

# UL 325

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Door, Drapery, Gate, Louver,  
and Window Operators and  
Systems



Underwriters Laboratories Inc. (UL)  
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The new and revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated September 20, 2001 and March 25, 2002. The bulletin(s) is now obsolete and may be discarded.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

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

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

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1-108 .....	June 7, 2002
A1-A2 .....	June 7, 2002
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## **UL 325**

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#### **Fifth Edition**

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This ANSI/UL Standard for Safety, which consists of the Fifth Edition including revisions through June 7, 2002, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to the UL Northbrook Standards Department, 333 Pfingsten Road, Northbrook, IL 60062.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 325 on January 21, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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## FOREWORD

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

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

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

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

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

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

## INTRODUCTION

### 1 Scope

1.1 These requirements cover electric operators for doors, draperies, gates, louvers, windows and other opening and closing appliances rated 600 V or less to be employed in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements also cover complete doors, gates, and other such assemblies that include electric opening and closing appliances.

1.3 These requirements also cover accessories, such as external entrapment protection devices, for use with appliances covered by this standard.

1.4 Doors and door operators intended for exit use as defined in the Life Safety Code, NFPA 101 and codes such as the BOCA National Building Code, the Standard Building Code, and the Uniform Building Code, are additionally subject to design requirements specific to such use.

### 2 Terminology

2.1 In the following text, a requirement that only applies to a specific type or types of equipment is identified by a specific reference in the requirement to the type or types of equipment covered by the requirement. In the absence of a specific reference, or if the term "appliance" or "operator" is used, it is understood that the requirement applies to all types of equipment within the scope of this Standard.

### 3 Glossary

3.1 CLASS 2 CIRCUIT – An isolated secondary circuit involving a potential of not more than 30 V (42.4 V peak) supplied by:

- a) An inherently-limited Class 2 transformer;
- b) A combination of an isolated transformer secondary winding and a fixed impedance or regulating network that together comply with the performance requirements for an inherently-limited Class 2 transformer;
- c) A dry-cell battery having output characteristics not greater than those of an inherently-limited Class 2 transformer;
- d) Any combination of (a), (b), and (c) above that together comply with the performance requirements for an inherently-limited Class 2 transformer; or
- e) One or more combinations of a Class 2 transformer and an overcurrent protective device that together comply with the performance requirements for a noninherently-limited Class 2 transformer.

A line-connected circuit connected in series with an impedance as a means of limiting the voltage and current is not a Class 2 circuit.

3.2 COMBINATION RIGID ONE-PIECE OVERHEAD GARAGE DOOR OPERATOR SYSTEM – A door and operator combination where the door is constructed in one rigid piece.

3.3 COMMERCIAL/GENERAL ACCESS VEHICULAR GATE OPERATOR – CLASS II – A vehicular gate operator (or system) intended for use in a commercial location or building such as a multi-family housing unit (five or more single family units), hotel, garages, retail store, or other building servicing the general public.

3.4 DOOR – A moving barrier such as a swinging, sliding, raising, lowering, rolling, or the like, barrier, that closes an opening for entrance and/or egress by persons or vehicles into or out of a building.

3.5 DRAPERY (or BLINDS, SHADES AND THE LIKE) OPERATOR (OR SYSTEM) – An operator (or system) for opening or closing of window drapery, blinds, shade, or other window coverings, other than louver or shutter operators and systems.

3.6 ENTRAPMENT – The condition when an object is caught or held in a position that increases the risk of injury.

3.7 EXTERNAL ENTRAPMENT PROTECTION DEVICE – A device, examples being an edge sensor, a photoelectric sensor, or similar entrapment protection device, which provides protection against entrapment when activated and is not incorporated as a permanent part of an operator.

3.8 GATE – A moving barrier such as a swinging, sliding, raising, lowering, rolling, or the like, barrier, that is a stand-alone passage barrier or is that portion of a wall or fence system that controls entrance and/or egress by persons or vehicles and completes the perimeter of a defined area.

3.9 INDUSTRIAL/LIMITED ACCESS VEHICULAR GATE OPERATOR – CLASS III – A vehicular gate operator (or system) intended for use in an industrial location or building such as a factory or loading dock area or other locations not intended to service the general public.

3.10 INHERENT ENTRAPMENT PROTECTION SYSTEM – A system, examples being a motor current or speed sensing system, which provides protection against entrapment upon sensing an object and is incorporated as a permanent and integral part of an operator.

3.11 LIGHT DUTY (COMMERCIAL/INDUSTRIAL) VEHICULAR DOOR OR GATE OPERATOR (OR SYSTEM) – A commercial or industrial vehicular door or Class II, III, or IV vehicular gate operator (or system) intended and marked for limited or restricted duty.

3.12 LOUVER OPERATOR (OR SYSTEM) – An operator (or system) intended to open and close louvers or shutters used for ventilation or as window coverings.

3.13 PEDESTRIAN DOOR OR GATE OPERATOR (OR SYSTEM) – A swinging, sliding, biparting, folding, or rotating door or gate operator (or system) that is used at pedestrian entrances or exits to buildings or other pedestrian traffic ways. They are not used for vehicular traffic.

3.14 RESIDENTIAL GARAGE-DOOR OPERATOR – A vehicular door operator serving a residential building of one to four single family units.

3.15 RESIDENTIAL VEHICULAR GATE OPERATOR – CLASS I – A vehicular gate operator (or system) intended for use in a home of one-to four single family dwelling, or a garage or parking area associated therewith.

3.16 RESTRICTED ACCESS VEHICULAR GATE OPERATOR – CLASS IV – A vehicular gate operator (or system) intended for use in a guarded industrial location or building such as an airport security area or other restricted access locations not servicing the general public, in which unauthorized access is prevented via supervision by security personnel.



3.17 SYSTEM – In the context of these requirements, a system refers to a group of interacting devices intended to perform a common function.

3.18 TWO SEQUENTIAL ACTIVATIONS – Two activations of an entrapment protection device that are not interrupted by an open or close limit device.

3.19 VEHICULAR BARRIER (ARM) OPERATOR (OR SYSTEM) – An operator (or system) that controls a cantilever type device (or system), consisting of a mechanical arm or barrier that moves in a vertical arc, intended for vehicular traffic flow at entrances or exits to areas such as parking garages, lots or toll areas.

3.20 VEHICULAR DOOR OPERATOR (OR SYSTEM) – A door operator (or system) that is intended for vehicular traffic at entrances or exits to commercial or industrial buildings areas such as garages, loading docks, or parking lots.

3.21 VEHICULAR HORIZONTAL SLIDE-GATE OPERATOR (OR SYSTEM) – A vehicular gate operator (or system) that controls a gate which slides in a horizontal direction that is intended for use for vehicular entrance or exit to a drive, parking lot, or the like.

3.22 VEHICULAR SWING-GATE OPERATOR (OR SYSTEM) – A vehicular gate operator (or system) that controls a gate which swings in an arc in a horizontal plane that is intended for use for vehicular entrance or exit to a drive, parking lot, or the like.

3.23 VEHICULAR VERTICAL LIFT-GATE OPERATOR (OR SYSTEM) – A vehicular gate operator (or system) that controls a gate which moves in the vertical direction and is intended for use at a vehicular entrance or exit to a drive, parking lot, or similar location.

3.24 VEHICULAR VERTICAL PIVOT-GATE OPERATOR (OR SYSTEM) – A vehicular gate operator (or system) that controls a gate that moves in an arc in a vertical plane that is intended for use for vehicular entrances or exits to a drive, parking lot, or the like.

3.25 WINDOW OPERATOR (OR SYSTEM) – An operator (or system) for opening casement, sliding, or other types of windows including skylights.

3.26 WIRED CONTROL – A control implemented in a form of fixed physical interconnections between the control, the associated devices, and an operator to perform predetermined functions in response to input signals.

3.27 WIRELESS CONTROL – A control implemented in means other than fixed physical interconnections (such as radio waves or infrared beams) between the control, the associated devices, and an operator to perform predetermined functions in response to input signals.

## 4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

4.2 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.

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

4.4 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.

## 5 Units of Measurement

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

## 6 References

6.1 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.

## CONSTRUCTION

### 7 General

7.1 An appliance shall employ materials that are acceptable for the use and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

7.2 An appliance shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing its risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

## 8 Frame and Enclosure

8.1 For an unreinforced flat surface, cast metal shall not be less than 1/8-in (3.2-mm) thick, except that malleable iron may be not less than 3/32-in (2.4-mm) thick, and die-cast metal may be not less than 5/64-in (2.0-mm) thick. Corresponding thicknesses of not less than 3/32, 1/16, and 3/64 in (2.4, 1.6, and 1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or of a shape or size that provides mechanical strength equivalent to that required.

8.2 An enclosure of sheet metal shall be judged with respect to size, shape, thickness of metal, and acceptability for the application considering the intended use of the complete appliance. The use of sheet steel having a thickness of less than 0.026 in (0.66 mm) if uncoated or 0.029 in (0.74 mm) if galvanized or of nonferrous sheet metal having a thickness of less than 0.036 in (0.91 mm) is not acceptable.

*Exception: An area that is relatively small or a surface that is curved or otherwise reinforced.*

8.3 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 in (0.81 mm) if uncoated steel, not less than 0.034 in (0.86 mm) if galvanized steel and not less than 0.045 in (1.14 mm) if nonferrous.

8.4 The effects of the following factors shall be determined for compliance of a nonmetallic enclosure or an enclosure of magnesium with 7.2:

- 1) Mechanical strength,
- 2) Resistance to impact,
- 3) Moisture-absorption properties,
- 4) Combustibility, and
- 5) Resistance to distortion at temperatures to which the material is subjected under conditions of normal or abnormal use.

8.5 The enclosure of an appliance shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the appliance is supported.

8.6 The requirement in 8.5 will necessitate the use of a barrier of noncombustible material:

- a) Under a motor unless:
  - 1) The structural parts of the motor or of the appliance provide the equivalent of such a barrier;
  - 2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the appliance when the motor is energized under each of the following fault conditions:
    - i) Open main winding,
    - ii) Open auxiliary winding,
    - iii) Starting switch short-circuited, and

iv) Capacitor of a permanent-split capacitor motor short-circuited – the short circuit is to be applied before the motor is energized, and the rotor is to be locked;

3) The motor is provided with a thermal protector – a protective device that is sensitive to temperature and current – that will prevent the temperature of the motor windings from exceeding 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked; or

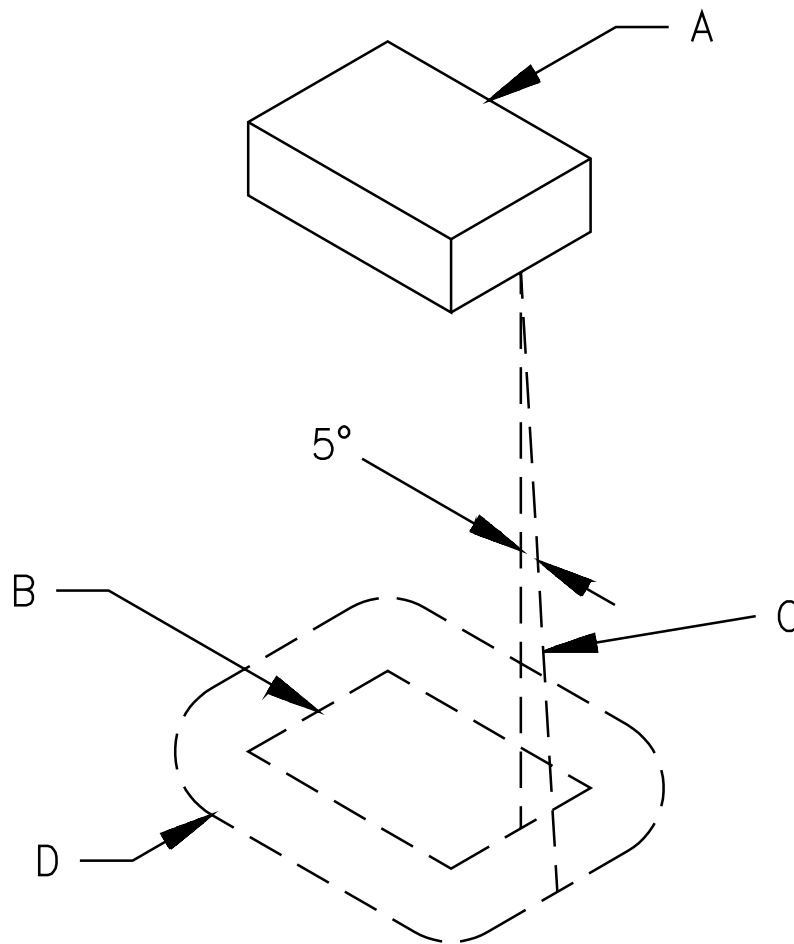
4) The motor complies with the requirements in the Standard for Impedance-Protected Motors, UL 519, and the temperature of the motor winding will not exceed 150°C (302°F) during the first 72 h of operation with the rotor of the motor locked.

b) Under wiring, unless it is neoprene, cross-linked or thermoplastic-insulated.

8.7 The requirements in 8.5 will also necessitate that a switch, a relay, a solenoid, or the like be individually and completely enclosed, except for terminals, unless it can be shown that breakdown or malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the appliance enclosure.

8.8 The barrier mentioned in 8.6 shall be horizontal, shall be located as illustrated in Figure 8.1, and shall have an area in accordance with that illustration. Openings for drainage, ventilation, and the like may be employed in the barrier if such openings would not permit molten metal, burning insulation, or the like to fall on combustible material.

**Figure 8.1**  
**Location and extent of barrier**



EB120A

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded and will consist of the unshielded portion of a component that is partially shielded by the component enclosure or equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. The line is always:

- a) tangent to the component,
- b) 5 degrees from the vertical, and
- c) oriented so that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

## 9 Accessibility of Uninsulated Live Parts and Film-Coated Wire

9.1 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either (a) or (b). See 14.4.2.

- a) For an opening that has a minor dimension (see 9.5) less than 1 in (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 9.1.
- b) For an opening that has a minor dimension of 1 in or more, such a part or wire shall be spaced from the opening as specified in Table 9.1.

*Exception: A motor need not comply with these requirements if the integral enclosure of the motor complies with the requirements in 9.2.*

9.2 With respect to an integral enclosure of a motor as mentioned in the exception to 9.1:

- a) An opening that has a minor dimension (see 9.5) less than 3/4 in (19.1 mm) is acceptable if:
  - 1) Film-coated wire cannot be contacted by the probe illustrated in Figure 9.3;
  - 2) In a directly accessible motor (see 9.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 9.4; and
  - 3) In an indirectly accessible motor (see 9.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 9.2.
- b) An opening that has a minor dimension of 3/4 in or more is acceptable if a part or wire is spaced from the opening as specified in Table 9.1.

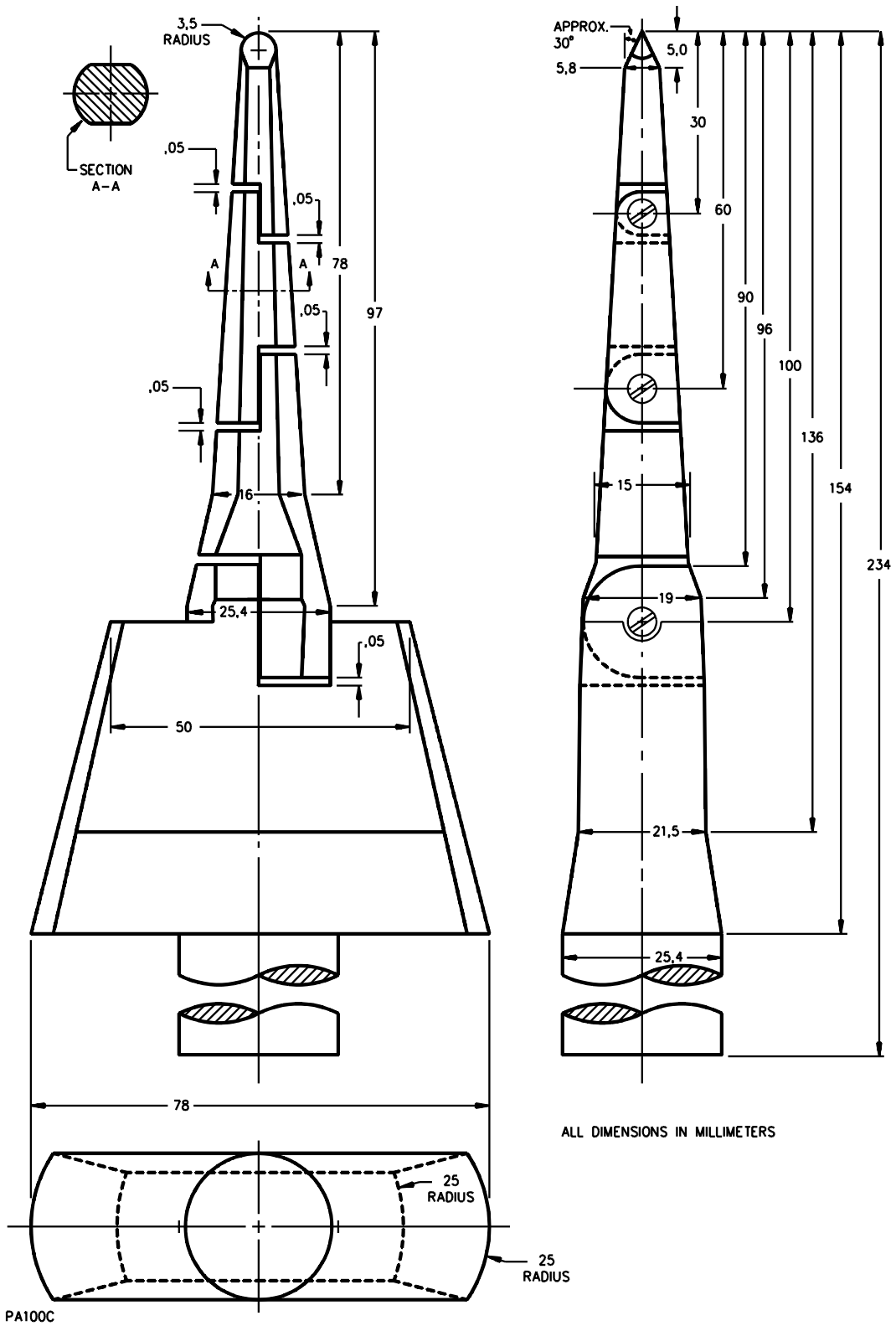
9.3 The probes mentioned in 9.1 and 9.2 and illustrated in Figures 9.1, 9.2, 9.3, and 9.4 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figures 9.1 and 9.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

9.4 The probes mentioned in 9.1 and 9.2 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

9.5 With reference to the requirements in 9.1 and 9.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

9.6 With reference to the requirements in 9.2, an indirectly accessible motor is a motor that is accessible by the probe illustrated in Figure 9.1 only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed with or without using a tool under the conditions noted in 9.7 (a) and (b), or will be located higher than 8 ft (2.44 m) above the floor when the operator is installed as intended and is marked in accordance with 59.3.7. A directly accessible motor is a motor that can be contacted by the probe illustrated in Figure 9.1 without opening or removing any part and will be located 8 ft (2.44 m) or less above the floor when the operator is installed as intended.

Figure 9.1  
Articulate probe with web stop



9.7 During the examination of a product to determine whether it complies with the requirements in 9.1 or 9.2, a part of the enclosure that may be opened or removed by the user (to attach an accessory, to make an operating adjustment, relamping, or for other reasons) is to be opened or removed if:

- a) The enclosure can be removed without tools, or
- b) The enclosure can only be removed using a tool, but it is necessary that the appliance be connected to the source of supply or instructions specify it be connected to the supply during user servicing operations.

9.8 With reference to the requirements in 9.1 and 9.2, insulated brush caps are not required to be additionally enclosed.

**Table 9.1**

**Minimum acceptable distance from an opening to a part that may involve a risk of electric shock**

Minor dimension <sup>a</sup> of opening,		Minimum distance from opening to part,	
In <sup>b</sup>	(mm)	In <sup>b</sup>	(mm)
3/4 <sup>c</sup>	(19.1)	4-1/2	(114)
1 <sup>c</sup>	(25.4)	6-1/2	(165)
1-1/4	(31.8)	7-1/2	(190)
1-1/2	(38.1)	12-1/2	(318)
1-7/8	(47.6)	15-1/2	(394)
2-1/8	(54.0)	17-1/2	(444)
d		30	(762)

<sup>a</sup> See 9.5.  
<sup>b</sup> Between 3/4 in and 2-1/8 in, interpolation is to be used to determine a value between values specified in the table.  
<sup>c</sup> Any dimension less than 1 in applied to a motor only.  
<sup>d</sup> More than 2-1/8 in, but not more than 6 in (152 mm).



