moving parts.

5.2.5 A safety valve shall function as intended as a safety shutoff, regardless of the position of any damper or external operating lever or any reset device. The manipulation of a manual-reset device shall not cause the valve to function as an automatic-reset valve.

5.2.6 A safety valve shall not be equipped with means for manually latching the valve in the open position if such latching may prevent the valve from functioning as a safety shutoff.

5.2.7 The appropriate positions or the direction of movement for a manual operating lever or reset handle included in a safety valve shall be clearly indicated.

5.3 Class 2 valves

5.3.1 Valves whose coils are powered by a Class 2 source shall comply with the construction requirements defined in Table 5.1 and the performance requirements defined in Table 24.3.

Table 5.1
Construction requirements applicable to valves supplied only from a Class 2 source

Requirement	Type of valve or fluid handled		
	General purpose Nonhazardous / Nonflammable	**General purpose Hazardous / Flammable / Combustible**	**Safety Valve**
Section 4	Applies	Applies	Applies
Sections 5 – 11	All apply, note exception in 6.1.5	All apply, note exception in 6.1.5	All apply, exception in 6.1.5 is not applicable
Sections 12	Not required	Not required	Not required
Section 13 and 14	13.2.3 and all of sections 13.4, 13.8 and 13.9 are applicable. Section 14 applies.	13.2.3 and all of sections 13.4, 13.8 and 13.9 are applicable. Section 14 applies.	13.1.1, 13.1.2, 13.2.3 and all of sections 13.4, 13.8 and 13.9 are applicable. Section 14 applies.
Sections 15 – 18	Section 15 is not applicable. 16.2 – 16.4 are applicable. Section 17 is not applicable. 18.1 and 18.6 are applicable.		
Section 19	19.1 is applicable		
Section 20	Applies	Applies	Applies
Sections 21 and 22	Not required	Not required	Applies

6 Materials

6.1 All valves

6.1.1 A part in contact with the fluid to be handled shall be resistant to the action of the fluid.

6.1.2 Zinc, copper, and copper base alloys such as brass are subject to rapid destructive action by ammonia in the presence of water and shall not be used in contact with ammonia.

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6.1.3 Iron and steel parts, except bearings, thermal elements, laminated relay cores, and the like, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other means that have been determined to be equivalent.

6.1.4 The requirement in 6.1.3 applies to enclosing cases whether of sheet steel or cast iron, to current-carrying parts, and to other parts upon which intended mechanical operation may depend. It does not apply to small minor parts of iron or steel, such as washers, screws, bolts, and the like, that are not current-carrying, if malfunction of such unprotected parts does not introduce a risk of injury to persons.

6.1.5 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated current-carrying parts of other than Class 2 nonsafety circuits.

6.1.6 A nonmetallic material that is used for the valve body or as a fluid-confining part of a general purpose pneumatic (air) valve shall comply with the following:

a) The material shall have a minimum Relative Thermal Index (Mech RTI) of 50°C or an RTI in accordance with UL 746B that is not less than the maximum rated ambient/fluid temperature, or the maximum operating temperature measured on the valve body or other fluid-confining part of the valve during the Temperature Test, Section 26, whichever is greater.

b) Samples of the complete valve assembly shall be subjected to the additional tests outlined in Table 24.2.

6.1.7 Glass covering an observation opening in the fluid containing body shall be subjected to the Sight Glass Impact, Section 49 and Sight Glass Temperature Shock, Section 50 requirements.

6.2 Safety valves and general purpose valves for flammable, combustible and hazardous fluids

6.2.1 A fluid-confining or operating part of a valve, if malfunction of such a part will allow leakage or introduce a risk of injury to persons, shall have the strength and durability for intended service of the parts and the assembly.

6.2.2 With reference to the requirements in 6.2.1, a material (except a valve disc or soft seat, an epoxy seal, a seal ring, a diaphragm, or a gasket) shall have a melting point (solidus temperature) of not less than 510°C (950°F) and a tensile strength of not less than 10,000 psi (69 MPa) at 204°C (400°F).

6.2.3 A brazing material used for joining fluid-confining parts of a valve for LP-Gas shall have a melting point (solidus temperature) of not less than 538°C (1000°F). Brazing involving copper or copper base alloys shall not be used on valves intended for use with ammonia.

6.3 Synthetic rubber materials

6.3.1 A synthetic rubber part in contact with one of the fluids indicated in Table 6.1 shall not show excessive volume change or loss of weight, when considered on the basis of its intended function, following immersion for 70 hours in the specified test liquid. See the Immersion-Volume Change Test, Section 46, and the Immersion-Extraction Test, Section 47. The immersion-extraction test is not to be conducted with Reference Fuel A or IRM Oil No. 903.

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Table 6.1
Test fluid for synthetic rubber materials

Fluid handled	Test liquid
Anhydrous ammonia	Liquid anhydrous ammonia
Manufactured, natural fuel gases, and LP-Gas	IRM Oil No. 903 (ASTM D471) and n-Hexane
Fuel oils	IRM Oil No. 903 (ASTM D471)
Gasoline	IRM Oil No. 903 (ASTM D471) and Reference Fuels A and C (ASTM D471)
Hydraulic oils	IRM Oil No. 903 (ASTM D471)
Caustic, corrosive, toxic	Fluid handled
Refrigerants (excluding ASHRAE Class A1), Refrigeration system oils	Specific refrigerant and refrigerant oil combinations

6.3.2 With reference to the requirements in 6.3.1, the change in volume shall not be more than 25 percent swelling (40 percent in Reference Fuel C or H) or 1 percent shrinkage, and the weight loss (extraction) shall not be more than 10 percent.

6.3.3 If the limits for volume change or weight loss in 6.3.1 are exceeded, a complete valve assembly is to be filled with the appropriate test liquid for 70 hours. Following the conditioning the liquid shall be drained and the valve assembly permitted to dry in free air for 70 hours at any ambient temperature in the range of 10 – 40° C (50 – 104° F). The valve shall then comply with the requirements for the External Leakage Test, Section 29, the Seat Leakage Test, Section 30, and the Hydrostatic Strength Test, Section 34 as appropriate for the type of seal and valve.

6.3.4 External seal parts, and operating parts of safety valves affecting the closing of the valve and made of synthetic rubber shall not crack or show visible evidence of deterioration after being subjected to hand flexing following exposure as specified in the accelerated air-oven aging test in the Standard for Gaskets and Seals, UL 157. The oven temperature is based on the maximum normal operating (service) temperature of the seal or operating part. The oven temperature shall not be less than 60°C (140°F).

Exception No. 1: Oxygen bomb test for valves rated for oxygen service.

Exception No. 2: When a synthetic rubber material only used as a static seal cracks or shows visible evidence of deterioration following exposure as specified in the accelerated air-oven aging test, new samples of the synthetic rubber material are to be tested in the complete valve assembly, or as an alternative, new samples of the synthetic rubber material are to be tested in a test setup, which simulates the seal or gasket in the valve. After the accelerated air-oven aging testing, the samples shall comply with the requirements for the External Leakage Test, Section 29 and the Hydrostatic Strength Test, Section 34. For accelerated air-oven aging testing on the valve assembly, other seals or gaskets for which the valve assembly oven aging test is not intended, may be removed from the valve assembly before the accelerated air-oven aging test and then installed prior to the External Leakage Test and the Hydrostatic Strength Test.

6.3.5 External seal parts, and operating parts of safety valves affecting the closing of the valve made of a thermoplastic material in contact with one of the fluids listed in Table 6.1 shall be subjected to the Dimensional Stability Test in Section 51.

6.3.6 External seal parts, and operating parts of safety valves affecting the closing of the valve made of elastomeric and synthetic rubber material in contact with Hydrogen gas at pressures greater than 75 psig shall be subjected to the Accelerated Hydrogen-Pressure Aging Test, Section 54.

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6.3.7 External seal parts, and operating parts of safety valves affecting the closing of the valve made of a composite gasket material shall be subjected to Tensile Strength Test as-received and following immersions in the test fluids indicated in Table 6.1 and air oven aging conditioning specified in 6.3.4, and the retention properties shall not be less than 50% of the as-received values. The Tensile Strength test method is as described in the Standard for Gaskets and Seals, UL 157.