Figure 9.2  
Probe for uninsulated live parts

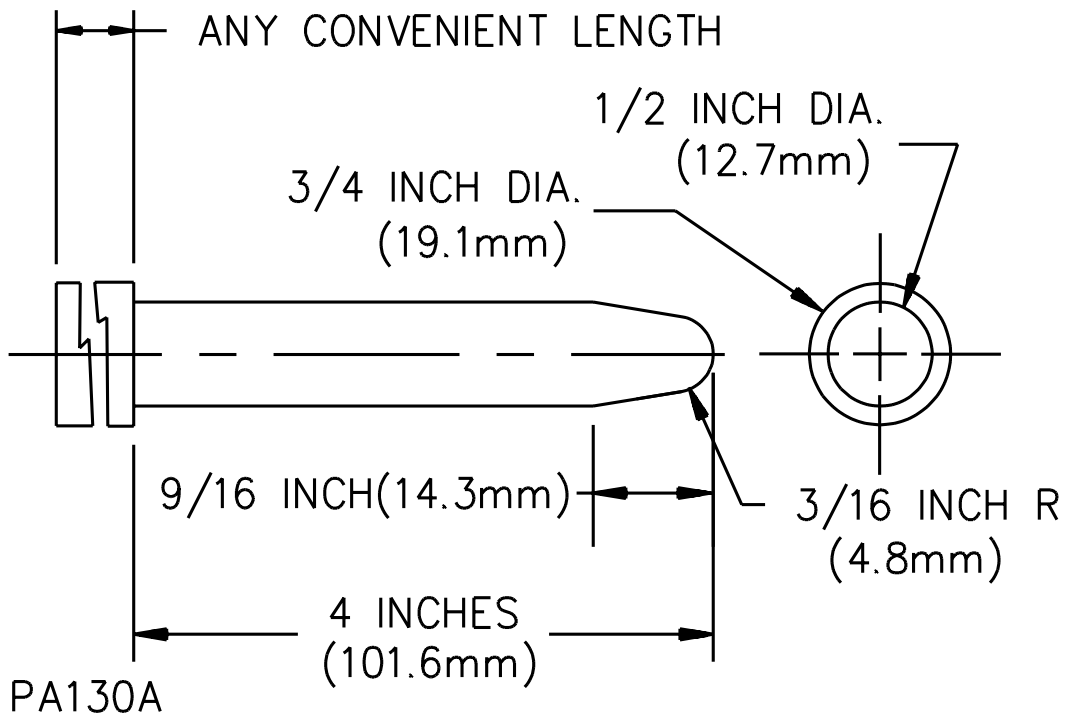
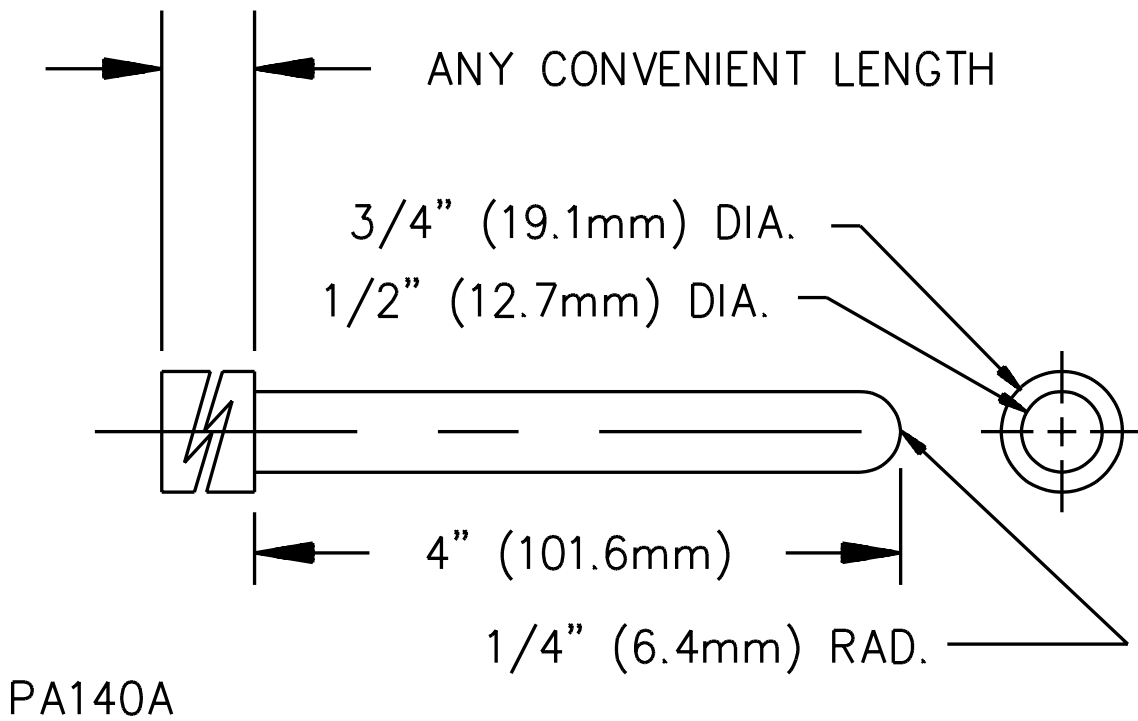
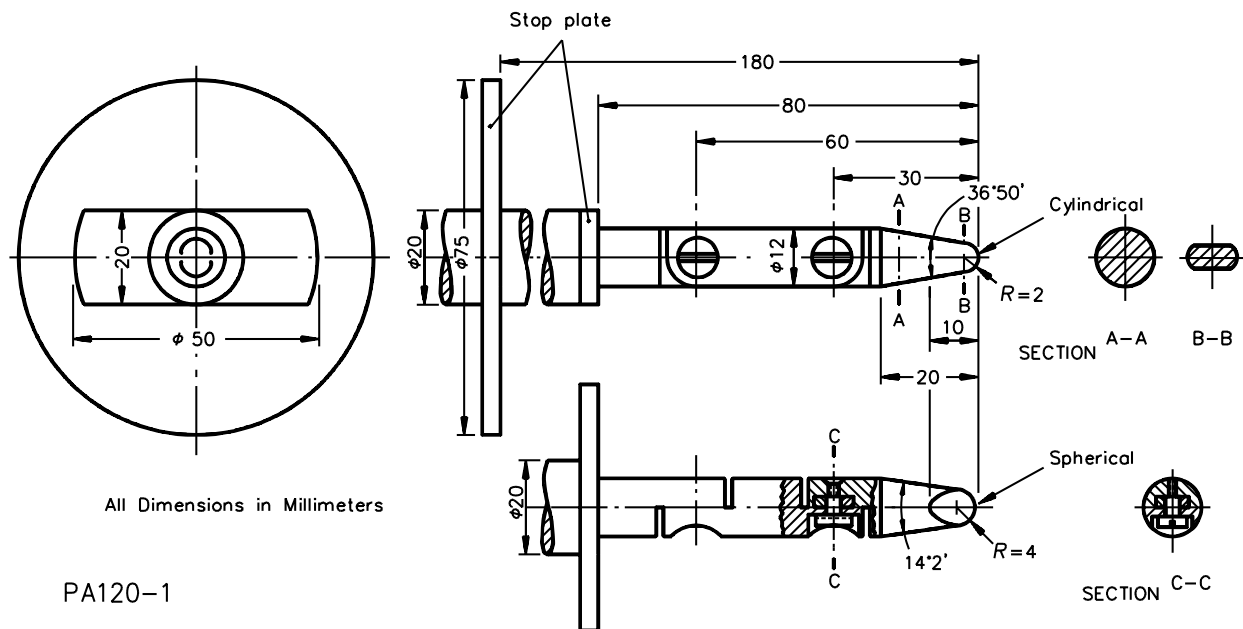


Figure 9.3  
Probe for film-coated wire



**Figure 9.4**  
**International electrotechnical commission (IEC) articulate accessibility probe with stop plate**  
 Courtesy of IEC



## 10 Mechanical Assembly

10.1 An appliance shall be assembled so that it will not be adversely affected by the vibration of normal operation. Brush caps shall be tightly threaded or otherwise designed to prevent loosening.

10.2 A switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and, shall be prevented from shifting or turning.

*Exception No. 1: A switch need not be prevented from turning if all four of the following conditions are met:*

- a) The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch.*
- b) Means for mounting the switch make it unlikely that operation of the switch will loosen it.*
- c) Spacings are not reduced below the minimum acceptable values if the switch rotates.*
- d) Normal operation of the switch is by mechanical means rather than direct contact by persons.*

*Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.*

10.3 Means for preventing the turning mentioned in 10.2 is to consist of more than friction between surfaces – for example, a properly applied lock washer, may be used to prevent the turning of a small stem-mounted switch or other device having a single-hole mounting means.

## 11 Protection Against Corrosion

11.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means, if corrosion of such parts could result in a risk of fire, electric shock, or injury to persons.

*Exception No. 1: Surfaces of sheet steel and cast iron parts within an enclosure if the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors.*

*Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like.*

*Exception No. 3: A sheath of a heating element of other than an immersion-type.*

11.2 An enclosure of an appliance intended for outdoor installation shall be protected against corrosion as indicated in Table 11.1 and 11.7 – 11.12 or by other coating that has been shown by investigation to provide at least equivalent protection. See 8.1 and 8.2 for the required enclosure thickness.

**Table 11.1**  
**Protection against corrosion**

Type of enclosure	0.053 in (1.4 mm) or thicker sheet steel, protection as specified in	Sheet steel thinner than 0.053 in (1.4 mm), protection as specified in
A. Outer enclosure protecting motors, wiring, or enclosed live parts	11.9	11.8
B. Outer enclosure that is the sole enclosure of live parts	11.8	11.8
C. Outer enclosure that does not enclose electrical parts	11.9	11.9
D. Interior enclosure protecting live parts other than motors and which is not provided with outer enclosure complying with item B	11.9	11.8

11.3 Metal shall not be used in combinations that are not galvanically compatible.

11.4 The requirements in 11.5 – 11.12 do not apply to a metal part, such as a decorative grille, that is not required to form a part of the enclosure.

11.5 Aluminum, brass, copper, or stainless steel may be used without additional protection against corrosion.

11.6 A nonmetallic enclosure is to be judged on the basis of the effect of exposure to ultraviolet light and water.

11.7 An enclosure of cast iron at least 1/8-in (3.2-mm) thick is considered to be protected by one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.

11.8 To comply with Table 11.1 referenced to this requirement, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G90 in Table I of ASTM Designation A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM specification. The weight of zinc coating may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the test method of ASTM Designation A90/A90M-93.
- b) A zinc coating other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 in (0.015 mm) on each surface with a minimum thickness of 0.00054 in (0.014 mm). The thickness of the coating shall be established by the Metallic-Coating-Thickness Test, Section 47. An annealed coating shall also comply with 11.12.
- c) A zinc coating conforming with 11.9 (a) or (b) with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.
- d) A cadmium coating not less than 0.001-in (0.025-mm) thick on both surfaces. The thickness of coating shall be established by the Metallic-Coating-Thickness Test, Section 47.
- e) A cadmium coating not less than 0.00075-in (0.019-mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.0005-in (0.013-mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with the Metallic-Coating-Thickness Test, Section 47, and the paint shall be as specified in (c).

11.9 To comply with Table 11.1 referenced to this requirement, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in Table I of the Standard Specification for Sheet Steel, Zinc Coated (Galvanized) by Hot-Dip Process, General Requirements, ASTM Designation A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM specification. The weight of zinc coating may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM Designation A90/A90M-93. An A60 (alloyed) coating shall also comply with 11.12.

- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 in (0.010 mm) on each surface with a minimum thickness of 0.00034 in (0.008 mm). The thickness of the coating shall be established by the Metallic-Coating-Thickness Test, Section 47. An annealed coating shall also comply with 11.12.
- c) Two coats of an organic finish of the epoxy or alkyd resin type or other outdoor paint applied after forming on each surface. The acceptability of the paint is to be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.
- d) Any one of the means specified in 11.8.

11.10 With reference to 11.8 and 11.9, other finishes, including paints, metallic finishes, and combinations of the two may be accepted when comparative tests with galvanized sheet steel – without annealing, wiping or other surface treatment – conforming with 11.8(a) or 11.9(a), as applicable, indicate they provide equivalent protection. Among the factors that are taken into consideration when judging the acceptability of such coating systems are exposure to salt spray, moist carbon dioxide-sulfur dioxide-air mixtures, moist hydrogen sulfide-air mixtures, ultraviolet light and water.

11.11 If tests are required, the test specimens of a finish as described in 11.7 or 11.10 or 11.8(c) or 11.9(c), are to be consistent with the finish that is to be used in production with respect to the base metal, cleaning or pretreatment method, application method, number of coats, curing method, thickness, and the like.

11.12 A hot-dipped mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing that is not otherwise required to be painted shall be painted in the bent or formed area if the shaping process damages the zinc coating, except that such an area on the inside surface of an enclosure that water does not enter during the rain test need not be painted. The zinc coating is considered to be damaged if flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification. Simple sheared or cut edges and punched holes are not considered to be formed.

## **12 Power-Supply Connections**

### **12.1 General**

12.1.1 Other than as noted in 12.1.2 and 12.1.3, an appliance shall have provision for permanent connection of a wiring system.

12.1.2 A drapery operator and a residential overhead garage door operator as described in 12.4.1 may be provided with a power-supply cord.

12.1.3 A residential or commercial pedestrian door operator as described in 12.5.1 may be provided with a power-supply cord.

## 12.2 Cord-connected operators

### 12.2.1 Strain relief

12.2.1.1 Strain relief shall be provided to prevent a mechanical stress on a flexible cord from being transmitted to terminals, splices, or internal wiring.

12.2.1.2 Means shall be provided to prevent the flexible cord from being pushed into the appliance through the cord-entry hole if such displacement may subject the cord to mechanical damage or exposure to a temperature higher than that for which the cord is rated, or may reduce spacings, such as to a metal strain-relief clamp, below the minimum acceptable values.

12.2.1.3 If a knot in a flexible cord serves as strain relief, a surface that the knot may contact shall be free from projections, sharp edges, burrs, fins, and the like, that may cause abrasion of the insulation on the conductors.

### 12.2.2 Bushings

12.2.2.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall be substantial, reliably secured in place, and shall have a smooth, rounded surface against which the cord may bear. If Type SPT-2 or other cord lighter than Type SV is employed, the wall or barrier is of metal, and the construction is such that the cord may be subjected to strain or motion, an insulating bushing shall be provided. Ceramic materials and some molded compositions are generally acceptable for insulating bushing, but separate bushings of wood or of hot molded shellac-and-tar compositions are not acceptable.

## 12.3 Drapery operators

12.3.1 A cord-connected drapery operator shall be provided with a length of flexible cord and an attachment plug for connection to the supply circuit.

12.3.2 The flexible cord shall be of a type acceptable for the application. It shall be rated for use at a voltage not less than the rated voltage of the appliance, and shall have an ampacity not less than the current rating of the appliance.

12.3.3 The flexible supply cord shall be Type SPT-2 or heavier duty cord.

12.3.4 The length of the flexible cord shall not be less than 6 ft (1.83 m) nor more than 10 ft (3.05 m).

12.3.5 The attachment plug shall be rated for use at a current not less than the rated current and at a voltage equal to the rated voltage of the appliance.

12.3.6 The attachment plug shall be of the polarized type if the product is not provided with a grounding type attachment plug – see 24.1.

## 12.4 Residential garage door operators

12.4.1 With reference to 12.1.2, a residential garage door operator supplied with a flexible cord for connection to a supply circuit shall:

- a) Not be rated greater than 120 V;
- b) Not have a maximum appliance current draw greater than 15 A under a locked-rotor condition including the current draw of lamps and external devices; and
- c) Comply with the requirements in 12.4.2 – 12.4.6.

*Exception: Compliance with 12.4.3 – 12.4.6 is not required when that portion of the product intended to be connected to the source of supply is not intended to be permanently attached to the building structure. Mounting to the building by keyhole slots is not permanently attached.*

12.4.2 A flexible cord shall be Type SJT or heavier duty cord, not longer than 6 ft (1.83 m). The cord shall incorporate a grounding conductor and be terminated with a grounding type attachment plug.

12.4.3 The wiring compartment shall be so constructed and the cord so attached that permanent connection can be made to the power supply.

12.4.4 The cord shall enter the wiring compartment through a 7/8-in (22.2-mm) diameter hole that, after the cord and any bushing or fitting provided have been removed, provides an opening acceptable for attachment of a wiring system.

12.4.5 The power-supply cord shall be connected to the internal wiring by a device – terminal block, pressure cable connector, or the like – that will readily accommodate permanent wiring having a rated ampacity acceptable for the appliance.

12.4.6 The internal wiring terminals and leads for connection to the power supply shall be identified in accordance with 12.6.2.12, 12.6.2.13, 12.6.2.16, and 12.6.2.17.

## 12.5 Residential and commercial pedestrian door operators

12.5.1 A residential or commercial pedestrian door operator intended for indoor wall mounting only may be provided with flexible cord for connection to a supply circuit provided that the door operator:

- a) Complies with the requirements in 12.5.2 – 12.5.5, and
- b) Is provided with instructions in accordance with 56.2.4 and 56.2.5.

12.5.2 The flexible cord shall be Type AFS, S, SJ, SJO, SJT, SJTO, SO, ST, or STO, not longer than 18 in (0.46 m), and shall employ a grounding conductor and a grounding attachment plug.

12.5.3 The construction of the wiring compartment shall comply with the requirements in 12.4.3 and 12.4.4.

12.5.4 The internal power-supply cord connections shall comply with the requirements in 12.4.5.

12.5.5 The internal wiring terminals and leads shall comply with the requirements in 12.4.6.

## 12.6 Permanently connected appliances

### 12.6.1 Terminal compartments

12.6.1.1 A terminal compartment intended for connection of a supply raceway shall be attached to the appliance so as to be prevented from turning with respect thereto.

12.6.1.2 An outlet or terminal box in which connections to the power-supply circuit will be made shall be located so that, after the appliance has been installed as intended, such connections will be accessible for inspection.

12.6.1.3 The compartment mentioned in 12.6.1.2 shall be located so that during conduit connections thereto, internal wiring and electrical components will not be exposed to mechanical abuse or stress.

12.6.1.4 A conduit opening for connection of conduit to a terminal compartment shall accommodate conduit of the trade size determined in accordance with Table 12.1.

**Table 12.1**  
**Trade size of conduit**

Wire size, AWG	Number of wires	Conduit trade size, in
14	2, 3, 4, 5, or 6	1/2
12	2, 3, or 4	1/2
12	5 or 6	3/4
10	2 or 3	1/2
10	4, 5, or 6	3/4
8	2, 3, or 4	3/4
8	5 or 6	1
6	2 or 3	3/4
6	4	1
6	5 or 6	1-1/4

NOTE— This table is based on the assumption that all conductors are of the same size and there are no more than six conductors in the conduit. Where more than six conductors are involved or where the conductors are not all the same size, the internal cross-sectional area of the smallest conduit for which a conduit opening is to be supplied shall be determined by multiplying the total cross-sectional area of the wires by 2.5. The cross-sectional area of the individual wires is to be based on Type THW wire.

12.6.1.5 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 in (0.81 mm) if uncoated steel, not less than 0.034 in (0.86 mm) if galvanized steel and not less than 0.045 in (1.14 mm) if nonferrous.



## 12.6.2 Wiring terminals and leads

12.6.2.1 Wiring terminals or leads employed shall be acceptable for the connection of conductors having an ampacity not less than the sum of 125 percent of the motor load and 100 percent of the other loads as marked on the appliance.

12.6.2.2 If an appliance, other than a commercial or industrial appliance, is constructed so that it may be adapted upon installation for either of two different supply voltages, it shall be provided with means by which the appropriate connections may be made during field installation, without the necessity of changing or disrupting internal wiring or connections other than at the point of field connection. See 59.1.11.

12.6.2.3 A wiring terminal shall be provided with a pressure terminal connector securely fastened in place – for example, firmly bolted or held by a screw.

*Exception: A wire-binding screw may be employed at a wiring terminal intended for connection of a No. 10 AWG or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.*

12.6.2.4 A wiring terminal shall be prevented from turning.

12.6.2.5 A wire-binding screw shall thread into metal.

12.6.2.6 A wire-binding screw at a wiring terminal shall not be smaller than No. 10.

*Exception No. 1: A No. 8 screw may be used at a terminal intended only for the connection of a No. 14 AWG conductor.*

*Exception No. 2: A No. 6 screw may be used for the connection of a No. 16 or 18 AWG conductor.*

12.6.2.7 A No. 14 AWG is the smallest conductor that may be used for branch-circuit wiring, and thus is the smallest conductor that is anticipated at a terminal for connection of a power-supply wire.

12.6.2.8 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050-in (1.27-mm) thick. There shall be no fewer than two full threads in the metal.

*Exception: A plate not less than 0.030-in (0.076-mm) thick is acceptable if the tapped threads have equivalent mechanical strength.*

12.6.2.9 A terminal plate may have the metal extruded at the tapped hole to provide the thickness necessary for two full threads or more, if the thickness of the unextruded metal is not less than the pitch of the thread.

12.6.2.10 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 12.6.2.1 and 12.6.2.6 under the head of the screw or the washer.

12.6.2.11 An appliance intended for connection to a grounded supply circuit and employing a lampholder of the Edison-screw-shell type, or either a single-pole switch or an overcurrent protective device other than an automatic control without a marked off position, shall have one terminal or lead identified for connection of the grounded conductor of the supply circuit. The identified terminal or lead shall be the one connected to screw shells of lampholders and to which are connected no single-pole switches or single-pole controls other than automatic controls without a marked off position.

12.6.2.12 A terminal for connection of a grounded power-supply conductor shall be of or plated with metal substantially white in color and shall be readily distinguishable from the other terminals; or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on a wiring diagram adjacent to the terminals.

12.6.2.13 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector shall be marked in accordance with 59.2.5. The wire-binding screw or pressure wire connector shall be located so that it does not require removal during the normal servicing of the appliance.

12.6.2.14 A terminal used solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size acceptable for the application.

12.6.2.15 An appliance shall be provided with an equipment-grounding terminal or lead.

12.6.2.16 The surface of a lead intended for connection to a grounded power-supply conductor shall be white or natural grey, and shall be readily distinguishable from the other leads.