6.4 Corrosion protection

6.4.1 Metallic parts shall be resistant to atmospheric corrosion and degradation by the fluid it normally contacts in service when corrosion of such parts may cause external leakage, or prevent a safety valve from functioning as a safety shutoff.

6.4.2 If atmospheric corrosion of a ferrous part will interfere with the intended function of a valve, the part shall be of a corrosion-resistant material or be provided with a corrosion-resistant protective coating.

6.5 Insulating materials

6.5.1 A material that is used for the direct support of an uninsulated live part shall comply with the Relative Thermal Index (RTI), Hot Wire Ignition (HWI), High-Current-Arc Resistance to Ignition (HAI), Comparative Tracking Index (CTI) values indicated in Table 6.2. A material is in direct support of an uninsulated live part when:

a) It is in direct physical contact with the uninsulated live part; and

b) It serves to physically support and maintain the relative position of the uninsulated live part An insulating material is considered to be in direct support of an uninsulated live part when the material acts to maintain the relative position of the uninsulated live part when the part is not retained in position when the part is rotated in any direction. An encapsulant is not considered direct support unless there is no other primary means to hold the live part in position.

Exception No. 1: With respect to RTI temperatures of insulating materials, see footnote a) of Table 6.2.

Exception No. 2: A generic material provided in the thickness indicated in Table 6.3 shall comply with this requirement without additional evaluation.

Table 6.2
Minimum material characteristics for the direct support of uninsulated live parts

Flame Class	RTI Electrical	Maximum Performance Level Category (PLC)		
		HWI[b, c]	HAI[d, e]	CTI[f, g, h]
HB	a	2	1	3
V-2, VTM-2	a	2	2	3
V-1, VTM-1	a	3	2	3
V-0, VTM-0	a	4	3	3

[a] The electrical Relative Thermal Index (RTI) value of a material is to be determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, by test or by use of the generic RTI table. This material characteristic is dependent upon the minimum thickness at which the material is being used. The RTI shall not be exceeded during the Temperature Test, Section 26. Where an insulating material forms part of an insulation system that complies with the Standard for Systems of Insulating Materials – General, UL 1446, is described as a major insulating ground/interwinding/encapsulant component in the system, and the insulation system forms part of the valve construction, the material may be used at temperatures appropriate for that rated class system.

Table 6.2 Continued on Next Page

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Table 6.2 Continued

Flame Class	RTI Electrical	Maximum Performance Level Category (PLC)		
		HWI[b, c]	HAI[d, e]	CTI[f, g, h]

[b] The Hot Wire Ignition (HWI) value of a material is to be determined by test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. This material characteristic is dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a HWI value, the material is evaluated as in footnote c.

[c] A material without an HWI Performance Level Category (PLC) value or with a HWI PLC value greater (worse) than the value required by this table shall be subjected to the end-product Abnormal Overload Test or the Glow-Wire End-Product Test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or for AC coil constructions to the Burn Out Test, Section 39.

[d] The High Current Arc Resistance to Ignition (HAI) value of a material is to be determined by test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. This material characteristic is dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a HAI value, the material is evaluated as in footnote e. For constructions where there are no arcing parts or no mechanically secured electrical connections subjected to movement (for example electrical connections are potted or encapsulated), HAI is not applicable.

[e] A material without an HAI PLC value or with an HAI PLC value greater (worse) than the value required by this table shall be subjected to the End-Product Arc Resistance Test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[f] The Comparative Tracking Index (CTI) PLC value of a material is to be determined by test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. This material characteristic is not dependent upon the minimum thickness at which the material is being used. When the thickness of an insulating material is less than the minimum specified thickness corresponding to a CTI value, the material is evaluated as having the same CTI value found for the greater thickness. The CTI value applies to insulating materials used in pollution degree 3 environments for voltages of 600 V or less. For equipment where pollution degree 1 or 2 is maintained, an insulating material shall have a CTI PLC of 4 or less. For constructions where creepage distances between uninsulated live parts of opposite polarity or between uninsulated live parts and grounded or dead metal parts are greater than 12.7 mm, CTI is not applicable.