12.6.2.17 The surface of an insulated lead intended solely for connection to an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

12.6.2.18 The requirements in 12.6.2.16 and 12.6.2.17 relating to color coding for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

12.6.2.19 The free length of a lead inside an outlet box or wiring compartment shall be 6 in (152 mm) or more if the lead is intended for field connection to an external circuit.

*Exception: A lead may be less than 6-in long if it is evident that the use of a longer lead might result in a risk of fire or electric shock.*

12.6.2.20 A lead intended to be spliced in the field to a power-supply conductor shall not be smaller than No. 18 AWG and the insulation, if rubber or thermoplastic, shall not be less than 1/32-in (0.8-mm) thick.

12.6.2.21 A terminal or lead connected to a Class 2 power source and intended for connection of a Class 2 circuit to an external device shall be marked in accordance with 59.2.7.

### 13 Live Parts

13.1 Other than as noted in 13.2 and 14.4.2, a current-carrying part shall be of silver, copper, a copper alloy, or other material acceptable for the purpose. Unplated iron or steel shall not be used.

13.2 Plated iron or steel is an alternative for a current-carrying part:

- a) The temperature of which during normal operation is more than 100°C (212°F),
- b) Within a motor or associated governor, or
- c) In accordance with 4.1.

The foregoing restrictions do not apply to stainless steel and other corrosion-resistant alloys.

13.3 An uninsulated live part shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum acceptable values.

13.4 Friction between surfaces is not acceptable as the sole means to prevent the turning of a live part, but a properly applied lock washer may be used for this purpose.

### 14 Internal Wiring

#### 14.1 General

14.1.1 The wiring and connections between parts of an appliance shall be protected or enclosed.

*Exception: A length of flexible cord may be employed for external connections if flexibility is essential. See 14.1.5 and 14.1.6. The design shall be such as to prevent damage to the cord resulting from contact with the door or building.*

14.1.2 The internal wiring of an appliance shall consist of wires of a type or types that are acceptable for the application, when considered with respect to the temperatures and voltage to which the wiring is likely to be subjected, with respect to its exposure to oil or grease, and with respect to other conditions of service to which it is likely to be subjected.

14.1.3 Thermoplastic-insulated wire employed for internal wiring shall be standard building wire or appliance wiring material acceptable for the purpose.

14.1.4 Type AF or CF wire shall not be employed.

14.1.5 Internal wiring of an appliance is considered to be all the interconnecting wiring beyond the point where the power-supply cord of a cord-connected appliance enters the enclosure, or beyond the wiring terminals or leads for power-supply connection of a permanently connected appliance, some of such wiring may not be completely enclosed and some of it may be in the form of flexible cord. With reference to exposure of insulated wiring through an opening in the enclosure of an appliance, the protection of such wiring required in 14.1.1 is considered to exist if, when judged as though it were enameled wire, the wiring would be acceptable according to 9.2. Internal wiring not so protected may be acceptable if it is secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

14.1.6 Type SJT, SJTO, ST, or STO cord – not longer than 12 in (305 mm) if it terminates in a conventional attachment plug – may be used to connect subassemblies of a residential door operator that is permanently connected to the power supply. See 14.1.1.

14.1.7 The internal wiring between components of an appliance shall consist of wires having insulation not less than 1/32-in (0.8-mm) thick.

*Exception: The thickness of insulation on wiring in circuits supplied by a Class 2 transformer rated 30 V rms or less is not specified.*

14.1.8 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method that is acceptable for the combination of metals involved at the connection point.

14.1.9 With reference to 14.1.8, a wire-binding screw or a pressure terminal connector used as a termination device shall be acceptable for use with aluminum under the conditions involved – for example, temperature, heat cycling, vibration, and the like.

14.1.10 A nominal 0.110-in, 0.125-in, 0.187-in, 0.205-in, or 0.250-in wide quick-connect terminal shall comply with the requirements for quick-connect terminals in the Standard for Electrical Quick Connect Terminals, UL 310. Other sizes of quick-connect terminals shall be investigated with respect to crimp pull-out, engagement-disengagement forces of the connector and tab, and temperature rises. All tests are to be conducted in accordance with the requirements for quick-connect terminals in the Standard for Electrical Quick Connect Terminals, UL 310.

## **14.2 Protection of wiring**

14.2.1 If the wiring of an appliance is located so that it may be in proximity to combustible material or may be subject to mechanical damage, it shall be in armored cable, rigid metal conduit, electrical metallic tubing, metal raceway, or otherwise acceptably protected.

14.2.2 Wires within an enclosure, compartment, raceway, or the like shall be located or protected so that no damage to conductor insulation can result from contact with any rough, sharp, or moving part.

14.2.3 A hole, through which insulated wires pass in a sheet-metal wall within the overall enclosure of an appliance shall be provided with a smooth, rounded bushing or shall have smooth rounded surfaces upon which the wires may bear to prevent abrasion of the insulation. A flexible cord used for external interconnection as mentioned in 14.1.1 shall be provided with bushings and strain relief in accordance with 12.2.1.1 – 12.2.2.1 and Strain-Relief Test, Section 50 unless the construction is such that the cord will be protected from stress or motion.

14.2.4 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of the appliance.

### 14.3 Splices and connections

14.3.1 All splices and connections shall be mechanically secure and shall provide reliable electrical contact. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in a risk of fire, electric shock, or injury to persons.

14.3.2 A splice shall be provided with insulation equivalent to that of the wires involved if the spacing between the splice and other metal parts may not be permanently maintained.

14.3.3 Insulation consisting of two layers of friction tape, of two layers of acceptable thermoplastic tape, or of one layer of friction tape on top of one layer of rubber tape may be used on a splice if the voltage involved is less than 250 V. In determining if splice insulation consisting of coated-fabric, thermoplastic, or other type of tubing is acceptable, consideration is to be given to such factors as its dielectric properties, heat resistance, moisture-resistance characteristics, and the like. Thermoplastic tape wrapped over a sharp edge is not acceptable. An insulated splicing device is acceptable within the limits of its voltage and temperature ratings.

14.3.4 The means of connecting standard internal wiring to a wire-binding screw shall be such that loose strands of wire cannot contact other live parts not always of the same polarity as the wire or contact dead metal parts. This may be accomplished by the use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other reliable means.

### 14.4 Secondary circuits

14.4.1 Other than as noted in 14.4.2 and 14.4.4, secondary circuits are judged under the requirements for line-voltage circuits.

14.4.2 In a Class 2 circuit:

- a) Live parts are not required to be enclosed;
- b) The frame is useable as a current-carrying part;
- c) The spacing requirements of Table 23.2 do not apply; and
- d) The dielectric voltage-withstand test potential is as specified in 44.1(d).

14.4.3 A Class 2 transformer used as a supply for a Class 2 circuit shall comply with the Standard for Class 2 and Class 3 Transformers, UL 1585.

14.4.4 In a circuit that is supplied from an isolating transformer that does not comply with the requirements for a Class 2 transformer, has an open-circuit sinusoidal potential of 30 V (42.4 V peak) or less, and that includes:

- a) A reliable fixed impedance,
- b) A fuse, or

- c) A nonadjustable manually reset circuit protector that limits the power available to the levels for Class 2 transformers,

the portion of the circuit on the load side of the impedance, fuse, or protector is to be treated as though it were supplied from a Class 2 transformer. The secondary winding of the transformer; the impedance, the fuse, or the protector; and the wiring between the two are to be evaluated as though they are part of a line-voltage circuit. See 59.2.7.

14.4.5 A fuse or circuit protector used to limit the power as specified in 14.4.4 is to be rated or set at not more than 3.2 A for a circuit operating between 20 and 30 V rms sinusoidal and at not more than 5.0 A for a 0 – 20 V rms sinusoidal circuit. If an impedance is used to limit the current, its value is to limit the current under short-circuit conditions to not more than 8.0 A measured after 1 min.

14.4.6 The wiring in the secondary circuits mentioned in 14.4.2 and 14.4.4 shall be reliably routed away from the wiring and uninsulated live parts of other circuits or shall be provided with insulation that is rated for use at the highest of the voltages in the other circuits.

14.4.7 Wiring compartments or the equivalent for field-wiring terminals for secondary circuits shall be separated or segregated by barriers from wiring compartments for other terminals.

14.4.8 Cable supplied with the operator for connection of a Class 2 circuit to an external device shall be:

- a) Type CL2, CL2P, CL2R, or CL2X complying with the Standard for Power-Limited Circuit Cables, UL 13, or,
- b) Other cable with equivalent or better electrical, mechanical, and flammability ratings.

## 15 Electrical Insulation

15.1 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or other insulating material acceptable for the application.

15.2 Ordinary vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts if shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock. Thermoplastic materials are not considered to be acceptable for the sole support of uninsulated live parts, but may be employed if found to have equivalent mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric strength, and other properties acceptable for the application.

15.3 Small molded parts, such as brush caps, shall be constructed to have the necessary mechanical strength and rigidity to withstand the stress of actual service. Brush caps shall be secured or located to be protected from mechanical damage that might result during normal use.

## 16 Motors

16.1 A motor shall be acceptable for the application, and shall be capable of handling the maximum normal load of the appliance as described in 43.2.1 – 43.10.1 without introducing a risk of fire, electric shock, or injury to persons.

16.2 A motor winding shall be such as to resist the absorption of moisture, and shall be formed and assembled in a workmanlike manner.

16.3 With reference to the requirements in 16.2, enameled wire is not required to be additionally treated to prevent absorption of moisture.

16.4 A brush-holder assembly shall be constructed so that when a brush is worn out – no longer capable of performing its function – the brush, spring, and other parts of the assembly will be retained to the degree necessary to prevent accessible dead metal parts from becoming energized, and to prevent live parts from becoming accessible.

## 17 Overload Protection

17.1 A motor shall incorporate thermal or overload protection for running-overload (heating) and locked-rotor conditions complying with the requirements in 17.2.

*Exception No. 1: A drapery operator incorporating a momentary contact switch – a switch that requires continuous pressure – is not required to have overload protection.*

*Exception No. 2: An integral horsepower or polyphase motor used on a commercial or industrial door operator is considered to have acceptable overload protection if it is protected against locked-rotor conditions only.*

*Exception No. 3: A motor supplied from a Class 2 circuit need not be provided with overload protection.*

17.2 Motor-overload protection required for a product in accordance with 17.1 shall consist of one of the following:

- a) Thermal protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111.

*Exception No. 1: When a product includes a control, such as a timer, that positively and reliably limits the length of time the product is able to operate, a shorter test duration for the Locked-Rotor Temperature, the Running Heating Temperature, and the Locked-Rotor Endurance tests meets the intent of the requirement. For this construction, the duration of these tests shall not be less than the time to which the control limits product operation.*

*Exception No. 2: When the time required to operate a manually reset protective device through 10 cycles of operation is longer than the time the product is intended to be operated during each use, less than 10 cycles of operation of the device for the Locked-Rotor Temperature Test meets the intent of the requirement. For this construction, the number of cycles shall be 4 cycles or the number of cycles required for maximum intended operating time of the product, whichever is longer.*

*Exception No. 3: A motor intended only for moving air and that has an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor shaft is not required to have running overload protection.*

b) Impedance protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111, when the motor is tested as used in the product under locked-rotor conditions.

c) Other protection that is shown by test to be equivalent to the protection specified in item (a).

17.3 The functioning of a motor-protective device, whether such device is required or not, shall not result in a risk of fire, electric shock, or injury to persons.

17.4 An overload- or overcurrent-protective device shall not open the circuit during normal operation of the appliance, except as noted in 43.7.2.

17.5 An overcurrent or thermal protective device shall be of a type acceptable for the application.

17.6 A protective device, such as a fuse, the normal functioning of which requires renewal or replacement, shall be in a readily accessible location.

*Exception No. 1: If the appliance, with the protective device shunted out of the circuit, complies with all applicable requirements in this standard, the protective device need not be readily accessible.*

*Exception No. 2: If the presence of the protective device would ordinarily be unknown to the user of the appliance because of its location and the omission of reference to the device in the operating instructions, circuit diagrams, and the like for the appliance, the protective device need not be readily accessible.*

17.7 A protective device shall be wholly inaccessible from outside the appliance without opening a door or cover.

*Exception: The operating handle of a circuit breaker, the operating button of a manually operable motor protector, and similar parts may project outside the appliance enclosure.*

17.8 Unless the appliance is marked in accordance with 59.1.15, a fuseholder shall be designed and installed so that no uninsulated live part other than the screwshell or clips will be exposed to contact by a person removing or replacing a fuse. The screwshell of a plug-type fuseholder shall be connected toward the load.

*Exception: The requirement relating to exposure of uninsulated live parts does not apply under the conditions described in Exception No. 2 to 17.6.*

17.9 The door or cover of an enclosure shall be hinged or otherwise attached in an equivalent manner if it gives access to any overload protective device, the normal functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation of the protective device.

17.10 Means shall be provided for holding the door or cover over a fuseholder in a closed position, and the door or cover shall be tight-fitting.



## 18 Switches and Controls

18.1 A switch shall be located or protected so that it will not be exposed to mechanical damage during normal use.

18.2 A switch shall be acceptable for the application, and shall have a current and voltage rating not less than that of the load that it controls when the appliance is operated normally.

18.3 A switch controlling one or more electric heating elements shall be arranged so that opening the switch will disconnect all the ungrounded conductors of the power-supply circuit.

18.4 A switch or other device that controls a contactor, a relay coil, or other electromagnetic device shall have voltage and volt-ampere ratings not less than the corresponding ratings of the load it controls.

18.5 The current rating of a switch that controls an inductive load, such as a transformer or an electric-discharge-lamp-ballast, shall not be less than twice the rated full-load current of the transformer or ballast unless the switch has been investigated and found to be acceptable for the application.

18.6 A switch that controls a medium-base lampholder of other than a pilot or indicating light shall be acceptable for use with tungsten-filament lamps.

18.7 A switch provided as part of an appliance intended to be connected to a power-supply circuit having a potential to ground of more than 150 V shall be acceptable for the maximum potential to ground of the circuit.

*Exception: An appliance marked in accordance with 59.1.6 or 59.1.7.*

18.8 A commercial or industrial operator connected to a 2-wire, single-phase, or a 3-wire, 3-phase appliance with a rating in the range from 220 – 240 V is assumed to involve a potential to ground of more than 150 V.

18.9 A nominal 208 V, single or 3-phase appliance is considered to involve a potential to ground of less than 150 V.

18.10 An appliance control containing solid-state components that complies with the applicable requirements in the Standard for Solid-State Controls for Appliances, UL 244A, is acceptable for use in equipment covered by this standard.

18.11 If a switch or circuit breaker is mounted such that movement of the operating handle, either linearly or rotationally, between the on and off positions results in one position being above the other position, then the upper position shall be the on position.

*Exception: The requirement does not apply to a switching device having more than two on positions such as a double throw switch, or a switching device located in a low voltage circuit.*

18.12 No switch or overcurrent-protective device of the single-pole type other than an automatic control without a marked off position shall be electrically connected to a terminal or lead intended for connection to the grounded conductor of the supply circuit.

## 19 Heating Elements

19.1 A heating element shall be supported in a substantial and reliable manner, and shall be protected against mechanical damage and contact with outside objects.

## 20 Lampholders

20.1 If an appliance is intended to be connected to the grounded conductor of the power-supply circuit, the screw shell of any Edison-base lampholder in the appliance shall be connected to that conductor.

20.2 A lampholder shall be designed or installed so that uninsulated live parts other than a lamp contact will not be exposed to contact by persons removing or replacing lamps in normal service.

## 21 Receptacles

21.1 An attachment-plug receptacle intended for use by the serviceman shall be of the grounding type.

21.2 The face of a receptacle shall:

- a) Be flush with or project beyond a nonconductive surrounding surface, or
- b) Project at least 0.015 in (0.31 mm) beyond a conductive surrounding surface.

21.3 An appliance having a general-use convenience receptacle rated 120 V, single phase, and 15 or 20 A shall be provided with a ground-fault circuit interrupter.

21.4 A general purpose receptacle rated for use on a nominal 120 V circuit shall be of a polarized type. The grounded supply conductor shall be connected to the terminal that is substantially white in color or otherwise marked to indicate that it is intended for connection to the grounded supply conductor.

## 22 Capacitors

22.1 The voltage rating of a capacitor, other than a motor capacitor, shall not be less than the maximum steady-state potential to which the capacitor is subjected during operation of the appliance.

22.2 A capacitor connected from one side of the line to the frame or enclosure of an appliance shall have a capacitance rating of not more than 0.10  $\mu\text{f}$ .

## 23 Spacings

23.1 Other than noted in 14.4.2, 23.6, and 23.9, the spacing between field-wiring terminals of opposite polarity and the spacing between a field-wiring terminal and any other uninsulated metal part – dead or live – not of the same polarity, shall not be less than specified in Table 23.1.

23.2 Spacings in a motor shall comply with the spacing requirements in the Standard for Electric Motors, UL 1004.

23.3 Other than at field-wiring terminals and as noted in 14.4.2 and 23.6, the spacing between uninsulated live parts of opposite polarity, and between an uninsulated live part and dead metal part that is exposed to contact by persons or that may be grounded, shall not be less than the value specified in Table 23.2. If an uninsulated live part is not rigidly fixed in position, by means other than friction between surfaces, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that the required minimum acceptable spacing will be maintained.

**Table 23.1**  
**Spacings at field-wiring terminals**

Potential involved, V	Minimum spacings, in (mm)				
	Between wiring terminals, through air, or over surface	Between terminals and other uninsulated terminals, metal parts not always through air, of the same polarity <sup>a</sup>			
		Over surface		Through air	
250 or less	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)
More than 250	1/2 (12.7) <sup>b</sup>	1/2 (12.7) <sup>b</sup>	1/2 (12.7) <sup>b</sup>	3/8 (9.5)	3/8 (9.5)

<sup>a</sup> Applies to the sum of the spacings involved where an isolated dead part is interposed.

<sup>b</sup> A spacing of not less than 3/8 in, through air and over surface, is acceptable at wiring terminals in a wiring compartment or terminal box if the compartment or box is integrated with a motor.

23.4 A wiring terminal is considered to be a terminal to which a wire may be connected in the field, unless the wire and a means of making the connection – a pressure terminal connector, soldering lug, soldered loop, crimped eyelet, or the like – factory-assembled to the wire, are provided as a part of the appliance.

23.5 In applying Table 23.1 to an appliance incorporating two or more motors of different sizes, the spacings in the appliance are judged on the basis of the size of the largest motor in the appliance.

23.6 The spacing requirements in 23.1 – 23.5 do not apply to the inherent spacings of a component of the appliance, such as a snap switch; such spacings are judged on the basis of the requirements for the component in question.

**Table 23.2**  
**Spacings at other than field-wiring terminals**

Potential involved, V	Minimum spacings, in (mm)							
	Motor diameter 7 in (178 mm) or less <sup>a</sup>				Motor diameter more than 7 in (178 mm) <sup>a</sup>			
	Over surface		Through air		Over surface		Through air	
0 – 125	3/32	(2.4) <sup>b</sup>	3/32	(2.4) <sup>b</sup>	1/4	(6.4) <sup>c</sup>	1/8	(3.2) <sup>c</sup>
125 – 250	3/32	(2.4)	3/32	(2.4)	1/4	(6.4) <sup>c</sup>	1/4	(6.4) <sup>c</sup>
251 – 600	1/2	(12.7) <sup>c</sup>	3/8	(9.5) <sup>c</sup>	1/2	(12.7) <sup>c</sup>	3/8	(9.5) <sup>c</sup>

<sup>a</sup> This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and the like, used solely for motor mounting, cooling, assembly, or connection.

<sup>b</sup> For a motor rated 1/3 horsepower (250 W output) or less, these spacings may not be less than 1/16 in.

<sup>c</sup> Film-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 in over surface and through air is acceptable between film-coated wire rigidly supported and held in place on a coil and a dead metal part.

23.7 Where an isolated dead metal part is interposed between, or is in close proximity to:

- a) Live parts of opposite polarity,
- b) A live part and an exposed dead metal part, or
- c) A live part and a dead metal part that is to be grounded;

the spacing shall not be less than 3/64 in (1.2 mm) between the isolated dead metal part and any one of the other parts specified in (a) – (c) and the total spacing between the isolated dead metal part and the two other parts shall not be less than the value specified in Table 23.1 or Table 23.2, whichever is applicable.

23.8 In the application of 44.1 and Table 23.2 to a motor not rated in horsepower, use is to be made of the appropriate table of the National Electrical Code, ANSI/NFPA 70, that gives the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single-phase, alternating current motor is to be used if the appliance is marked for use on alternating current only; otherwise, the table applying to direct-current motors is to be used.

23.9 At terminal screws and studs to which connection may be made in the field by means of wire connectors, eyelets, or the like, it is required that the spacings be not less than those specified in Table 23.2 when such connectors, eyelets, and the like are in such position that minimum spacings – opposite polarity and to dead metal – exist.

23.10 An insulating lining or barrier of vulcanized fiber or similar materials employed where spacings would otherwise be insufficient shall not be less than 1/32-in (0.8-mm) thick, and shall be so located or of such material that it will not be adversely affected by arcing.