[g] A material without a CTI PLC value or with a CTI PLC value greater (worse) than the value required by Table 6.2 shall have a proof tracking index of 175 when used in pollution degree 3 environment or a proof tracking index of 100 when used in pollution degree 1 or 2 environment as determined by the end-product Proof Tracking Test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[h] CTI requirements are not applicable if the over surface spacing between uninsulated live parts (e.g., spade terminals) at opposite polarity or uninsulated live parts and grounded or accessible dead metal are separated with an over-surface electrical spacing (creepage) of at least 1/2-in (12.7 mm).

Table 6.3
Generic materials for direct support of uninsulated live parts

Generic Material	Minimum thickness, Inch	(mm)	Maximum Temperature, °C[a]
Diallyl Phthalate	0.028	(0.71)	105
Epoxy	0.028	(0.71)	105
Melamine	0.028	(0.71)	130
Melamine-Phenolic	0.028	(0.71)	130
Phenolic	0.028	(0.71)	150
Unfilled Nylon	0.028	(0.71)	105
Unfilled Polycarbonate	0.028	(0.71)	105
Urea Formaldehyde	0.028	(0.71)	100
Ceramic, Porcelain, and Slate	No limit		No limit
Beryllium Oxide	No limit		No limit

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Table 6.3 Continued

Generic Material	Minimum thickness, Inch	(mm)	Maximum Temperature, °C[a]
NOTE – Each material shall be used within its minimum thickness and its Maximum Temperature value shall not be exceeded during the Temperature Test, Section 26.			
[a] *Exception – A material formulation used for one of the generic materials in the Table above may be used when the value measure during the Temperature Test does not exceed the electrical Relative Thermal Index (RTI) value. The RTI value of a material is to be determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, by test or by use of the generic RTI table. This material characteristic is dependent upon the minimum thickness at which the material is being used. Where a material forms part of an insulation system that complies with the Standard for Systems of Insulating Materials – General, UL 1446, is described as a major insulating ground/interwinding/encapsulant component in the system, and the insulation system forms part of the valve construction, the material may be used at temperatures appropriate for that rated class system.*			

7 Fluid Connections

7.1 An opening threaded for connection of pipe shall be in accordance with the Standard for Pipe Threads General Purpose (Inch), ANSI/ASME B1.20.1 or the Standard for Dryseal Pipe Threads (Inch), ANSI/ASME B1.20.3. See also 58.1(h).

Exception: Valves intended for use in installations where pipe fittings incorporate other than NPT type threads shall be permitted to be provided with pipe threads complying with a national pipe thread standard compatible with those fittings. The pipe thread type shall be identified in accordance with 58.16.

7.2 Flanged pipe connections shall be in accordance with the Standard for Classes 25, 125 and 250 Cast Iron Pipe Flanges and Flanged Fittings, ASME B16.1 or the Standard for Pipe Flanges and Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard, ANSI/ASME B16.5.

7.3 A valve intended for connection to pipe larger than 3-inch nominal size shall be provided with flanged pipe connections in accordance with 7.2.

7.4 Tube fitting connections shall be in accordance with Standard for Automotive Tube Fittings, SAE J512; Cast Copper Alloy Fittings for Flared Copper Tubes, ANSI/ASME B16.26; Standard for Refrigeration Tube Fittings – General Specifications, SAE J513; and Pneumatic Fluid Power-Connections-Ports and Stud Ends, ISO 16030.

7.5 Solder joint connections shall be in accordance with the Standard for Cast Copper Alloy Solder Joint Pressure Fittings, ASME/ANSI B16.18 or Wrought Copper and Copper Alloy Solder Joint Pressure Fittings, ASME/ANSI B16.22.

7.6 Weld joint connections shall be in accordance with the Standard for Factory-Made Wrought Steel Buttwelding Fittings, ASME/ANSI B16.9 or Forged Steel Fittings, Socket-Welding and Threaded, ASME/ANSI B16.11.

8 Seals and Stuffing Boxes

8.1 A manually operated stem shall not back out of the valve nor shall threads of a stem enter a stuffing box recess when the stem is rotated or reciprocated, even though an adjustable packing nut or other takeup is disengaged.

Exception: A stem such as that provided for a fuel-gas pilot adjusting screw, not complying with these requirements, may be used if provided with a cap requiring the use of a tool to gain access to the stem.

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8.2 If packing is used to reduce the risk of leakage around a valve stem, and if it is necessary for the user to adjust or renew the packing during intended usage or as wear occurs, a stuffing box conforming to the following shall be used:

a) The stuffing box shall be provided with a removable gland or follower, and shall be provided with a packing nut or other means for adjustment.

b) The stuffing box gland shall be made of corrosion-resistant material.

c) The stuffing box shall be fully packed prior to shipment of the valve.

8.3 A stuffing box for an automatically operated valve shall be constructed to reduce the risk of binding of the valve stem.

8.4 An adjustable stuffing box used to seal an automatically actuated stem of a safety valve shall be constructed so that any adjustment of the packing takeup will not bind the stem sufficiently to interfere with automatic functioning of the valve. A gland shall be spring-loaded.

8.5 The physical characteristics of a takeup spring shall be such that it will advance the gland through not less than one-half its possible travel from its initial setting with the spring compressed. At the advanced position of the gland, a takeup spring shall not require further adjustment to prevent leakage from the stuffing box when tested in accordance with these requirements.

9 Springs

9.1 A spring shall be protected against abrasion and shall be guided or arranged to reduce the risk of binding, buckling, or other interference with its free movement.

10 Diaphragms

10.1 All valves

10.1.1 The assembly of a diaphragm type valve shall be such that positive motion of the valve will follow as a result of diaphragm movement.

10.1.2 A metal part coming in contact with a diaphragm shall have no sharp edges, burrs, projections, and the like, that may chafe or abrade the diaphragm.

10.2 Flammable and hazardous fluid valves

10.2.1 A valve in which a flexible diaphragm, bellows, or similar construction constitutes the only fluid seal, shall have the atmospheric side of the diaphragm or bellows enclosed in a casing constructed to limit external leakage in the event of a diaphragm or bellows rupture, or shall have provisions for connection of a vent pipe or tubing intended to be routed to the outdoors or other acceptable location. See 29.6.

11 Operating Mechanisms

11.1 If threaded fasteners secure moving parts, they shall be upset, locked, or otherwise prevented from loosening when tested in accordance with these requirements.

11.2 Operation of a manually actuated mechanism of a valve shall not subject parts to distortion or damage to the extent that their intended function is impaired.

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11.3 Moving parts shall be separated from conductors by barriers or by its physical location so that such an operating part is not obstructed by stowed wiring.

11.4 A valve using an electronic control circuit shall be investigated under conditions of actual service to determine compliance with applicable requirements.

12 Current-Carrying Parts

12.1 A current-carrying part shall be silver, copper, copper alloy, or other metal that has been determined to be acceptable for such use.

12.2 An uninsulated live part, including a terminal or contact assembly, shall be secured to its supporting surface by methods other than friction between surfaces so that it will be prevented from turning or shifting in position.

12.3 A lock washer may be used to prevent turning of a terminal or connection stud.

13 Electrical Enclosures

13.1 General

13.1.1 The mechanism of a valve shall be protected by an enclosure to reduce the risk of damage to or interference with operating parts. Electrical parts, other than Class 2 terminals in nonsafety circuits, shall be located or enclosed so that protection against unintentional contact or shorting of live parts will be provided if such contact or shorting may result in a risk of fire, electric shock, or injury to persons.

13.1.2 Class 2 terminals for a safety-control circuit shall comply with the requirements in 13.1.1 if shorting or grounding of the terminals may result in a risk of fire, electric shock, or injury to persons, or cause improper operation of a safety control.

13.1.3 The enclosure shall provide room for the distribution of wires and cables required for the intended wiring of the valve. See 14.4.1.

13.1.4 The enclosure and any part of the enclosure such as a cover, or the like, shall be provided with means for securing it in place.