*Exception No. 1: Vulcanized fiber not less than 1/64-in (0.4-mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.*

*Exception No. 2: Insulating material having a thickness less than that specified may be used if, upon investigation, it is found to be acceptable for the application.*

## 24 Grounding

24.1 Except for drapery operators, all exposed dead metal parts and all dead metal parts within the enclosure that are exposed to contact by the user or serviceman and that are likely to become energized shall be reliably connected to:

- a) The equipment-grounding terminal or lead of a permanently installed appliance.
- b) The equipment-grounding conductor of the cord of a cord-connected machine.

24.2 The surface of insulation on a grounding conductor of a flexible cord shall be green or green with or without one or more yellow stripes. The grounding conductor shall be secured to the frame or enclosure of the appliance by means of a screw or other reliable means that is not unintentionally removable during any servicing operation involving the power-supply cord. A sheet-metal (spaced thread) screw shall not be used to secure a grounding conductor. Solder alone shall not be used for securing the grounding conductor. The grounding conductor shall be connected to the grounding blade or equivalent fixed contacting member of an attachment plug. For the purpose of this requirement, servicing includes repair of the appliance by a qualified serviceman.

24.3 The following are considered to constitute means for grounding:

- a) In an appliance intended to be permanently connected to a wiring system – the equipment-grounding terminal or lead.
- b) In a cord-connected appliance – an equipment-grounding conductor in the cord.

## PROTECTION AGAINST RISK OF INJURY TO PERSONS

### 25 General

25.1 If an automatically-reset protective device is employed, automatic restarting of a motor shall not result in a risk of injury to persons.

25.2 An appliance is considered to comply with the requirement in 25.1 if some means is provided to prevent the motor from restarting when the protector closes.

25.3 Parts supported or actuated hydraulically shall not develop a risk of injury to persons due to pressure loss.

25.4 A part of a gate operator system or a door operator system supported or counterbalanced by a spring mechanism which is supplied with the operator system, such as a torsion or extension spring, shall not develop a risk of injury in the event the spring breaks. Similarly, the operator or system shall be equipped with a device capable of restraining the spring or any part of the spring in the event the spring breaks.

25.5 An enclosure, an opening, a frame, a guard, a knob, a handle, or the like shall not be sufficiently sharp to cause a risk of injury to persons in normal maintenance or use.

25.6 Software for use in an inherent secondary entrapment protection device shall comply with the Standard for Software in Programmable Components, UL 1998.

25.7 An electronic or solid-state circuit that performs a back-up, limiting, or other function intended to reduce the risk of fire, electric shock, or injury to persons, including entrapment protection circuits, shall comply with the requirements in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, including environmental and stress tests appropriate to the intended usage of the end-product.

25.8 The following test parameters are to be used in the investigation of the circuit covered by 25.7 for compliance with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991:

- a) With regard to electrical supervision of critical components, an operator being inoperative with respect to downward movement of the door meets the criteria for trouble indication.
- b) A field strength of 3 V per meter is to be used for the Radiated EMI Test.
- c) The Composite Operational and Cycling Test is to be conducted for 14 days at temperature extremes of minus 35°C (minus 31°F) and 70°C (158°F).
- d) Exposure Class H5 is to be used for the Humidity Test.
- e) A vibration level of 5 g is to be used for the Vibration Test.
- f) When a Computational Investigation is conducted,  $\lambda_p$  shall not be greater than 6 failures/ $10^6$  hours for the entire system. For external secondary entrapment protection devices that are sold separately,  $\lambda_p$  shall not be greater than 0 failures/ $10^6$  hours. For internal secondary entrapment protection devices whether or not they are sold separately,  $\lambda_p$  shall not be greater than 0 failures/ $10^6$  hours. The Operational Test is to be conducted for 14 days.

*Exception: An external secondary entrapment protection device that is sold separately, and that has a  $\lambda_p$  greater than 0 failures/ $10^6$  hours meets the intent of the requirement when for the combination of the operator and the specified external secondary entrapment protection device  $\lambda_p$  does not exceed 6 failures/ $10^6$  hours. See 59.3.3 – 59.3.5.*

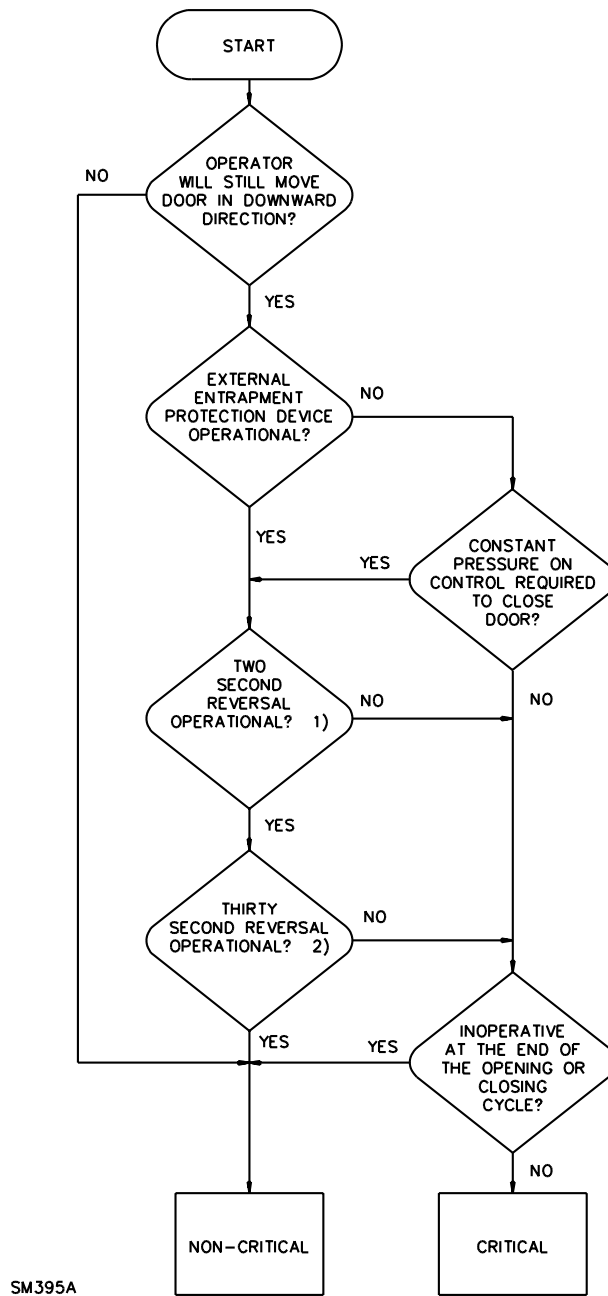
- g) When the Demonstrated Method Test is conducted, the multiplier is to be based on the continuous usage level, and a minimum of 24 units for a minimum of 24 h per unit are to be tested.
- h) The Endurance Test is to be conducted concurrently with the Operational Test. The control shall perform its intended function while being conditioned for 14 days in an ambient air temperature of 60°C (140°F), or 10°C (18°F) greater than the operating temperature of the control, whichever is higher. During the test, the control is to be operated in a manner representing the opening and closing of the door or gate at a rate of one open-close operation per minute.
- i) For the Electrical Fast Transient Burst Test, test level 3 is to be used for residential garage door operators and all other indoor use operators. For all other operators, test level 4 is to be used.

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25.9 In the evaluation of entrapment protection circuits used in residential garage door operators, the critical condition flow chart shown in Figure 25.1 shall be used to:

- a) Conduct a failure-mode and effect analysis (FMEA),
- b) In investigating the performance during the Environmental Stress Tests, and
- c) During the Power Cycling Tests in accordance with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991.

**Figure 25.1**  
**Critical condition flow chart for residential garage door operator entrapment protection devices and functions**



NOTES –

1) See 32.2.1.

2) See 32.2.7.



25.10 The conditions specified in paragraph 25.11 shall be used during the following:

- a) Failure-mode and effect analysis (FMEA),
- b) Investigation of performance during the Environmental Stress Test, and
- c) Power Cycling Tests in accordance with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991.

*Exception: If the fault in a component results in a shutdown or inoperative unit (any case in which the operator will not complete a full cycle, open and close, of travel) the component is considered non-critical.*

25.11 In the evaluation of entrapment protection circuits used in gate operators:

- a) The primary entrapment protection device shall be operational,
- b) The secondary entrapment protection device shall be operational,
- c) An alarm shall be present and functional for a Class I or II operator with a Type A entrapment protection device,
- d) Monitoring for the presence and correct operation of an external device when it is the primary device shall be operational, and
- e) A Class I or II operator for a horizontal slide gate or vertical lift gate shall not result in gate movement that exceeds that specified in 31.1.19.

## **26 Pressure Vessels and Parts Subject to Pressures**

### **26.1 General**

26.1.1 Other than as noted in 26.1.2, a pressure vessel having an inside diameter of more than 6 in (152 mm) and subject to a pressure of more than 15 psig (103.5 kPa) shall be certified by the National Board of Boiler and Pressure Vessel Inspectors and marked in accordance with the appropriate boiler and pressure vessel code symbol – other than the UM symbol – of the American Society of Mechanical Engineers (ASME) for a working pressure not less than the pressure determined by applying 26.1.3.

26.1.2 If a pressure vessel, because of its application, is not covered by the inspection procedure of the ASME code, it shall be designed and constructed so that it will comply with the requirements in 26.1.3.

26.1.3 Other than as noted in 26.1.4 – 26.1.6, a part that is subject to air or vapor pressure, including the vapor pressure in a vessel containing only a super-heated fluid, during normal or abnormal operation shall withstand without malfunction a pressure equal to the highest of the following that is applicable:

- a) Five times the pressure corresponding to the maximum setting of a pressure reducing valve provided as part of the assembly, but not more than five times the marked maximum supply pressure from an external source, nor more than five times the pressure setting of a pressure-relief device provided as part of the assembly.
- b) Five times the marked maximum supply pressure from an external source, except as provided in (a).
- c) Five times the pressure setting of a pressure relief device provided as part of the assembly.

- d) Five times the maximum pressure that can be developed by an air compressor that is part of the assembly, unless the pressure is limited by a pressure-relief device in accordance with (a).
- e) Five times the working pressure marked on the part.

26.1.4 A pressure vessel certified by the National Board of Boiler and Pressure Vessel Inspectors and bearing the ASME Code inspection symbol – other than the UM symbol – is considered to comply with the requirement in 26.1.3 if the vessel is marked with a value of working pressure not less than that to which it is subjected during normal or abnormal operation. A vessel bearing the ASME Code UM symbol is required to be tested as described in 26.1.7.

26.1.5 A test need not be performed to determine whether a part complies with the requirements in 26.1.3 if study and analysis indicate that the strength of the part is adequate for the purpose as a result of its material and dimensions.

26.1.6 A section of a pressure system constructed of a length of continuous tubing or of lengths of tubing connected by hard-soldered, brazed, or welded joints or by metallic compression fittings will be considered to comply with the requirement in 26.1.3 if the wall thickness of the tubing is not less than the value specified in Table 26.1.

26.1.7 If a test is necessary to determine whether a part complies with requirements in 26.1.3 and 26.1.4, two samples of the part are to be subjected to a hydrostatic pressure test. Each sample is to be filled with water to exclude air, and is to be connected to a hydraulic pump. The pressure is to be raised gradually to the specified test value, and is to be held at that value for 1 min. The results are not acceptable if either sample bursts or leaks.

*Exception: Leakage at a gasket during the hydrostatic pressure test is not considered unacceptable unless it occurs at a pressure 40 percent or less of the required test value.*

## **26.2 Pressure-relief devices**

26.2.1 A means for safely relieving pressure shall be provided for all parts in which pressure might be generated by an external source of heat.

26.2.2 Pressure-relief devices – see 26.2.8 – fusible plugs, soldered joints, nonmetallic tubing, or other pressure-relief means, or the equivalent, may be employed to comply with the requirement in 26.2.1.

26.2.3 There shall be no shut-off valve between the pressure-relief means and the parts that it is intended to protect.

26.2.4 A vessel having an inside diameter of more than 3 in (76.2 mm) and subject to air or steam pressure generated or stored within the appliance shall be protected by a pressure-relief device.

26.2.5 The start-to-discharge pressure setting of the pressure-relief device shall not be higher than the working pressure marked on the vessel. The discharge rate of the device shall be adequate to relieve the pressure.

26.2.6 A pressure-relief device shall comply with all four of the following:

- a) Be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect.
- b) Be installed so that it is readily accessible for inspection and repair and cannot be readily rendered inoperative.
- c) Have its discharge opening located and directed so that the risk of scalding is reduced to an acceptable degree.
- d) Have its discharge opening located and directed so that operation of the device will not deposit moisture on bare live parts, insulation, or components affected detrimentally by moisture.

26.2.7 A pressure-relief device having an adjustable setting is judged on the basis of its maximum setting, unless the adjusting means is reliably sealed at a lower setting.

26.2.8 A pressure-relief device is considered to be a pressure-actuated valve or rupture member designed to relieve excessive pressures automatically.

26.2.9 If a pressure-relief device is required, the control responsible for limiting the pressure in the vessel shall perform under rated load for 100,000 cycles of operation and shall prevent the pressure from exceeding 90 percent of the relief device setting under any condition of normal operation.

**Table 26.1**  
**Wall thickness for copper and steel tubing**

Outside diameter, in (mm)		Minimum wall thickness, in (mm)		Maximum pressure, PSIG (kPa)					
				Seamless copper		Butt-welded steel		Seamless steel	
3/8 or smaller	(9.5)	0.016	(0.41)	500	(3447)	600	(4136)	1000	(6895)
1/2	(12.7)	0.016	(0.41)	400	(2758)	480	(3310)	800	(5515)
5/8	(15.9)	0.016	(0.41)	320	(2206)	384	(2647)	640	(4412)
5/8	(15.9)	0.021	(0.53)	420	(2896)	504	(3475)	840	(5791)
3/4	(19.1)	0.021	(0.53)	360	(2482)	432	(2979)	720	(4964)
3/4	(19.1)	0.025	(0.63)	420	(2896)	504	(3475)	840	(5791)
1	(25.4)	0.021	(0.53)	260	(1793)	312	(2151)	520	(3585)
1	(25.4)	0.025	(0.63)	320	(2206)	384	(2647)	640	(4412)

## 27 Moving Parts

27.1 The rotor of a motor, a pulley, a belt, gears, a chain, a fan, or other moving part shall be enclosed or guarded so as to reduce the risk of injury to persons.

27.2 The effects of the following factors shall be determined for compliance of an exposed moving part with 27.2:

- a) The degree of exposure,
- b) The sharpness of the moving part,
- c) The risk of unintentional contact therewith,
- d) The speed of the moving part, and
- e) The risk of fingers, arms, feet, or clothing becoming endangered by the moving parts.

These factors shall be evaluated with respect to both normal and abnormal operation.

27.3 A belt or a chain on a door 6 ft (1.83 m) or more above the floor or a door operator intended to be mounted 6 ft or more above the floor need not be guarded over its entire length, but is to be guarded where it enters a pulley or engages a sprocket. A moving nut or shaft end that is not sufficiently sharp to present a risk of a cut need not be guarded.

27.4 An opening in a guard or enclosure around a moving part capable of causing injury – a gear, a pulley, a fan, a chain, or the like:

- a) Shall be provided with a baffle to prevent contact with the moving part – see 27.5, or
- b) Shall not permit passage of a 1-in (25.4-mm) diameter probe having a hemispherical tip applied with a force of 3 lbf (13.34 N) and shall be spaced from the moving part as indicated in 27.5.

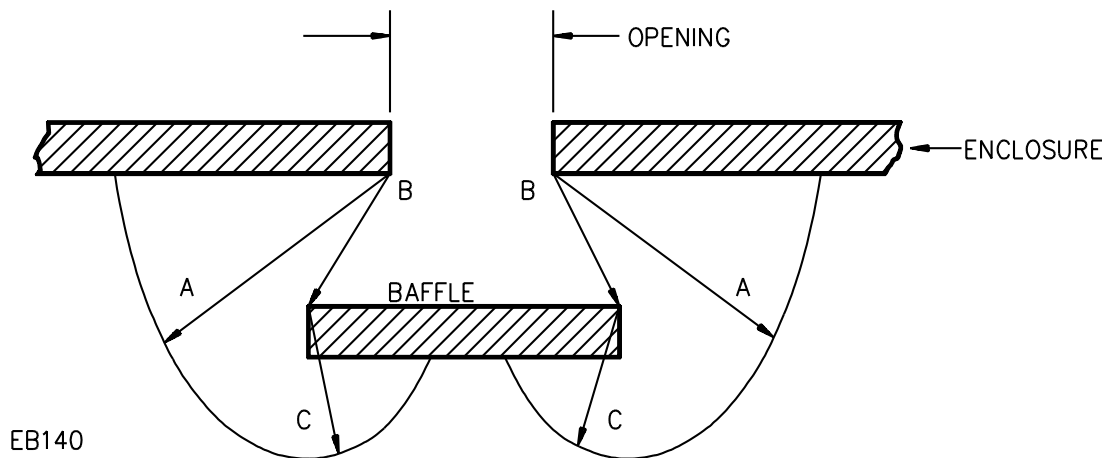
*Exception No. 1: A fan blade is considered to be acceptably guarded or enclosed if it cannot be contacted by the probe illustrated in Figure 9.2.*

*Exception No. 2: Exposed moving parts of an industrial door that are located more than 8 ft (2.44 m) above the floor are not required to be guarded or enclosed.*

*Exception No. 3: Exposed moving parts of an industrial door operator that is intended to be mounted more than 8 ft above the floor are not required to be guarded or enclosed if the operator is marked in accordance with 59.3.7.*

27.5 A baffle as mentioned in 27.4(a), is considered to prevent contact with a moving part if the distance from the opening in the guard or enclosure to the moving part, measured around the baffle as illustrated in Figure 27.1, is not less than  $8D - 1.5$  in (12.7 mm), where  $D$  is the minor dimension of the opening in inches but not less than 1/4 in (6.4 mm). No distance is specified between a moving part and an opening having a minor dimension less than 1/4 in.

**Figure 27.1**  
**Measurement around a baffle**



A – Minimum distance from opening to moving part as specified in 27.5.

B – Distance from opening to edge of baffle.

C – A minus B.

## 28 Surface Temperatures

28.1 During the temperature test, a temperature on a surface of an appliance that may be contacted by the user shall not be more than the value specified in Table 28.1.

28.2 With reference to the requirement in 28.1, if the test is conducted at an ambient temperature other than 25°C (77°F), the results are to be corrected to that temperature – that is, a temperature is to be decreased or increased, as appropriate, 1 degree for each degree the temperature is greater than or less than 25°C. The appliance is to be at room temperature at the beginning of the test.

**Table 28.1**  
**Maximum acceptable surface temperatures**

Location	Composition of surface			
	Metal		Nonmetallic	
	°C	°F	°C	°F
Handle, lever, or knob likely to be grasped	50	122	60	140
Accessible surface during operation	60	140	85	185
Surface subject to casual contact	70	158	95	203

## 29 Pedestrian Doors and Door Operators

### 29.1 General

29.1.1 A door is considered to be remotely actuated if it is not within sight of a person at the location of the actuating device. A door is considered to be automatically actuated if it is controlled by any of the following:

- a) Automatic means such as a mat, a photocell, or a time switch; or
- b) A momentary-contact switch that will cause the door to operate through a cycle of opening or closing.

### 29.2 Panic hardware

29.2.1 Panic hardware provided on any type of pedestrian door is judged under the requirements for panic hardware.

### 29.3 Interruption of power

29.3.1 Interruption of power shall not preclude the opening of a sliding or swinging pedestrian door. A door operator intended for use with a sliding or swinging pedestrian door and that is intended to be sold without the door shall not, in case of interruption of power, interfere with the opening of the door.

29.3.2 Unless compliance with 29.3.1 is apparent from the design of the door, a door operator is to be subjected to simulated interruption of power, and is considered to comply with 29.3.1 if the force required to open the door manually is not more than 50 lbf (222.4 N). The force is to be applied in a manner and at a location representative of manual opening of the door. A door operator that is intended to be sold without the door is to be tested using a door that is:

- a) Recommended by the manufacturer for use with the operator, and
- b) Most difficult to operate manually.

## 29.4 Entrapment

29.4.1 A commercial or residential single-horizontally-sliding door or a center-parting sliding pedestrian door that is either remotely or automatically actuated or both:

- a) Shall not develop kinetic energy in excess of 7 ft-lbf (9.49 J),
- b) If it develops kinetic energy of more than 2-1/2 ft-lbf (3.39 J), shall employ a reopening device or other means to prohibit motion of the door when an obstruction is in its path, and
- c) Shall not require a force in excess of 30 lbf (133.4 N) applied in either direction on either part of a center-parting door to prevent the door from closing.

29.4.2 The kinetic energy specified in 29.4.1 is to be computed using the average speed at which the door travels through the distance:

- a) For a single, horizontally-sliding door located between the two vertical jambs, and extending from a point 2 in (50.8 mm) from one jamb to a point 2 in from the other.
- b) For a center-parting, sliding door, located between either jamb and the center meeting line of the door, and extending from a point 1 in (25.4 mm) from either jamb to a point 1 in from the center meeting line of the door.

29.4.3 A commercial or residential swinging pedestrian door or either single-leaf or double-leaf construction that is either remotely or automatically actuated, or both – see 29.1.1:

- a) Shall not close with a force greater than 40 lbf (177.9 N) at the latch side of the closing stile, and
- b) Shall not close through the final 10 degrees in less than 1.5 s.

29.4.4 To comply with the requirements in 29.4.3(a), the free leaf of a double-leaf door having one leaf jammed shall not have a closing force greater than 40 lbf (177.9 N) at the latch side of the closing stile.