13.1.5 Automotive fuel valves are not required to comply with these enclosure requirements.

13.1.6 Glass used for an observation window not more than 4 inches (102 mm) in any dimension and not less than 1/16 in. (1.60 mm) thick or glass used for an observation window having no dimension greater than 12 inches (305 mm) and not less than 1/8 in. (3.2 mm) thick need not be subject to additional evaluation. Glass used to cover a larger opening shall comply with the Crushing resistance test and Resistance to Impact (normal only) test specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

13.1.7 A nonmetallic enclosure or enclosure part, including coil retainers, shall comply with 13.3 as appropriate. Coil retainers of enclosed valves where the coil retainer is exposed to the same degree as the enclosures shall be additionally subjected to the Coil Retainer Impact and Coil Retainer Mechanical Strength Tests in Sections 52 and 53 respectively.

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13.2 Metallic enclosures

13.2.1 The thickness of a metal enclosure shall not be less than that specified in Table 13.1, Table 13.2, and Table 13.3.

13.2.2 A part such as a dial or nameplate that constitutes part of the enclosure, shall be of metal or other material as specified for the basic enclosure.

Table 13.1
Thickness of sheet metal for enclosures – carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Uncoated,		Metal coated,	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch	(mm)	inch	(mm)
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited		0.020[d,e]	(0.51)	0.023[d,e]	(0.58)
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)				
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited		0.026[d,e]	(0.66)	0.029[d,e]	(0.74)
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)				
8.0	(20.4)	Not limited		12.0	(30.5)	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)				
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)				

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has the same outside dimensions as the enclosure surface and which has torsional rigidity to resist the bending moments which is capable of being applied via the enclosure surface when it is deflected. Construction that is determined to have equivalent reinforcing is allowed to be accomplished by constructions that produce a structure which is as rigid as one built with a frame of angles or channels. Constructions determined to be without supporting frame include:

1) Single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame, for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure are allowed to have supports in common and be made of a single sheet.

[c] For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

[d] Sheet metal for an enclosure intended for outdoor (rainproof, raintight or watertight) use shall comply with 13.6.1 – 13.6.5.

[e] At points where a wiring system is to be connected, the thickness shall not be less than 0.032 inch (0.81 mm) if uncoated and not less than 0.034 inch (0.86 mm) if zinc coated.

Table 13.2
Minimum thickness of sheet metal for enclosures aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,			
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch	(mm)
3.0	(7.6)	Not limited		7.0	(17.8)	Not limited		0.023[d,e]	(0.58)
3.5	(8.9)	4.0	(10.2)	8.5	(21.7)	9.5	(24.1)		

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Table 13.2 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,			
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch	(mm)
4.0	(10.2)	Not limited		10.0	(25.4)	Not limited		0.029[e]	(0.74)
5.0	(12.7)	6.0	(15.2)	10.5	(26.7)	13.5	(34.2)		
6.0	(15.2)	Not limited		14.0	(35.6)	Not limited		0.036[e]	(0.91)
6.5	(16.5)	8.0	(20.3)	15.0	(38.1)	18.0	(45.7)		
8.0	(20.3)	Not limited		19.0	(48.3)	Not limited		0.045	(1.14)
9.5	(24.1)	11.5	(29.2)	21.0	(53.3)	25.0	(63.5)		
12.0	(30.5)	Not limited		28.0	(71.1)	Not limited		0.058	(1.47)
14.0	(35.6)	16.0	(40.6)	30.0	(76.2)	37.0	(94.0)		

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has the same outside dimensions as the enclosure surface and which has torsional rigidity to resist the bending moments which are capable of being applied via the enclosure surface when it is deflected. Construction that is determined to have equivalent reinforcing is allowed to be accomplished by constructions that produce a structure which is as rigid as one built with a frame of angles or channels. Constructions considered to be without supporting frame include:

1) Single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame (for example, with spring clips).

[b] The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

[c] For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

[d] Sheet copper, brass, or aluminum for an enclosure intended for outdoor use (rainproof, raintight or watertight) shall not be less than 0.029 inch (0.74 mm) thick.

[e] At points where a wiring system is to be connected, the thickness shall not be less than 0.045 inch (1.14 mm).