29.4.5 A pedestrian door operator that is to be marketed without the door:

- a) Shall be tested using a typical door construction but of the maximum or minimum weight specified by the manufacturer's instructions, if operating speed would be increased;
- b) Shall comply with the applicable requirements of 29.4.1 and 29.4.3; and
- c) Shall be marked in accordance with 59.3.6.

## 29.5 Glazing material

29.5.1 The glazing material in both fixed and sliding panels of all sliding doors and in all unframed swinging doors shall comply with the requirements in the Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings, ANSI Z97.1–1984. Glazing material for other pedestrian doors shall also comply with ANSI Z97.1-1984, except that single strength or heavier glass may be used for those portions of doors involving a glazed area of less than 1 ft<sup>2</sup> (0.9 m<sup>2</sup>) and having no dimension greater than 18 in (457 mm).

## 29.6 Clearance

29.6.1 The opening at the hinge side of a swinging door shall be:

- a) Less than 1/4-in (6.4-mm) wide with the door in any position, or
- b) At least 3/4-in (19.1-mm) wide with the door in any position.

*Exception: A door that does not comply with the above is acceptable if provided with a finger guard.*

## 30 Industrial Doors and Door Operators and Commercial Vehicular Door Operators

### 30.1 Entrapment

30.1.1 A door or door operator shall be provided with:

- a) An actuating device that requires continuous pressure by the person operating the door for door closing movement and reversing means or release mechanism; or
- b) Means for connection of a reversing edge switch, or the equivalent, that will reverse the direction of the door upon striking an object during the closing cycle; or
- c) A three-button control station – up, down, stop; open, close, stop; raise, lower, stop; or the equivalent – provided that the operator:
  - 1) Does not incorporate an automatic closing control – such as a photoelectric cell – a pull rope actuator, or the like, and the installation instructions do not recommend use of such a control.
  - 2) Is provided with a permanent placard carrying a warning not to start the door downward unless the doorway is clear. See 59.3.12.
  - 3) Is provided with installation instructions that stress the need to mount the placard adjacent to the 3-button control station and the need to locate both the control station and the placard within sight of the doorway.
  - 4) Is permanently marked, adjacent to the wiring compartment, to indicate that the control station is to be located so that the door will be within sight of the person operating the control and that the door is to be controlled by the 3-button control station only.



**31 Class I, II, III, and IV Vehicular Gate and Vehicular Vertical Pivot-Gate Operators and Systems**

**31.1 General entrapment protection provisions**

31.1.1 A vehicular gate operator or vehicular barrier (arm) operator shall have provisions for, or be supplied with, at least one independent primary and one independent secondary means as specified in Table 31.1 to protect against entrapment.

*Exception: An operator for a vehicular barrier (arm) that is not intended to move toward a rigid object closer than 2 ft (610 mm), and does not have a pinch point between moving parts by virtue of the operator’s design or as a result of installation in accordance with instructions supplied with the operator as specified in 56.8.4 is not required to be provided with means to protect against entrapment.*

**Table 31.1  
Protection against entrapment**

Usage class	Gate operator category			
	Horizontal slide, vertical lift, and vertical pivot		Swing and vertical barrier (arm)	
	Primary type <sup>a</sup>	Secondary type <sup>a</sup>	Primary type <sup>a</sup>	Secondary type <sup>a</sup>
Vehicular I and II	A	B1, B2, or D	A, or C	A, B1, B2, C, or D
Vehicular III	A, B1, or B2	A, B1, B2, D, or E	A, B1, B2, or C	A, B1, B2, C, D, or E
Vehicular IV	A, B1, B2, or D	A, B1, B2, D, or E	A, B1, B2, C, or D	A, B1, B2, C, D, or E

Note – The same type of device shall not be utilized for both the primary and the secondary entrapment protection means. Use of a single device to cover both the opening and closing directions is in accordance with the requirement; however, a single device is not required to cover both directions. A combination of one Type B1 for one direction and one Type B2 for the other direction is the equivalent of one device for the purpose of complying with the requirements of either the primary or secondary entrapment protection means.

<sup>a</sup> Entrapment protection types:  
 Type A – Inherent entrapment protection system. See 31.1.5.  
 Type B1 – Provision for connection of, or supplied with, a non-contact sensor (photoelectric sensor or the equivalent). See 31.1.6 – 31.1.9.  
 Type B2 – Provision for connection of, or supplied with, a contact sensor (edge device or the equivalent). See 31.1.7 and 31.1.10 – 31.1.12.  
 Type C – Inherent adjustable clutch or pressure relief device. See 31.1.13.  
 Type D – Provision for connection of, or supplied with, an actuating device requiring continuous pressure to maintain opening or closing motion of the gate. See 31.1.14 and 31.1.15.  
 Type E – An inherent audio alarm. See 31.1.16, 31.1.17, and 31.1.18.

31.1.2 A vehicular gate operator or vehicular barrier (arm) operator for Classes I and II shall be supplied with an audio alarm complying with 31.1.3 and 31.1.4. The alarm shall signal upon two sequential activations of an entrapment protection device, where the first activation is either a Type A or B2 device and the second activation is a Type A device. The alarm shall signal for a minimum of 5 min or until a renewed manual input from an integral control or a permanently mounted control located in the line-of-sight of the gate has been entered. An audio alarm is not required for Classes III and IV.

31.1.3 An audio alarm specified in 31.1.2 shall comply with the applicable requirements in All Devices, Section 34, and Audio Alarms, Section 37.

31.1.4 The audio alarm signals for the alarm specified in 31.1.2 shall be generated by devices such as bells, horns, sirens, or buzzers. The signal shall have a frequency in the range of 700 to 3400 Hz, either a cycle of the sound level pulsations of 4 to 5 per s or one continuous tone, a sound level at least 100 dB 1 ft (305 mm) in front of the device, and not vary more than  $\pm 8$  dB over the voltage range of operation.

31.1.5 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Type A in Table 31.1 to comply with 31.1.1 shall upon sensing an obstruction in any direction:

- a) Stop and initiate the reversal of the gate within a maximum of 2 s. The gate operator shall reverse the gate a minimum of 2 in (50.8 mm). The gate operator shall require a renewed, intended input (via wired or wireless control or integral control, a loop sensor, a card reader, or similar device) prior to enabling any automatic actuation devices such as a timer or any other maintained input that was present when the reversing function occurred.
- b) Stop the gate upon sensing a second sequential obstruction. The gate operator shall require a renewed, intended input (via an integral control or a permanently mounted control in the line-of-sight of the gate but excluding portable wireless controls and loop detectors). The renewed, intended input shall occur prior to enabling any actuation device that is not in the line-of-sight of the gate including a portable wireless device. An alarm shall comply with paragraph 31.1.2.

31.1.6 A gate operator utilizing entrapment protection designated Type B1 in Table 31.1 by having provision for connection of, or providing with the operator, a non-contact sensor (photoelectric sensor or equivalent) to comply with 31.1.1 shall, upon sensing an obstruction in the direction of travel of the gate:

- a) Stop or reverse the gate within a maximum of 2 s,
- b) Stop the gate upon sensing a second sequential obstruction in the opposite direction while in the process of reversal as described in (a),
- c) Result in a gate at rest remaining at rest unless a Type D device is actuated, and
- d) Return to normal operation when the sensor is no longer actuated.

31.1.7 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Types B1 and B2 in Table 31.1 as the primary device to comply with 31.1.1 by having provision for connection of such device, or providing such device with the operator, shall monitor for the presence and correct operation of the device, including the wiring to it, at least once during each open and close cycle. The operator shall function as required by 31.1.15 in the event the device is not present or a fault condition occurs which precludes the sensing of an obstruction. A fault condition includes an open or short circuit in the wiring that connects the external entrapment protection device to the operator and the device's supply source.

31.1.8 A gate operator utilizing a non-contact sensor for entrapment protection in accordance with 31.1.1 shall be supplied with instructions in compliance with 56.8.4.

31.1.9 A non-contact sensor (photoelectric sensor or equivalent) supplied with, or separately supplied for, a gate operator that is intended to reduce the risk of entrapment or obstruction shall comply with the applicable requirements in All Devices, Section 34, and Photoelectric Sensors, Section 35. A separately supplied sensor shall comply with 59.3.3, 59.3.4, and 59.3.5.

31.1.10 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Type B2 in Table 31.1 by having provision for connection of, or providing with the operator, a contact sensor (edge sensor or equivalent) to comply with 31.1.1 shall, upon sensing an obstruction in the direction of travel of the gate:

- a) Stop and initiate the reversal of the gate within a maximum of 2 s. The gate operator shall reverse the gate a minimum of 2 in (50.8 mm),
- b) Stop the gate, or stop and initiate reversal of the gate upon sensing a second sequential obstruction,
- c) Result in a gate at rest remaining at rest, unless a Type D device is actuated, and
- d) After the sensor is actuated no more than 2 times while closing without having reached the close limit device, or once in a single opening cycle, a renewed intended input shall be required (via wired or wireless control or integral control, a loop sensor, a card reader, or a similar device) prior to enabling any automatic activation devices such as a timer or any other maintained input that was present when the obstruction occurred.

31.1.11 A gate operator utilizing a contact sensor for entrapment protection to comply with 31.1.1 shall be supplied with instructions on the placement of the sensors for each Type of application in compliance with 56.8.4.

31.1.12 A contact sensor (edge sensor or equivalent) supplied with, or separately supplied for, a gate operator that is intended to reduce the risk of entrapment or obstruction shall comply with the applicable requirements in All Devices, Section 34, and Edge Sensors, Section 36. A separately supplied sensor shall comply with 59.3.3, 59.3.4, and 59.3.5.

31.1.13 A swing-gate operator utilizing entrapment protection designated Type C in Table 31.1 to comply with 31.1.1 shall, upon sensing an obstruction in any direction, stop the gate and:

- a) Not result in a force after 100,000 cycles of operation under rated load of more than 10 percent higher than the initial setting to stop the gate. When adjustable, the initial setting is to be at the setting for maximum force, and
- b) Be readily accessible for inspection and repair and not readily rendered inoperative.

31.1.14 A gate operator utilizing entrapment protection designated Type D in Table 31.1 by having a provision for connection of, or providing with the operator, a continuous pressure actuation device to comply with 31.1.1 shall be constructed so that a wireless control shall not operate the gate. Also see paragraph 56.8.4 (e), 58.1.5, and 58.1.6.

31.1.15 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Type D in Table 31.1 to comply with 31.1.1 shall require constant pressure or actuation to initiate and continue movement of the gate in either the opening or closing direction. Upon removal of pressure, movement of the gate shall cease. Unless supplied with separate Open and Close buttons, each subsequent pressing of the control button shall reverse direction of the gate.

31.1.16 A gate operator utilizing entrapment protection designated Type E in Table 31.1 by having a provision for, or providing with the operator, audio alarms to comply with 31.1.1 shall:

- a) Initiate actuation of the alarm(s) a minimum of 2 s prior to movement of the gate, and
- b) Continue actuation of the alarm(s) throughout the entire opening and closing cycle of the gate.

31.1.17 An audio alarm for a Type E device shall comply with 31.1.18 and the applicable requirements in All Devices, Section 34, and Audio Alarms, Section 37.

31.1.18 The audio alarm signal for a Type E device shall be generated by devices such as bells, horns, sirens, or buzzers. The signal shall have a frequency in the range of 700 to 3400 Hz, a cycle of the sound level pulsations of 1 to 2 per second, a sound level at least 100 dB 1 ft (305 mm) in front of the device, and not vary more than  $\pm 8$  dB over the voltage range of operation. When the audio alarm is not supplied with the operator, instructions specifying the signal criteria shall be supplied with the operator.

31.1.19 A Class I or Class II horizontal slide-gate or vertical lift-gate operator (or system) shall not result in a gate movement of greater than 1 ft/s with the operator exerting a pull force of 75 lbf (333.6 N) and when connected to a supply circuit of maximum rated voltage and rated frequency.

31.1.20 A vehicular gate operator shall have a means for manual operation so that the gate is capable of being moved independently of the gate operator. For a Class I, II, or III vehicular gate operator, the means for manual operation shall be supplied as an integral part of the gate operator and the gate operator shall be marked with instructions on how to manually operate the gate. For a Class IV vehicular gate operator, the use of a nearby keyed release or a remotely located non-keyed release to release the gate operator from the gate meets the intent of this requirement. A risk of injury to persons shall not result when the means for manual operation is activated and the gate operator is then energized.

Revised 31.1.20 effective June 7, 2004

31.1.21 In an application where security or restricted access is a primary concern, acceptability of the entrapment protection provisions for a Class IV vehicular gate operator shall be demonstrated by test that the gate operator functions to reduce the risk of entrapment while performing its intended security functions.

## 31.2 Entrapment protection (Types A, B1, B2, and C)

### 31.2.1 General

31.2.1.1 When Types A, B2, or C entrapment protection devices are used as the primary or secondary entrapment protection provisions, a gate operator shall, upon contact with the obstruction specified in 31.2.2 – 31.2.4:

- a) For Types A or B2 provisions, initiate reversal of the moving gate within 2 s. The gate operator shall reverse the gate a minimum of 2 in (50.8 mm) unless a control is actuated or an entrapment circuit senses an obstruction to stop the gate during its reversal, or
- b) For Type C provision, not open or close the gate with a force greater than 40 lbf (177.9 N) at the leading edge of the gate, except for the first 10 degrees of arc travel after any initiation of movement or a 2 s maximum time after any initiation of movement. If the force of the clutch can be adjusted during use, user maintenance or installation, the clutch is to be adjusted to the maximum setting. The measurement is to be made at the maximum length of the gate recommended by the manufacturer.

A gate operator shall be tested in accordance with all applicable requirements specified in 31.2.2 – 31.2.4 for all types of gates with which the gate operator is intended to be used. Each entrapment protection provision shall be tested separately and independently with the other entrapment protection provisions defeated.

31.2.1.2 When a Type B1 entrapment protection device is used as the primary or secondary entrapment protection provision, a gate operator shall stop a moving gate within 2 s of activation of the sensor.

31.2.1.3 A gate operator is to be tested for compliance with 31.2.1.1 for 50 open-and-close cycles of operation using the location representative of the greatest risk of entrapment as determined in 31.2.2.3, 31.2.3.3, and 31.2.4.3. The force adjustment on a gate operator is to be set to deliver the maximum force or at the setting that represents the most severe operating condition. Any devices or accessories that affects the entrapment protection of the gate operator, including all other entrapment protection provisions that are intended for use with the gate operator, are then to be attached and the test repeated for 10 additional open-and-close cycles of operation.

### 31.2.2 Vehicular horizontal slide-gate and vertical lift-gate, and vertical pivot-gate operators

31.2.2.1 With reference to 31.2.1.1, a 1-5/8-in by 3-1/2-in (41.3-mm by 88.9-mm) solid rectangular object not less than 6-in (152-mm) long is to be fixed in an immobile position with the longitudinal axis perpendicular to the edge of the gate. The 1-5/8-in (41.3-mm) side of the obstruction facing the leading edge is to contact the moving gate at various points along the leading edge of the gate. For vehicular horizontal slide-gates only, the same object is then to be arranged to contact the moving gate at various points along the trailing edge of the gate.

31.2.2.2 The test described in 31.2.2.1 is to be conducted at various locations over the path of the gate. Such locations shall include, and not be limited to, locations less than 1 ft (305 mm) from the fully open, the midpoint, and less than 1 ft from the fully closed positions of the gate.

31.2.2.3 As a result of the tests specified in 31.2.2.1 and 31.2.2.2, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 31.2.1.3.

### 31.2.3 Vehicular swing-gate operators

31.2.3.1 With reference to 31.2.1.1, a solid rectangular object as described in 31.2.2.1 is to be fixed in an immobile position and tangential to the arc with the 1-5/8-in (41.3-mm) side facing the leading or bottom edges of the gate to be contacted by the moving gate at various points along the leading and bottom edges of the gate.

31.2.3.2 The test described in 31.2.3.1 is to be conducted at various locations over the arc of the gate. Such locations shall include, and not be limited to, locations less than 1 ft (305 mm) from the fully open, the starting of the gate, the mid-arc, and less than 1 ft from the fully closed positions of the gate. The test is to be conducted both for the opening and closing movements of the gate.

31.2.3.3 As a result of the tests specified in 31.2.3.1 and 31.2.3.2, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 31.2.1.3.

### 31.2.4 Vehicular vertical barrier (arm) operators

31.2.4.1 With reference to 31.2.1.1, a solid rectangular object as described in 31.2.2.1 is to be fixed in an immobile position to be contacted by the moving barrier (arm) at various points along the barrier (arm) of the gate.

31.2.4.2 The test described in 31.2.4.1 is to be conducted at various locations over the arc of the gate. Such locations shall include, and not be limited to, locations less than 1 ft (305 mm) from the fully open, the starting of the gate, the mid-arc, and less than 1 ft from the fully closed positions of the gate. The test is to be conducted both for the opening and closing movements of the gate.

31.2.4.3 As result of the tests specified in 31.2.4.1 and 31.2.4.2, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 31.2.1.3.

## 32 Residential Garage Door Operator and Door Operator Systems

### 32.1 General

32.1.1 A residential garage door operator system shall be supplied with primary inherent entrapment protection that complies with the requirements as specified in 32.2.1 – 32.2.9.

32.1.2 In addition to the primary inherent entrapment protection as required by 32.1.1, a residential garage door operator shall comply with one of the following:

a) Shall be constructed to:

- 1) Require constant pressure on a control to lower the door,
- 2) Reverse direction and open the door to the upmost position when constant pressure on a control is removed prior to operator reaching its lower limit, and
- 3) Limit a portable transmitter, when supplied, to functioning only to cause the operator to open the door;

- b) Shall be provided with a means for connection of an external secondary entrapment protection device as described in 32.3.1 – 32.3.3; or
- c) Shall be provided with an inherent secondary entrapment protection device as described in 32.3.1, 32.3.2, and 32.3.4.

32.1.3 In the case of a door operator system where the door is an integral part of the operator design that provides for an inherent secondary entrapment protection for compliance with the requirements in this Standard, the door shall comply with the requirements in Specifications for Sectional Overhead Type Doors, ANSI/DASMA 102-1996. A pinch point shall not be contacted by the probe illustrated in Figure 9.1 using the procedures described in paragraphs 9.3, 9.4, 9.5, and 9.7. In addition, a section joint of a residential sectional garage door, that admits a 0.35 in (8.9 mm) diameter rod that is 3.9-in (100-mm) long, shall also admit a 1.0 in (25.4 mm) diameter rod that is 3.9-in (100-mm) long, at all positions of the door. Rubber or textile coverings or shields, when used to cover the joint, shall pass the same test. Evaluation of pinch points shall be made with the door installed on all track configurations supplied with the door.

## 32.2 Inherent entrapment protection

32.2.1 Other than for the first 1 ft (305 mm) of travel as measured over the path of the moving door, both with and without any external entrapment protection device functional, the operator of a downward moving residential garage door shall initiate reversal of the door within 2 s of contact with the obstruction as specified in 32.2.2. After reversing the door, the operator shall return the door to, and stop the door at, the full upmost position. Compliance shall be determined in accordance with 32.2.2 – 32.2.9.

*Exception: The door operator is not required to return the door to, and stop the door at, the full upmost position when an inherent entrapment circuit senses a second obstruction or a control is actuated to stop the door during the upward travel.*

32.2.2 A solid object is to be placed on the floor of the test installation and at various heights under the edge of the door and located in line with the driving point of the operator. When tested on the floor, the object shall be 1-in (25.4-mm) high. In the test installation, the bottom edge of the door under the driving force of the operator is to be against the floor when the door is fully closed.

*Exception: For operators other than those attached to the door, a solid object is not required to be located in line with the driving point of the operator. The solid object is to be located at points at the center and within 1 ft of each end of the door.*

32.2.3 An operator is to be tested for compliance with 32.2.1 for 50 open-and-close cycles of operation while the operator is connected to the type of residential garage door with which it is intended to be used or with the doors specified in 32.2.5. For an operator having a force adjustment on the operator, the force is to be adjusted to the maximum setting or at the setting that represents the most severe operating condition. Any accessories having an effect on the intended operation of entrapment protection functions that are intended for use with the operator, are to be attached and the test is to be repeated for one additional cycle.

32.2.4 For an operator that is to be adjusted (limit and force) according to instructions supplied with the operator, the operator is to be tested for 10 additional obstruction cycles using the solid object described in 32.2.2 at the maximum setting or at the setting that represents the most severe operating condition.

32.2.5 For an operator that is intended to be used with more than one type of door, one sample of the operator is to be tested on a sectional door with a curved track and one sample is to be tested on a one-piece door with jamb hardware and no track. For an operator that is not intended for use on either or both of these types of doors, a one-piece door with track hardware or a one-piece door with pivot hardware shall be used for the tests. For an operator that is intended for use with a specifically dedicated door or doors, a representative door or doors shall be used for the tests. See the marking requirements in 59.3.1.

32.2.6 An operator, using an inherent entrapment protection system that monitors the actual position of the door, shall initiate reversal of the door and shall return the door to, and stop the door at, the full upmost position in the event the inherent door operation "profile" of the door differs from the originally set parameters. The entrapment protection system shall monitor the position of the door at increments not greater than 1 in (25.4 mm).

*Exception: The door operator is not required to return the door to, and stop the door at, the full upmost position when an inherent entrapment circuit senses an obstruction or a control is actuated to stop the door during the upward travel.*

32.2.7 An operator, using an inherent entrapment protection system that does not monitor the actual position of the door, shall initiate reversal of the door and shall return the door to, and stop the door at, the full upmost position, when the lower limiting device is not actuated within 30 s or less following the initiation of the close cycle.