Table 13.3
Cast-metal enclosures of malleable iron and die-cast or permanent mold cast aluminum, brass, bronze, or zinc

Use or dimensions of area involved	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast type,	
	inch	(mm)	inch	(mm)
Area of 24 square inches (155 cm^2) or less and having no dimension greater than 6 inches (152 mm)[a,b,c]	1/16	(1.6)	1/8	(3.2)
Area greater than 24 square inches or having any dimension greater than 6 inches	3/32	(2.4)	1/8	(3.2)
At a conduit hole	1/4	(6.4)	1/4	(6.4)

[a] The area limitation for metal 1/16 inch thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

[b] Die-cast metal may be minimum 0.035 inch (0.89 mm) thick if:

1) The enclosure is not intended to be used as a splice box and

2) The voltage rating of the complete device is such that the potential between any two conductors does not exceed 250 volts AC or DC.

[c] Die-cast metal may be minimum 0.028 inch (0.71 mm) thick for an enclosure housing only low-voltage circuits.

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13.2.3 If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall not be less than 3-1/2 threads in the metal and there shall be a smooth, rounded inlet hole for the conductors that affords protection to the conductors equivalent to that provided by a standard conduit bushing and that has an internal diameter as indicated in Table 13.4.

Table 13.4
Throat diameter of conduit stop

Trade size of conduit,		Minimum diameter,[a]		Maximum diameter,	
inch	(mm O.D.)	inch	(mm)	inches	(mm)
1/2	(21.3)	0.56	(14.2)	0.62	(15.8)
3/4	(26.7)	0.74	(18.8)	0.82	(20.9)
1	(33.4)	0.94	(23.9)	1.05	(26.7)

[a] A smaller diameter may be provided in a construction as described in 14.2.2 if the throat diameter of the conduit stop is of a sufficient size to accommodate the conductors without damage and the conductors will not be pulled through the opening during installation of the device.

13.3 Polymeric enclosures

13.3.1 A polymeric electrical enclosure or a polymeric part (such as a plug or other closure) that is relied upon to complete and maintain the integrity of an electrical enclosure shall comply with the Flammability – 127 mm (5 Inch) Flame Test, Crushing Resistance Test, Resistance to Impact Test (both normal and cold), and the Mold Stress-Relief Distortion Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and also with the additional requirements specified in this standard. Polymeric parts may be tested separately or may be tested as part of the overall electrical enclosure.

Exception No. 1: Polymeric enclosures enclosing Class 2 circuits only, need not comply with the flammability – 127 mm (5 Inch) flame rating, Crush Resistance Test, Resistance to Impact Test, maximum use temperature properties and the Mold Stress-Relief Distortion Test.

Exception No. 2: A polymeric plug or other closure made of a material classed in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and that serves to complete and maintain the integrity of an electrical enclosure is acceptable if the closure is:

a) Not more than 1.2 square inches (775 mm^2) in area and is:

1) Rated 5VA, 5VB, V-0, V-1, or V-2; or

2) Rated HB and complies with the Flammability – 127 mm (5 Inch) Flame Test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

b) More than 1.2 square inches (775 mm^2) in area and is:

1) Rated 5VA and complies with the Resistance to Impact Test requirements (both normal and cold) in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C or;

2) Rated 5VB, V-0, V-1, V-2 or HB and complies with the Flammability – 127 mm (5 Inch) Flame Test, the Resistance to Impact Test (both normal and cold) and the Crushing Resistance Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

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13.3.2 In addition to the requirements in 13.3.1 polymeric materials used for outdoor use type applications as defined in the Standard for Enclosures for Electrical Equipment, UL 50, such as Types 3, 3R, 4, and 4X enclosures or polymeric materials used for closures, fastenings, or hinges for these enclosures, shall comply with the Ultraviolet Light Exposure Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

13.3.3 In addition to the requirements in 13.3.1, polymeric materials used for Types 6 and 6P enclosures or polymeric materials used for closures, fastenings, or hinges for these enclosures, shall comply with the Ultraviolet Light Exposure Test and the Water Exposure and Immersion Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

13.4 Enclosure conduit connection

13.4.1 A conduit hub or nipple that is molded into a polymeric enclosure or attached to the enclosure of a valve by swaging, staking, or similar means shall withstand, without pulling apart or turning, a direct pull of 200 pounds (890 N), a bending moment of 600 pound-inches (67.8 N·m), and a torque of 600 pound-inches, each applied for 5 minutes.