*Exception: The door operator is not required to return the door to, and stop the door at, the full upmost position when an inherent entrapment circuit senses an obstruction or a control is actuated to stop the door during the upward travel. When the door is stopped manually during its descent, the 30 s shall be measured from the resumption of the close cycle.*

32.2.8 To determine compliance with 32.2.6 or 32.2.7, an operator is to be subjected to 10 open-and-close cycles of operation while connected to the door or doors specified in 32.2.3 and 32.2.5. The cycles are not required to be consecutive. Motor cooling-off periods during the test meet the intent of the requirement. The means supplied to comply with 32.2.1 and 32.3.1 are to be inoperative or defeated during the test. An obstructing object is to be used so that the door is not capable of activating a lower limiting device.

32.2.9 During the closing cycle, the system providing compliance with 32.2.1 and 32.2.6 or 32.2.1 and 32.2.7 shall function regardless of a short- or open-circuit anywhere in any low-voltage external wiring, any external entrapment devices, or any other external component.



### 32.3 Secondary entrapment protection

32.3.1 A secondary entrapment protection device supplied with, or as an accessory to, an operator shall consist of:

- a) An external photoelectric sensor that, when activated, results in an operator that is closing a door to reverse direction of the door and the sensor prevents an operator from closing an open door,
- b) An external edge sensor installed on the edge of the door that, when activated, results in an operator that is closing a door to reverse direction of the door and the sensor prevents an operator from closing an open door,
- c) An inherent door sensor independent of the system used to comply with Section 32.2 that, when activated, results in an operator that is closing a door to reverse direction of the door and the sensor prevents an operator from closing an open door, or
- d) Any other external or internal device that provides entrapment protection equivalent to (a), (b), or (c).

32.3.2 With respect to 32.3.1, the operator shall monitor for the presence and correct operation of the device, including the wiring to it, at least once during each close cycle. In the event the device is not present or a fault condition occurs which precludes the sensing of an obstruction, including an open- or short-circuit in the wiring that connects an external entrapment protection device to the operator and the device's supply source, the operator shall be constructed such that:

- a) A closing door shall open and an open door shall not close more than 1 ft (305 mm) below the upmost position, or
- b) The operator shall function as required by 32.1.2(a).

32.3.3 An external entrapment protection device shall comply with the applicable requirements in Sections 34 – 36 of this Standard.

32.3.4 An inherent secondary entrapment protection device shall comply with the applicable requirements in Door Sensors, Section 46.

### 32.4 Additional features

32.4.1 A means to manually detach the door operator from the door shall be supplied. The gripping surface (handle) shall be colored red and shall be easily distinguishable from the rest of the operator. It shall be capable of being adjusted to a height of 6 ft (1.83 m) above the garage floor when the operator is installed according to the instructions specified in 56.3.1 and 56.4.1(4). The means shall be constructed so that a hand firmly gripping it and applying a maximum of 50 lbf (223 N) of force shall detach the operator with the door obstructed in the down position. The obstructing object, as described in 32.2.2, is to be located in several different positions. A marking with instructions for detaching the operator shall be supplied. The marking shall comply with 57.1 – 57.8.

*Exception: A means to manually detach the door operator from the door is not required for a door operator that is not directly attached to the door and that controls movement of the door so that:*

- a) The door is capable of being moved open from any position other than the last (closing) 2 in (50.8 mm) of travel, and*
- b) The door is capable of being moved to the 2-in point from any position between closed and the 2-in point.*

32.4.2 Actuation of a control that initiates movement of a door shall stop and may reverse the door on the down cycle. On the up cycle, actuation of a control shall stop the door but not reverse it.

32.4.3 A residential garage door operator when tested as described in 42.1 shall have a maximum appliance current draw, excluding lamps or external devices, of not more than 5 A.

32.4.4 An operator shall be constructed so that adjustment of limit, force or other user controls and connection of external entrapment protection devices can be accomplished without exposing normally enclosed live parts or wiring. See 9.7.

### 33 Combination Rigid One-Piece Overhead Residential Garage Door and Operator System

33.1 A combination rigid one-piece overhead residential garage door and operator system shall comply with the applicable residential garage door operator requirements in this standard and shall additionally comply with the following:

- a) The speed of the door edge during the opening or closing motion shall not exceed 6 in (152 mm) per second.
- b) The system shall be supplied with two additional independent secondary entrapment protection devices complying with Secondary Entrapment Protection, Section 32.3. When photoelectric sensors are used, a minimum of two sensors in addition to a third secondary device shall be supplied. The instructions shall state that one photoelectric sensor shall be positioned to comply with Photoelectric Sensors, Section 35, and the other(s) shall be positioned on the left and right sides of the door to detect solid objects that would be within the space where the door moves as it opens or closes.
- c) A means to manually detach both door operators from the door shall be provided. For systems where the mechanical drive is located on a wall adjacent to the door, the means is not required to comply with 32.4.1. Instead, the means shall be located 5 ft (1.52 m) above the floor, shall not require a torque of more than 5 ft-lb (6.78 N-m) to initiate disconnection when the door is obstructed, and shall be clearly marked with operating instructions adjacent to the

mechanism. The gripping surface (handle) shall be colored red and shall be distinguishable from the rest of the operator. The marking which includes instructions for detaching the operator shall be provided in accordance with 57.1 – 57.9.

d) A means (interlock) shall be supplied to de-energize the operator whenever the operator is manually detached from the door. An electromechanical switch or relay employed as the means (interlock) shall also comply with the requirements in Section 49, as applicable.

e) A means (interlock) shall be supplied to de-energize the operator whenever an operable window or access (service) door that is mounted in the garage door is opened perpendicular to the surface of the garage door. An electromechanical switch or relay employed as the means (interlock) shall also comply with the requirements in Section 49, as applicable.

f) The door shall not move outward from the exterior wall surface during the opening or closing cycle.

g) The door or door system (mounting hardware, track assembly, and components that make up the door) shall comply with Moving Parts, Section 27.

h) A horizontal track assembly, including installation hardware, shall support a dead load equal to the door weight when the door is in the horizontal position when tested in accordance with Dead Load Test, Section 53.

i) Instructions for the installation of operable windows and access (service) doors and the interlocks specified in (e) shall be supplied with the operator.

## **EXTERNAL ENTRAPMENT PROTECTION DEVICES**

### **34 All Devices**

#### **34.1 General**

34.1.1 An external entrapment protection device shall perform its intended function when tested in accordance with 34.1.2 – 34.1.4.

34.1.2 The device is to be installed in the intended manner and its terminals connected to circuits of the operator as indicated by the installation instructions.

34.1.3 The device is to be installed and tested at minimum and maximum heights and widths representative of recommended ranges specified in the installation instructions. For doors, if not specified, devices are to be tested on a minimum 7-ft (2.13-m) wide door and maximum 20-ft (6.10-m) wide door.

34.1.4 If powered by a separate source of power, the power-input supply terminals are to be connected to supply circuits of rated voltage and frequency.

34.1.5 An external entrapment protection device requiring alignment, such as a photoelectric sensor, shall be provided with a means, such as a visual indicator, to show proper alignment and operation of the device.

## **34.2 Current protection test**

34.2.1 There shall be no damage to the entrapment protection circuitry if low voltage field-wiring terminals or leads are shorted or miswired to adjacent terminals.

34.2.2 To determine compliance with 34.2.1, an external entrapment protection device is to be connected to an operator or other source of power in the intended manner, after which all connections to low-voltage terminals or leads are to be reversed as pairs, reversed individually, or connected to any low-voltage lead or adjacent terminal.

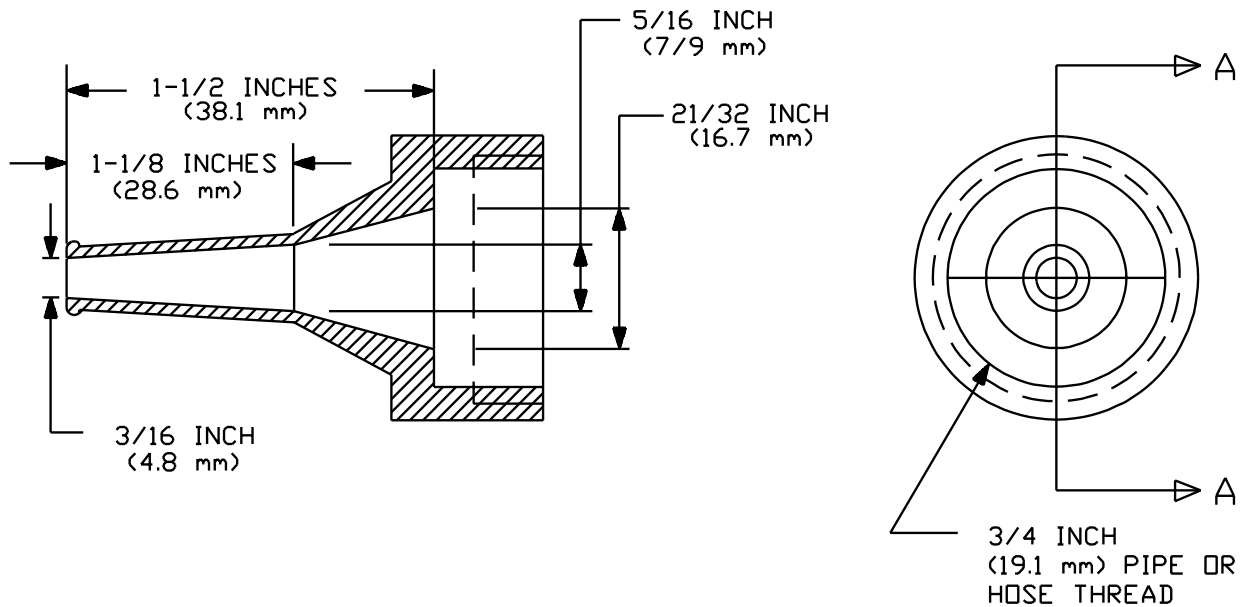
## **34.3 Water exposure tests**

### **34.3.1 Splash test**

34.3.1.1 An external entrapment protection device intended to be installed inside a garage 3 ft (914 mm) or less above the floor shall withstand indirect water spray as described in 34.3.1.2 without resulting in a risk of electric shock and shall function as intended. After exposure to the water spray, the external surface of the device is to be dried before determining its functionality.

34.3.1.2 External entrapment protection devices are to be indirectly sprayed using a hose having the free end fitted with a nozzle as illustrated in Figure 34.1 and connected to a water supply capable of maintaining a flow rate of 5 gal (19 L) per minute as measured at the outlet orifice of the nozzle. The water from the hose is to be sprayed, from all sides and at any angle, against the floor under the device in a manner that results in water spray on the enclosure of electrical components. The nozzle is not to be brought closer than 10 ft (3.05 m) horizontally to the device. The water is to be sprayed for 1 min.

**Figure 34.1  
Nozzle**



SM950

**34.3.2 Rain test**

34.3.2.1 External entrapment protection devices Types B1, B2, D, and E shall comply with Insulation Resistance Test and Dielectric Voltage-Withstand Test (Repeated), Section 45.

**34.4 Ultraviolet light exposure test**

34.4.1 A polymeric material used as a functional part of a device that is exposed to outdoor weather conditions shall comply with the Ultraviolet Light Exposure Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

### **34.5 Resistance to impact test**

34.5.1 An external entrapment protection device employing a polymeric or elastomeric material as a functional part shall be subjected to the impact test specified in 34.5.2. As a result of the test:

- a) There shall not be cracking or breaking of the part, and
- b) The part shall operate as intended.

A part that is dislodged, is not cracked or broken, and is capable of being restored to its original condition meets the intent of the requirement.

34.5.2 Samples of the external entrapment protection device are to be subjected to the Impact Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. The external entrapment protection device is to be subjected to 5 ft-lbf (6.8 J) impacts. Three samples are to be tested, each sample being subjected to three impacts at different points.

34.5.3 Each of three additional samples of a device used with a gate or a device exposed to outdoor weather when the door is in the closed position are to be cooled to a temperature of minus  $35.0 \pm 2.0^{\circ}\text{C}$  (minus  $31.0 \pm 3.6^{\circ}\text{F}$ ) and maintained at this temperature for 3 h. Three samples of a device employed inside the garage are to be cooled to a temperature of  $0.0^{\circ}\text{C}$  ( $32.0^{\circ}\text{F}$ ) and maintained at this temperature for 3 h. While the sample is still cold, the samples shall comply with 34.5.1.

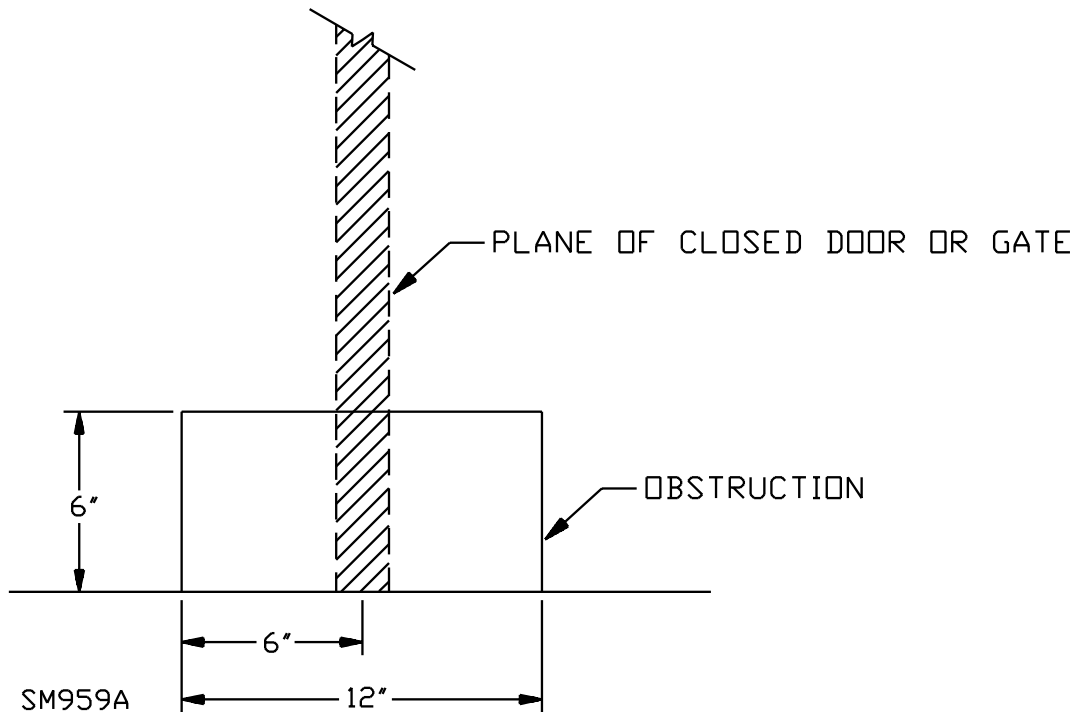
## **35 Photoelectric Sensors**

### **35.1 Normal operation test (doors, vertical lift gates, and vertical pivot gates)**

35.1.1 When installed as described in 35.1.2 – 34.1.1, a photoelectric sensor shall sense an obstruction as described in 34.1.4 that is to be placed on a level surface below the door or gate. The sensor is to be tested with the obstruction at a total of five different locations over the width of the door or gate opening. The locations shall include distances 1 in (25.4 mm) from each end, 1 ft (305 mm) from each end, and the midpoint.

35.1.2 The obstruction noted in 35.1.1 shall consist of a white vertical surface, 6-in (152-mm) high by 12-in (305-mm) long. The obstruction is to be centered under the door or gate perpendicular to the plane of the door or gate when in the closed position. See Figure 35.1.

**Figure 35.1**  
**Stationary obstruction**



### 35.2 Normal operation test (all other gates)

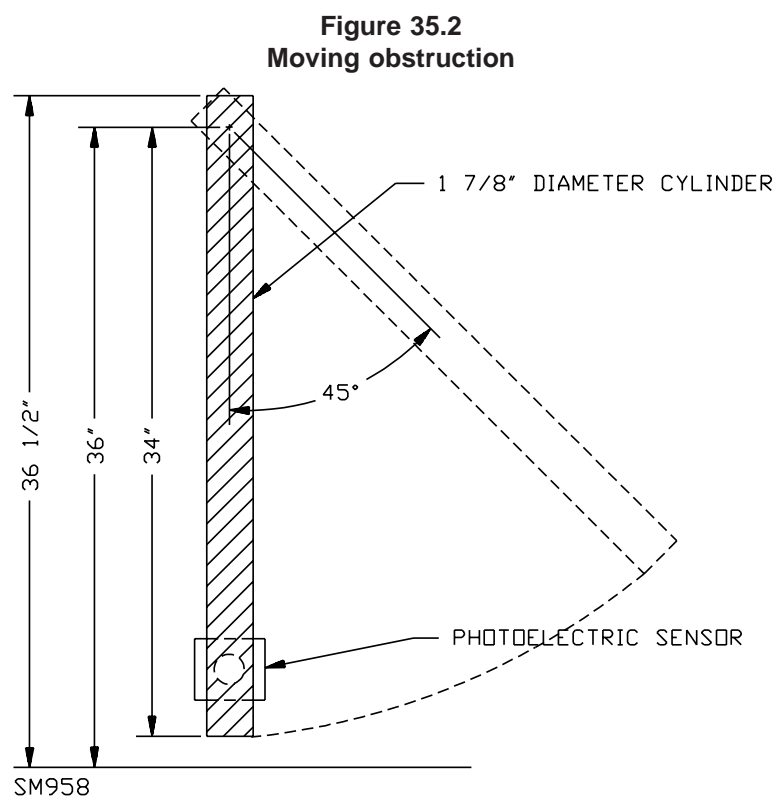
35.2.1 When installed as described in 34.1.1 – 34.1.4, a photoelectric sensor shall sense an obstruction as described in 35.2.2 that is placed on a level surface in the path of the leading edge of the gate. The sensor is to be tested with the obstruction at a total of five different locations over the width of the gate opening. The locations shall include distances 1 in (25.4 mm) from each end, 1 ft (305 mm) from each end, and the midpoint. The 1-ft side of the obstruction is to be centered across the gate opening perpendicular to a straight line across the opening.

35.2.2 The obstruction used for the test is to consist of a white vertical surface, 27-1/2-in (698-mm) high by 12-in (305-mm) wide. The obstruction is to be placed on the ground in accordance with 35.2.1.

### 35.3 Sensitivity test

35.3.1 When installed as described in 34.1.1 – 34.1.4, a photoelectric sensor shall sense the presence of a moving object when tested according to 34.2.2.

35.3.2 The moving object is to consist of a 1-7/8 in (47.6 mm) diameter cylindrical rod, 34-1/2-in (876-mm) long, with the axis point being 34 in (864 mm) from the end. The axis point is to be fixed at a point centered directly above the beam of the photoelectric sensor 36 in (914 mm) above the level surface below the door or gate. The photoelectric sensor is to be mounted at the highest position as recommended by the manufacturer. The rod is to be swung as a pendulum through the photoelectric sensor's beam from a position 45 degrees from the plane of the door or gate when in the closed position. See Figure 35.2.



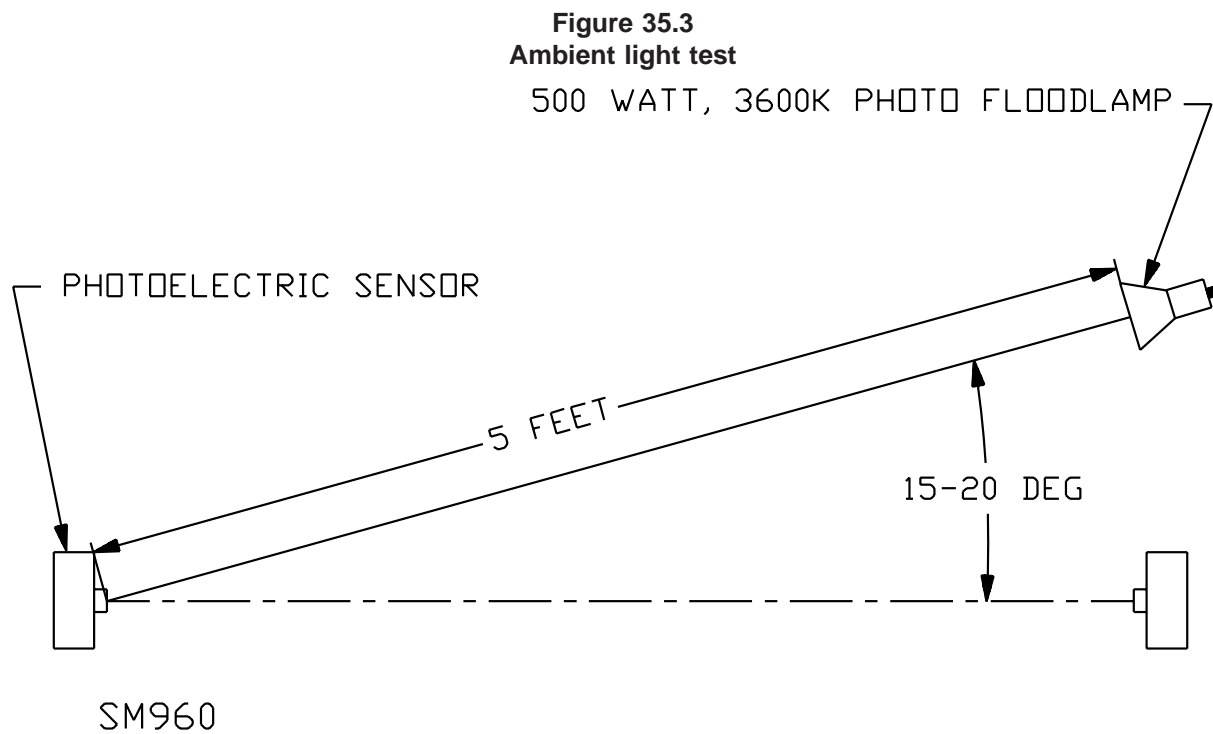
35.3.3 The test described in 34.2.2 is to be conducted at three points over the width of the door or gate opening, at distances of 1 ft (305 mm) from each end and the midpoint.