Exception: If the enclosure has only one conduit connection point and is intended to be an end of line device, the bending moment shall be 150 pound-inches (17.0 N-m), and the torque shall be 200 pound-inches (22.6 N-m)

13.4.2 For the pullout test in 13.4.1, the valve is to be supported by rigid conduit in the intended manner and is to support a weight of 200 pounds (90.7 kg).

13.4.3 For the bending and torsion tests in 13.4.1, the valve is to be rigidly supported by means other than the conduit fittings. In the bending test, the force is to be applied to the conduit at right angles to its axis, and the lever arm is to be measured from the wall of the enclosure in which the hub or stud is located to the point of application of the bending force. In the torsion test, the force is to be applied to the conduit in a direction tending to tighten the connection, and the lever arm is to be measured from the center of the conduit.

13.4.4 With reference to 13.4.1, the bending test, a 9 feet – 10-7/64 inch minimum (3.0 meter) length of conduit of the intended size shall be installed:

a) In a hub or an opening if provided as part of the enclosure; or

b) If a hub or opening is not provided, in the center of the largest unreinforced surface intended for the connection of conduit.

13.4.5 The enclosure shall be securely mounted as intended in service, but positioned so that the installed conduit extends in a horizontal plane. The test shall be terminated once the deflection of the conduit end exceeds 10 inches (255 mm). If a weight is necessary to cause the conduit end to deflect, the test shall be terminated once the deflection of the conduit end exceeds 10 inches (255 mm) or once a bending moment of 600 pound-inches (67.8 N·m) is achieved. For the SI system of units, the magnitude of the weight shall be determined from the equation:

$$W = (0.1M - 0.4CL) / L$$

in which,

W and C are measured in kilograms;

M is measured in Newton-meters; and

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L is measured in meters.

For the inch-pound units, the magnitude of the weight shall be determined from the equation:

$$W = (M - 0.5CL) / L$$

in which,

W is the weight, in pounds, to be hung at the end of the conduit;

L is the length of the conduit, in inches, from the wall of the enclosure to the point at which the weight is suspended;

C is the weight of the conduit, in pounds; and

M is the bending moment required, in inch-pounds.

13.5 Openings

13.5.1 An opening shall not be provided in an enclosure that houses a fuse or any portion of a circuit breaker other than the operating handle, unless the construction affords containment of electrical fault disturbances equivalent to that provided by an enclosure complying with the requirements in 13.1.1 – 13.3.3.

13.5.2 The following requirements apply to openings:

a) An opening shall not be provided in a compartment or part of an enclosure that contains field-wiring splices in a line-voltage circuit.

b) No openings shall be located in the mounting surface of an enclosure.

Exception: The following openings may be located in the mounting surface of an enclosure:

1) A mounting opening.

2) A maximum of four openings provided for the escape of air or paint during a painting process. The maximum dimension of such an opening shall not exceed 1/8 inch (3.2 mm).

3) A maximum of four unused holes provided for mounting of internal components. The maximum dimension of such an opening shall not exceed 3/16 inch (4.8 mm).

c) If the bottom surface is not the mounting surface, an opening may be provided in the bottom surface of an enclosure if the opening does not permit materials to fall directly out from the interior of the unit. See Figure 13.1 for an example of an acceptable construction.

d) The shortest distance between an opening and the bottom of an enclosure or a wall-mounting surface shall be at least one-quarter of the enclosure height or depth, respectively, or 1 inch (25.4 mm), whichever is less.

e) There shall not be emission of flame or molten material, or manifestation of risk of fire, during normal or abnormal tests on the control.

f) Unless the construction of a device provided with forced ventilation is such that there is no direct path between live parts and the outlet opening, burnout tests as described in Section 39 shall be conducted to determine that there is no emission of flame or molten material through the opening.

g) Air from an opening, either forced or otherwise, shall not be directed:

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