### 35.4 Ambient light test

35.4.1 A photoelectric sensor shall operate as specified in 32.3.1 and 32.3.2 when subjected to ambient light impinging at an angle of 15 to 20 degrees from the axis of the beam when tested according to 35.4.2 and, if appropriate, 35.4.3.

35.4.2 To determine compliance with 35.3.1, a 500 W, 3600K Photo Floodlamp, type DXC RFL-2, is to be energized from a 120-V, 60-Hz source. The lamp is to be positioned 5 ft (1.52 m) from the front of the receiver and aimed directly at the sensor at an angle of 15 to 20 degrees from the axis of the beam. See Figure 35.3.



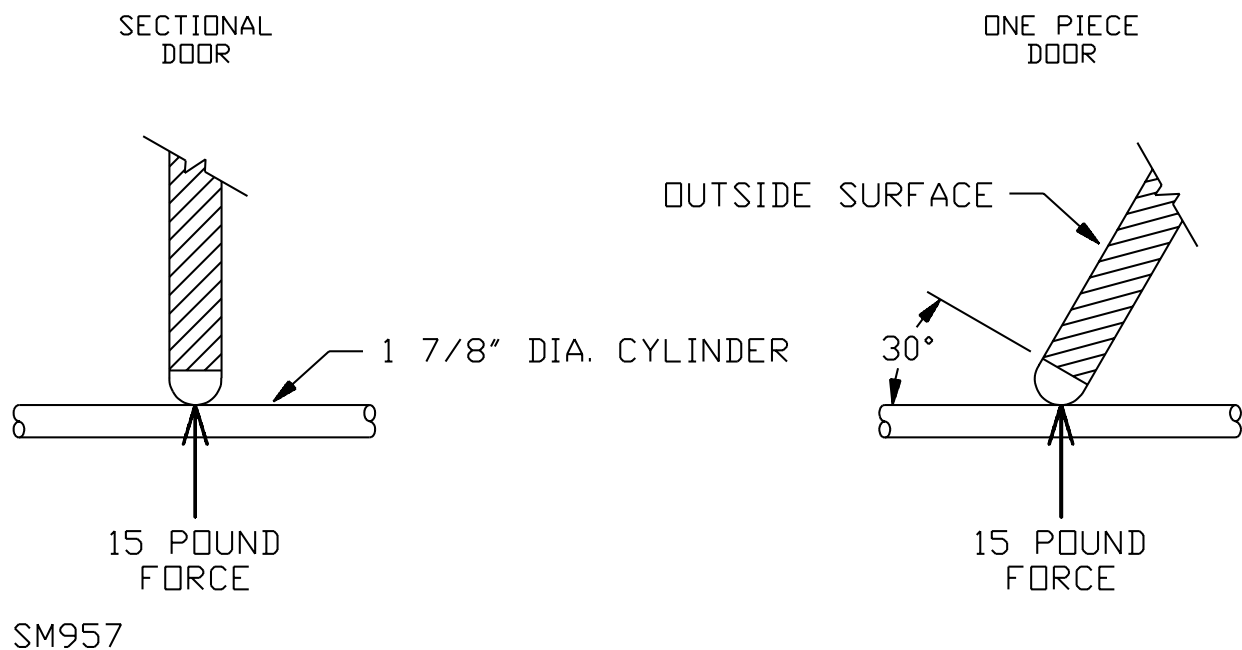
35.4.3 If the photoelectric sensor uses a reflector, this test is to be repeated with the lamp aimed at the reflector.

## 36 Edge Sensors

### 36.1 Normal operation test

36.1.1 When installed on a representative door edge, an edge sensor shall actuate upon the application of a 15 lbf (66.7 N) or less force in the direction of the application. For an edge sensor intended to be used on a sectional door, the force is to be applied by the longitudinal edge of a 1-7/8 in (47.6 mm) diameter cylinder placed across the sensor so that the axis is perpendicular to plane of the door. For an edge sensor intended to be used on a one piece door, the force is to be applied so that the axis is at an angle 30 degrees from the direction perpendicular to the plane of the door. See Figure 36.1.

**Figure 36.1**  
**Edge sensor normal operation test**



36.1.2 With respect to the test of 36.1.1, the test is to be repeated at various representative points of the edge sensor across the width of the door.

*Exception: The edge sensor need not be sensitive to actuation 2 in (50.4 mm) or less from each end of the intended width of the door opening.*

## **36.2 Endurance test**

36.2.1 An edge sensor system and associated components shall withstand 30,000 cycles of mechanical operation without failure. For this test, the edge sensor is to be cycled by the repetitive application of the force as described in 36.1.1. The force is to be applied to the same location for the entire test. For an edge sensor system employing integral electric contact strips, this test shall be conducted with the contacts connected to a load no less severe than it controls in the operator. For the last 50 cycles of operation, the sensor shall function as intended when connected to an operator.

## **36.3 Elastomeric material conditioning test**

36.3.1 An elastomeric material used as a functional part of an edge sensor shall function as intended when subjected to:

- a) Accelerated Aging Test of Gaskets, Section 48, and
- b) Puncture Resistance Test, Section 51.

36.3.2 An elastomeric material used for a functional part that is exposed to outdoor weather conditions when the door is in the closed position shall have physical properties as specified in Table 48.1 after being conditioned in accordance with the Ultraviolet Light Exposure Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

## **37 Audio Alarms**

### **37.1 Endurance test**

37.1.1 With reference to 31.1.17, an audio alarm shall withstand without malfunction or breakdown:

- a) An endurance test consisting of 6,000 cycles of 1 min on and 30 s off, and
- b) A durability test consisting of 72 h of continuous energization under the most severe end-use temperature at which the signal is likely to function when considering exposure to outdoor weather conditions.

### **37.2 Elastomeric material conditioning test**

37.2.1 An elastomeric material used as a functional part of an audio alarm shall function as intended when subjected to Accelerated Aging Test of Gaskets, Section 48.

37.2.2 An elastomeric material used for a functional part of an audio alarm intended to be exposed to outdoor weather conditions shall have physical properties as specified in Table 48.1 after being conditioned in accordance with the Ultraviolet Light Exposure Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

### **37.3 Activation test**

37.3.1 When the audio alarm is intended to be used on a Class I or II gate operator with a Type A entrapment protection device to comply with 31.1.2, the gate operator shall be obstructed twice without being reset between obstructions. The first obstruction shall be as specified as in 31.2.2– 31.2.4. The second obstruction shall be a rigid object placed behind the gate in a location so that the gate contacts the second obstruction upon reversal. The second obstruction shall be a solid object fixed in an immobile position. Upon sensing the second obstruction, the gate operator shall stop the gate and activate an audio alarm. The audio alarm shall comply with 31.1.4.

### **38 Trial Installation**

38.1 To determine whether the installation instructions in the instruction manual comply with the requirements in 56.1.1 – 56.1.3, 56.3.1, and 56.3.2, a trial installation is to be made using the instruction manual.

## **PERFORMANCE**

### **39 Leakage Current Test**

#### **39.1 General**

39.1.1 The leakage current of a cord-connected appliance rated for a nominal 250-V or less supply when tested in accordance with 39.1.3 – 39.2.2 shall not be more than:

- a) 0.5 mA for an ungrounded (2-wire) appliance, and
- b) 0.75 mA for a grounded (3-wire) appliance.

39.1.2 Leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of an appliance.

39.1.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively if simultaneously accessible and from one surface to another if simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure that provides protection against a risk of electric shock as defined in 9.1, 9.2 and 9.7. Surfaces are considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are not considered to involve a risk of electric shock.

39.1.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 10 by 20 cm in contact with the surface. If the surface is less than 10 by 20 cm, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the appliance.

39.1.5 The measurement circuit for leakage current is to be as illustrated in Figure 39.1. The measurement instrument is defined in (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

- a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15  $\mu\text{f}$ .
- b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.
- c) Over a frequency range of 0-100 kHz, the measurement circuitry is to have a frequency response – ratio of indicated to actual value of current – that is equal to the ratio of impedance of a 1500-ohm resistor shunted by a 0.15- $\mu\text{f}$  capacitor to 1500 ohms. At an indication of 0.5 or 0.75 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.

39.1.6 Unless the meter is being used to measure leakage from one part of an appliance to another, it is to be connected between the accessible parts and the grounded supply conductor.

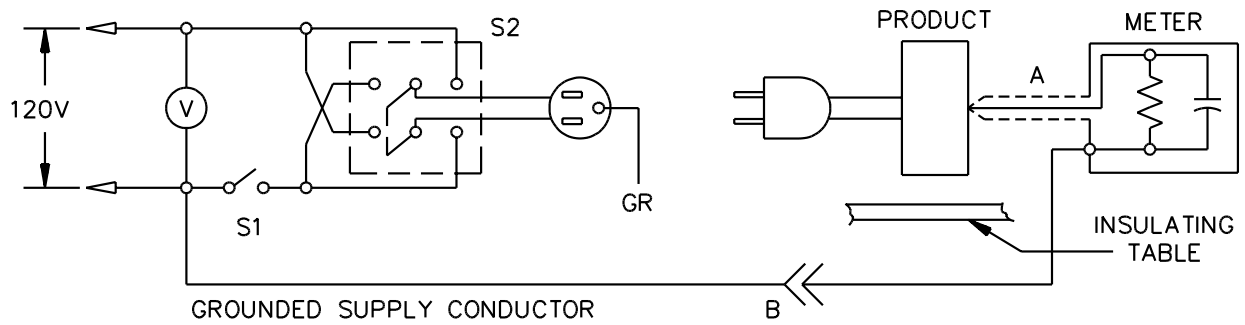
## 39.2 Tests

39.2.1 A sample of the appliance is to be tested for leakage current starting with the as-received condition, but with its grounding conductor, if any, open at the attachment plug – the as-received condition being without prior energization, except as may occur as part of the production-line testing. The supply voltage is to be adjusted to rated voltage. The test sequence, with reference to the measuring circuit – Figure 39.1 – is to be as follows:

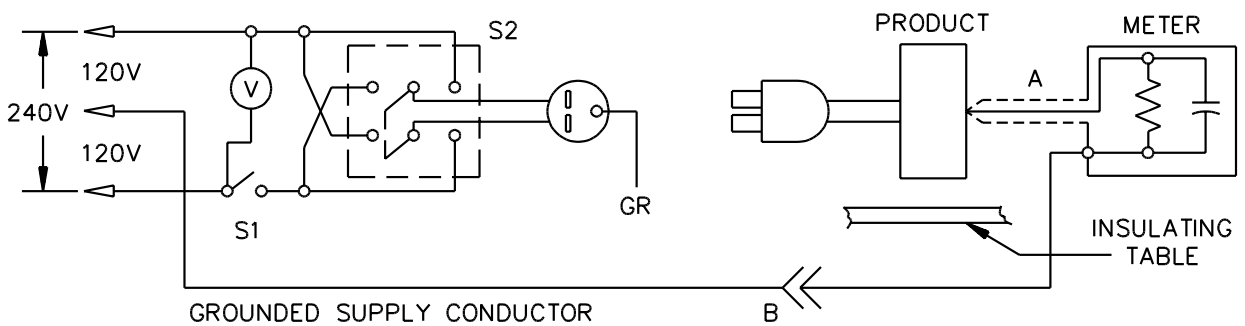
- a) With switch S1 open, the appliance is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, and with the appliance switching devices in all their normal operating positions.
- b) Switch S1 is then to be closed energizing the appliance; and within 5 s, the leakage current is to be measured using both positions of switch S2 and with the appliance switching devices in all their normal operating positions.
- c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is considered to be obtained by operation as in the normal temperature test.

39.2.2 Normally a sample will be carried through the complete leakage current test, as specified in 39.2.1, without interruption for other tests. With the concurrence of those concerned, the leakage current test may be interrupted for the purpose of conducting other nondestructive tests.

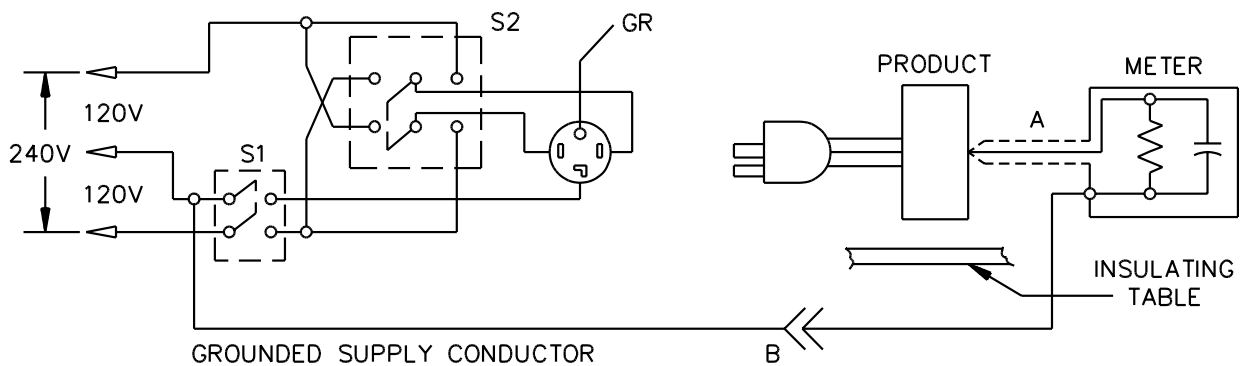
**Figure 39.1**  
**Leakage-current measurement circuit**



Product intended for connection to a 120-volt power supply, as illustrated above.



Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.



Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

LC300J

A: PROBE WITH SHIELDED LEAD.

B: SEPARATED AND USED AS CLIP WHEN MEASURING CURRENTS FROM ONE PART OF DEVICE TO ANOTHER.

#### 40 Leakage Current Test Following Humidity Conditioning

40.1 An appliance shall comply with the requirements for leakage current in Section 39 following exposure for 48 h to air having a relative humidity of  $88 \pm 2$  percent and at a temperature of  $32.0 \pm 2.0^\circ\text{C}$  ( $89.6 \pm 3.6^\circ\text{F}$ ).

40.2 To determine whether an appliance complies with the requirement in 40.1, a sample of the appliance at an initial temperature just above  $34.0^\circ\text{C}$  ( $93.2^\circ\text{F}$ ) is to be conditioned for 48 h in a humidity chamber maintained as specified in 40.1. Following the conditioning:

- a) An appliance as mentioned in 39.1.1 is to be tested unenergized as described in 39.2.1(a). The sample is then to be energized and tested as described in 39.2.1 (b) and (c). The test is to be discontinued when the leakage current stabilizes or decreases.
- b) An appliance other than as mentioned in (a) shall have an insulation resistance not less than 50,000 ohms between live parts and interconnected dead metal parts.

#### 41 Starting Current Test

41.1 An appliance other than as described in 41.2 shall start and operate normally on a circuit protected by an ordinary – not time-delay – fuse having a current rating corresponding to that of the branch circuit to which the appliance should be connected.

*Exception: The requirement does not apply if:*

- a) The construction of the appliance or the nature of its usage is such that it is likely to be used continually on the same branch circuit after installation, and*
- b) The appliance will start and operate normally on a circuit protected by a time-delay fuse.*

41.2 An appliance that would normally be used on a 15- or 20-A branch circuit shall start and operate normally on a circuit protected by a time-delay fuse having an ampere rating corresponding to that of the branch circuit on which the appliance would normally be used.

41.3 To determine whether an appliance complies with the requirement in 41.1, it is to be started three times, with the appliance at room temperature at the beginning of the test. The start of each motor is to be made under conditions representing the normal operating cycle and load. Each motor is to be allowed to come to full speed and then to come to rest between successive starts. The performance is unacceptable if the fuse opens. Tripping of an overload protector as part of the appliance is also unacceptable.

## 42 Input Current Test

42.1 The current input or wattage to an appliance shall not be more than 110 percent of the rated value when the appliance is operated under the condition of maximum normal load as described in 43.2.1 – 43.11.1, and when connected to a supply circuit of maximum rated voltage and rated frequency.

42.2 For an appliance having a single voltage rating, such as 115 or 230 V, maximum rated voltage is considered to be that single value of voltage. If the rating is given in terms of a range of voltage, maximum rated voltage is considered to be the highest value of the range – 120 or 240 V, minimum.

## 43 Normal Temperature Test

### 43.1 General

43.1.1 An appliance when tested under the conditions of maximum normal load as described in 43.2.1– 43.11.1 shall not attain a temperature at any point sufficiently high to result in a risk of fire, to damage any materials employed in the appliance, or to exceed the temperature rises specified in Table 43.1.

**Table 43.1**  
**Maximum temperature rises**

Material and component parts		Degrees	
		C	F
1.	Varnished-cloth insulation	60	108
2.	Fuses	65	117
3.	Fiber employed as electrical insulation	65	117
4.	Wood and other combustible material	65	117
5.	At any point within a terminal box or wiring compartment of a permanently connected appliance in which power-supply conductors are to be connected, including such conductors themselves	35	63
6.	A surface upon which a stationary appliance is expected to be mounted in service, and surfaces that are expected to be adjacent to the appliance when so mounted	65	117
7.	Class 105 (A) insulation on coil windings of an a-c motor having a diameter of more than 7 in (178 mm), of a d-c motor, and of a universal motor <sup>a,b</sup> :		
	A. In an open motor <sup>c</sup>		
	Thermocouple method	65	117
	Resistance method	75	135
	B. In a totally enclosed motor		
	Thermocouple method	70	126
	Resistance method	80	144
8.	Class 105 (A) insulation on coil windings of an a-c motor having a diameter of 7 in or less excluding a universal motor and on vibrator coils <sup>a,b</sup> :		
	A. In an open motor and on vibrator coils <sup>c</sup>		
	Thermocouple or resistance method	75	135
	B. In a totally enclosed motor		
	Thermocouple or resistance method	80	144
9.	Class 130 (B) insulation, except as indicated in items 15 and 16 <sup>a</sup>		
	A. Transformers		
	Thermocouple method	85	153
	Resistance method	95	171

Table 43.1 Continued on Next Page



Table 43.1 Continued

Material and component parts		Degrees															
		C	F														
B.	Relays or solenoid windings																
	Thermocouple method	85	153														
	Resistance method	105	189														
10.	Phenolic composition employed as electrical insulation or as a part, the deterioration of which results in a risk of fire or electric shock <sup>d</sup>	125	225														
11.	Rubber- or thermoplastic-insulated wire and cord <sup>d,e</sup>	35	63														
12.	Capacitor																
	Electrolytic <sup>f</sup>	40	72														
	Other types <sup>g</sup>	65	117														
13.	Sealing compound	40°C (104°F) less than melting point															
14.	Class 105 (A) insulation on windings of a relay, a solenoid, or similar component <sup>a,c</sup>																
	Thermocouple method	65	117														
	Resistance method	85	153														
15.	Class 130 (B) insulation on coil windings of an a-c motor having a diameter of 7 in or more, excluding a universal motor <sup>a,b</sup>																
A.	In an open motor <sup>c</sup>																
	Thermocouple method	85	153														
	Resistance method	95	171														
B.	In a total enclosed motor																
	Thermocouple method	90	162														
	Resistance method	100	180														
16.	Class 130 (B) insulation on coil windings of an a-c motor having a diameter of 7 in or less, excluding a universal motor <sup>a,b</sup>																
A.	In an open motor																
	Thermocouple or resistance method <sup>c</sup>	95	171														
B.	In a totally enclosed motor																
	Thermocouple or resistance method	100	180														
17.	Class 155 (F) insulation on coil windings of transformers																
	Thermocouple method	110	198														
	Resistance method	120	216														
	Class 155 (F) insulation on coil windings of motors, thermocouple or resistance method																
A.	In an open motor <sup>c</sup>	120	216														
B.	In a totally enclosed motor	125	225														
<p><sup>a</sup> See 43.1.2.</p> <p><sup>b</sup> See note a in Table 23.2.</p> <p><sup>c</sup> At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple is not restricted from being more than the maximum temperature rise specified in this table when the temperature rise as measured by the resistance method is not more than that specified. The temperature rise measured by means of a thermocouple shall not exceed the specified value by more than:</p> <table border="1"> <thead> <tr> <th>Item</th> <th>Additional Temperature rise</th> </tr> </thead> <tbody> <tr> <td>7, Subitem A</td> <td>15°C (27°F)</td> </tr> <tr> <td>8, Subitem A</td> <td>5°C (9°F)</td> </tr> <tr> <td>14</td> <td>15°C (27°F)</td> </tr> <tr> <td>15, Subitem A</td> <td>20°C (36°F)</td> </tr> <tr> <td>16, Subitem A</td> <td>10°C (18°F)</td> </tr> <tr> <td>17, Subitem A</td> <td>15°C (27°F)</td> </tr> </tbody> </table>				Item	Additional Temperature rise	7, Subitem A	15°C (27°F)	8, Subitem A	5°C (9°F)	14	15°C (27°F)	15, Subitem A	20°C (36°F)	16, Subitem A	10°C (18°F)	17, Subitem A	15°C (27°F)
Item	Additional Temperature rise																
7, Subitem A	15°C (27°F)																
8, Subitem A	5°C (9°F)																
14	15°C (27°F)																
15, Subitem A	20°C (36°F)																
16, Subitem A	10°C (18°F)																
17, Subitem A	15°C (27°F)																

Table 43.1 Continued

Material and component parts	Degrees	
	C	F
<p><sup>d</sup> The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to a compound that is rated for use at a higher temperature.</p> <p><sup>e</sup> Rubber-insulated conductors within a Class-A-insulated motor, rubber-insulated motor leads, and a rubber-insulated flexible cord entering a motor is not restricted from being subjected to a temperature rise of more than 35°C (63°F), when a braid is employed on the conductor of other than a flexible cord. However, this does not apply to thermoplastic-insulated wire or cord. See 43.1.4.</p> <p><sup>f</sup> For an electrolytic capacitor that is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure shall not be more than 65°C (117°F).</p> <p><sup>g</sup> A capacitor that operates at a temperature rise of more than 65°C (117°F) shall be investigated on the basis of its marked temperature limit.</p>		

43.1.2 Ordinarily, coil or winding temperatures are to be measured by thermocouples unless the coil is inaccessible for mounting these devices – for example, a coil immersed in sealing compound – or unless the coil wrap includes thermal insulation, such as asbestos or more than two layers – 1/32 in (0.8 mm) maximum – of cotton paper, rayon, or the like. For a thermocouple-measured temperature of a coil of an alternating-current motor, other than a universal motor, having a diameter of 7 in (178 mm) or less – items 8 and 16 in Table 43.1 – the thermocouple is to be mounted on the integrally applied insulation on the conductor.

43.1.3 All values for temperature rises in Table 43.1 are based on an assumed ambient temperature of 25°C (77°F). Tests may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). If the appliance incorporates a reel for the power-supply cord, one-third of the length of the cord is to be unreeled for the temperature test.

43.1.4 A short length of rubber- or thermoplastic-insulated flexible cord exposed to a temperature of more than 60°C (140°F), such as at terminals, is acceptable if supplementary heat-resistant insulation of adequate dielectric strength is employed on the individual conductors of the cord to protect the appliance against deterioration of the conductor insulation.

43.1.5 For the temperature test, the voltage of a direct-current power-supply circuit is to be 115 V or 230 V, and that of an alternating-current circuit is to be 120 V or 240 V, depending on whether the appliance has a nominal voltage rating of 115 V or 230 V. If the appliance has a single frequency rating, the test is to be conducted at that frequency. An appliance rated ac/dc or dc-60 Hz is to be tested on direct-current or 60-Hz alternating current, whichever results in higher temperatures. An appliance rated 25 – 60 Hz or 50 – 60 Hz is to be tested on 60-Hz alternating current.

43.1.6 Thermocouples are to consist of wires not larger than No. 24 AWG (0.21 mm<sup>2</sup>) and not smaller than No. 30 AWG (0.05 mm<sup>2</sup>). When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of No. 30 AWG iron and constantan wire and a potentiometer-type instrument, and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouples wire is to conform with the requirements specified in the Initial Calibration Tolerances For Thermocouples table in Temperature-Measurement Thermocouples, ANSI/ISA MC96.1.

43.1.7 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material the temperature of which is being measured. In most cases, adequate thermal contact will result from securely taping or cementing the thermocouple in place but, if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

43.1.8 A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but no less than 5 min intervals, indicate no change.

### **43.2 Maximum normal load**

43.2.1 Maximum normal load is the load that approximates as closely as possible the most severe conditions of normal use. It is not a deliberate overload except as the conditions of actual use are likely to be somewhat more severe than the maximum load conditions that are recommended by the manufacturer of the appliance. Test loads that have been found to be close approximations of the most severe conditions of normal use are described in 43.3.1 – 43.10.1 for some common forms of appliances. However, appliances having features not contemplated in these test procedures may be tested as necessary to meet the intent of these requirements.

### **43.3 Residential door operators**

43.3.1 The input test is to be conducted with the operator exerting a 25-lbf (111.21-N) pull or its rated pull, whichever is greater. The temperature test is to consist of five complete cycles of opening and closing without pause between the opening and closing operations. An interval equal to the time required for a complete opening and closing operation is to be allowed between the successive cycles of operation.

### **43.4 Light duty commercial vehicular doors and door operators**

43.4.1 The input test is to be conducted with the operator exerting its marked value of pull. The temperature test is to consist of opening and closing operations using a load, such as a brake or a weight, that results in the operator drawing an input current equal to that obtained in the input test or as noted in 43.4.2. There shall not be any pause between the opening and closing operations, but an interval equal to the time required for a complete opening and closing operation is acceptable between successive cycles of operation. The test is to be started at room temperature and conducted for 10 cycles of opening and closing. If the motor protector does not open, at the option of the manufacturer the test may be continued until constant temperatures are attained or until the motor protector opens. If the motor protector opens, the number of completed opening and closing operations is to be noted. See 56.7.1, 59.3.13, and 59.3.14.

43.4.2 With reference to 43.4.1, a door provided by the manufacturer may be used as the load for the normal temperature test. The door is to be not less than 12-ft (3.66-m) high and shall be such that it will require the rated pull of the operator to function.

### 43.5 Commercial or industrial door systems or operators

43.5.1 The input test is to be conducted with the operator exerting its marked value of pull. The temperature test is to consist of continuous operation until temperatures are constant, with the operator loaded by any means, such as a brake, so as to have an input equal to that measured in the input test. As an alternate, the temperature test of a commercial unit may be conducted with a load consisting of a door provided by the manufacturer. The door is to be not less than 12-ft (3.66-m) high, and is to be such that it will require the rated pull of the operator to cause it to function. If the operator is tested using the intended door as a load, the assembly is to be operated at the maximum possible rate of operation, but not faster than one complete cycle of opening and closing the door per minute. There is to be no pause between opening and closing parts of the cycle, and operation is to continue until temperatures have become constant.

### 43.6 Vehicular barrier (arm) operators

43.6.1 The input test is to be conducted with the gate arm among those provided that will afford the most severe load. The temperature test is to consist of 1 cycle of operation – raising and lowering – per minute until temperatures are constant. Auxiliary parking lot equipment is to be operated at the same rate.

### 43.7 Drapery operators

43.7.1 The input and temperature tests are to be conducted with the operator loaded with draperies of the maximum horizontal width that the operator will accommodate – 25 ft (7.62 m) is considered the maximum width for a residential unit that does not include a rod and is not marked with a maximum width and having the weight for which the operator is marked or, for a residential operator not marked with such information, having a weight of 1 lb/ft (0.45 kg/0.30 m) of width.

43.7.2 For a residential operator, the temperature test is to consist of 5 complete cycles of opening and closing the draperies completely, without pause between the opening and the closing operations. An interval equal to the time required for a complete opening and closing operation, or 1 min, whichever is greater, shall occur between consecutive cycles.

*Exception: When an overload- or overcurrent-protective device operates prior to the completion of the 5 cycles, and when the temperatures at the time of opening of the protector are not more than those specified in Table 43.1, the termination of the test by the overload- or overcurrent-protective device meets the intent of the requirement.*

43.7.3 A commercial-type operator is to be tested as described in 43.7.2. It is also to be operated continuously until temperatures become constant, with an interval of 10 min between successive cycles of opening and closing, each cycle consisting of opening and closing the draperies completely without pause.

### **43.8 Louvers**

43.8.1 The input test is to be conducted using the louver as the load. The temperature test is to consist of five complete cycles of opening and closing without pause between opening and closing operations. An interval equal to the time required for a complete opening and closing operation is to be allowed between successive cycles of operation. For a louver that is held open by stalling an impedance-protected motor, the motor is to be stalled until temperatures are constant.

### **43.9 Pedestrian doors**

43.9.1 The input test is to be conducted using that door among those intended to be used with the operator that imposes the most severe load. The temperature test is to be conducted with the door adjusted for maximum opening and closing time. The assembly is to be operated through one complete cycle of opening and closing per minute, without pause between the opening and closing parts of the cycle, until temperatures are constant.

### **43.10 Pedestrian door operators**

43.10.1 The input test is to be conducted using that door among those recommended by the manufacturer that will impose the most severe load. The door operator is to be adjusted for maximum opening and closing time. The temperature test is to be conducted with the operator loaded, by any means, so as to have an input equal to that measured in the input test. The operator is then to be cycled at the rate of 1 cycle – the time measured during input test for opening and closing – per minute until temperatures are constant. As an alternate, the actual door used in the input test may be used as the load.

### **43.11 Vehicular gate operators (or systems)**

43.11.1 The input test on a vehicular gate operator is to be conducted at the marked load or the marked force of the gate operator. The temperature test is to be conducted with the operator loaded as in the input test. See 43.11.2.

43.11.2 During the temperature test, the operator is to be cycled without pause between opening and closing. The interval between successive cycles is to be equal to the time required for a complete opening and closing operation unless the total opening and closing time is less than 30 s, in which case a cycle is to be started once every minute. Class I operators are to be subjected to ten complete cycles of operation. Class II, III, and IV operators are to be subjected to continuous operation until temperatures are constant.

*Exception: For an operator with built-in minimum pause-time provisions, the temperature test shall be conducted by cycling the operator with minimum pause between opening and closing.*

#### 44 Dielectric Voltage-Withstand Test

44.1 An appliance shall withstand for 1 min without breakdown the application of a 60-Hz primarily sinusoidal potential between live parts and dead metal parts, between primary and secondary circuits, and between live parts of opposite polarity for the test specified in (c) on a capacitor. The appliance is to be at the maximum operating temperature reached in normal use. The test potential shall be:

- a) 1000 V for an appliance employing a motor rated 1/2 horsepower (373 W) or less and 250 V or less.
- b) 1000 V plus twice the rated voltage for an appliance employing a motor rated at more than 1/2 horsepower or more than 250 V.
- c) 1000 V, or 1000 V plus twice the rated voltage for an appliance described in (a) or (b), between the terminals of a capacitor used for radio-interference elimination or arc suppression.
- d) 500 V for a circuit as described in 14.4.2 – 14.4.5.

*Exception: A dielectric voltage-withstand test is not required for low-voltage isolated secondary circuits where the maximum voltage is 30 V or less.*

44.2 To determine whether an appliance complies with the requirements in 44.1, the appliance is to be tested by means of a 500 VA or larger capacity transformer the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test value is reached, and is to be held at that value for 1 min. The increase in the applied potential is to be at a substantially uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

#### 45 Insulation Resistance Test and Dielectric Voltage-Withstand Test (Repeated)

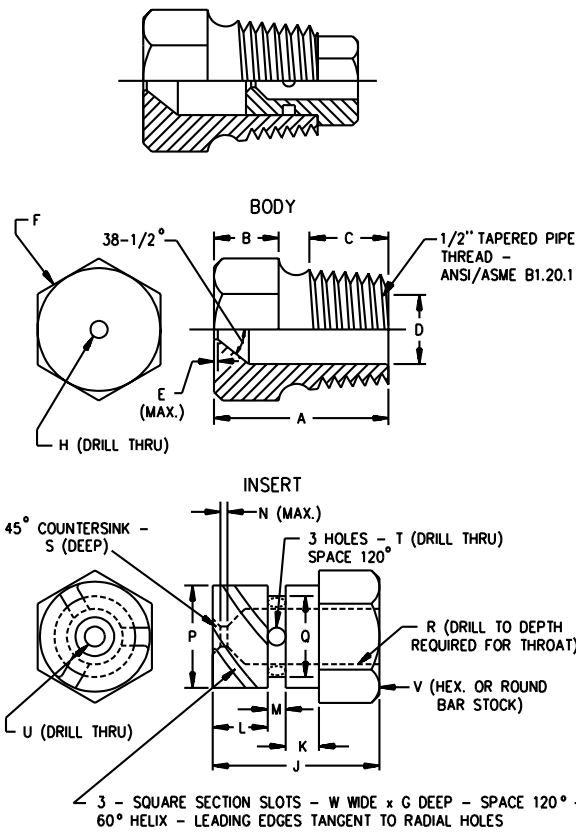
45.1 After exposure to a water spray as described in 45.1, an appliance intended to be used out-of-doors:

- a) Shall have an insulation resistance between live parts and exposed dead metal parts of not less than 50,000 ohms.
- b) Shall comply with the requirement in 44.1 in a repeated dielectric voltage-withstand test, and
- c) Shall have no water on uninsulated live parts.

45.2 An appliance is to be subjected to a water spray on its top and sides as described below. The water spray apparatus is to consist of three spray heads constructed in accordance with the details in Figure 45.1, mounted in a water supply pipe rack as illustrated in Figure 45.2. The water pressure is to be maintained at 5 psig (34 kPa) at each spray head. The distance between the center nozzle and the unit is to be approximately 5 ft (1.52 m). The spray is to be directed at an angle of 45 degrees to the vertical and in the direction or directions most likely to cause water to enter. The spray is to be applied for 1 h.

**Figure 45.1**  
**Spray head**

ASSEMBLY<sup>a</sup>



RT100C

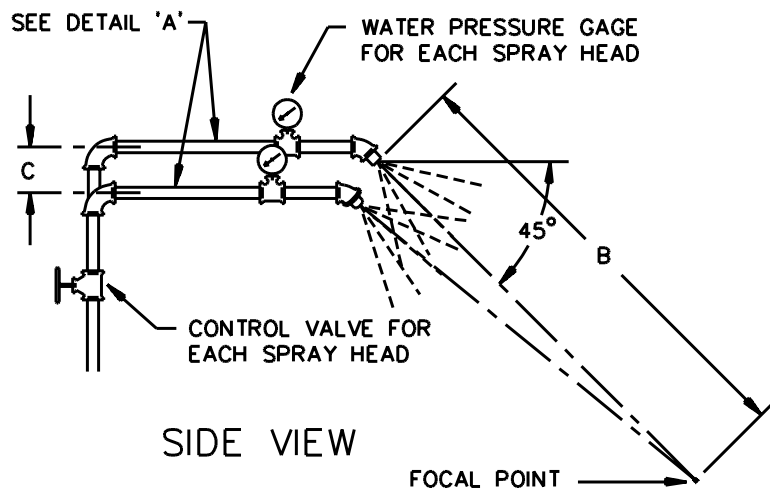
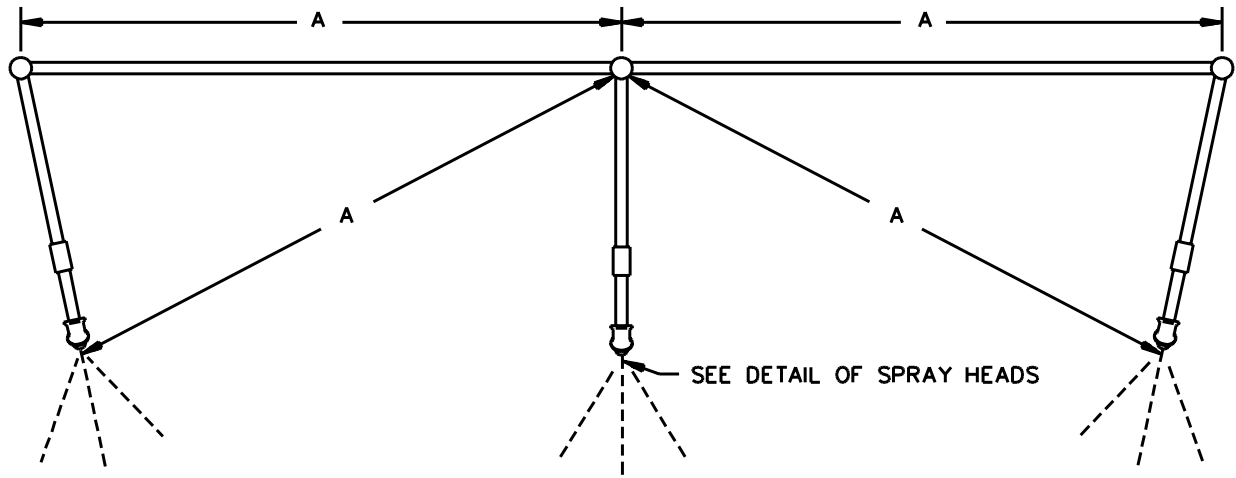
Item	in	mm	Item	in	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No.35) <sup>b</sup>	2.79
H	(No.9) <sup>b</sup>	5.0	U	(No.40) <sup>b</sup>	2.49
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

<sup>a</sup> - Molded nylon Rain-Test Spray Heads are available from Underwriters Laboratories, Inc.

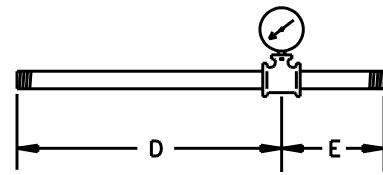
<sup>b</sup> - ANSI B94.11M Drill Size.

<sup>c</sup> - Optional - To serve as wrench grip.

Figure 45.2  
Spray head pipe rack  
PLAN VIEW



PIEZOMETER ASSEMBLY  
DETAIL 'A'



RT101B

Item	in	mm
A	28	710
B	55	1400
C	2-1/4	55
D	9	230
E	3	75



## 46 Inherent Secondary Force Activated Door Sensors

### 46.1 Normal operation test

46.1.1 A force activated door sensor of a door system installed according to the installation instructions shall actuate when the door applies a force of 15 lbf (66.7 N) or less in the down or closing direction and when the door applies a force of 25 lbf (111.2 N) or less in the up or opening direction. For a force activated door sensor intended to be used in an operator intended for use only on a sectional door, the force is to be applied by the door against the longitudinal edge of a 1-7/8 in (47.6 mm) diameter cylinder placed across the door so that the axis is perpendicular to the plane of the door. See Figure 36.1. The weight of the door is to be equal to the maximum weight rating of the operator.

46.1.2 The test described in 46.1.1 is to be repeated and measurements made at various representative points across the width and height of the door. For this test, a force activated door sensor system and associated components shall withstand a total of 9 cycles of mechanical operation without failure with the force applied as follows:

- a) At the center at points 1 ft, 3 ft, and 5 ft (305 mm, 914 mm and 1.52 m) from the floor,
- b) Within 1 ft (305 mm) of the end of the door, at points 1 ft, 3 ft, and 5 ft from the floor,
- c) Within 1 ft of the other end of the door at points 1 ft, 3 ft, and 5 ft from the floor.

The cycles are not required to be consecutive. Continuous operation of the motor without cooling is not required.

### 46.2 Adjustment of door weight

46.2.1 With the door at the point and at the weight determined by the tests of 46.1.2 and 46.2.2 to be most severe, the door sensor and associated components shall function as intended after 50 cycles of operation.

46.2.2 At the point determined by the test in 46.1.1 and 46.1.2 to be the most severe, weight is to be added to the door in 5.0-lb (2.26-kg) increments and the test repeated until a total of 15.0 lb (6.78 kg) has been added to the door. Before performing each test cycle, the door is to be cycled 2 times to update the profile. Similarly, starting from normal weight plus 15.0 lb, the test is to be repeated by subtracting weight in 5.0-lb increments until a total of 15.0 lb has been subtracted from the door.

## 47 Metallic-Coating-Thickness Test

47.1 The method of determining the thickness of zinc and cadmium coatings by the metallic-coating-thickness test is described in 47.2 – 47.9.

47.2 The solution to be used for the test is to be made from distilled water and is to contain 200 g/L of reagent grade chromic acid ( $\text{CrO}_3$ ) and 50 g/L of reagent grade concentrated sulfuric acid ( $\text{H}_2\text{SO}_4$ ). The latter is equivalent to 27 mL/L of reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of  $\text{H}_2\text{SO}_4$ .

47.3 The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube having an inside bore of 0.025 in (0.63 mm) and a length of 5.5 in (140 mm). The lower end of the capillary tube is to be tapered to form a tip, the drops from which are to be about 0.05 mL each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is  $100 \pm 5$  drops per min. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

47.4 The sample and the test solution are to be kept in the test room long enough to acquire the temperature of the room, which is to be noted and recorded. The test is to be conducted at a room temperature of  $70.0 - 90.0^\circ\text{F}$  ( $21.1 - 32.0^\circ\text{C}$ ).

47.5 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care is to be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

47.6 The sample to be tested is to be supported from 0.7 to 1.0 in (17.7 to 25.4 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested is to be inclined approximately 45 degrees from horizontal.

47.7 After cleaning, the sample to be tested is to be put in place under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stop watch until the dropping solution dissolves the protective metal coating, exposing the base metal. The end point is the first appearance of the base metal recognizable by a change in color at the point.

47.8 Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface and at an equal number of points on the outside surface, at places where the metal coating may be expected to be thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation are likely to have thin coatings.

47.9 To calculate the thickness of the coating being tested, select from Table 47.1 the thickness factor appropriate for the temperature at which the test was conducted and multiply by the time in seconds required to expose base metal as noted in 47.7.

**Table 47.1**  
**Coating thickness factors**

Temperature,		Thickness factors, 0.00001 in (0.0003 mm) per second	
°F	(°C)	Cadmium platings	Zinc platings
70	(21.1)	1.331	0.980
71	(21.7)	1.340	0.990
72	(22.2)	1.352	1.000
73	(22.8)	1.362	1.010
74	(23.3)	1.372	1.015
75	(23.9)	1.383	1.025
76	(24.4)	1.395	1.033
77	(25.0)	1.405	1.042
78	(25.6)	1.416	1.050
79	(26.1)	1.427	1.060
80	(26.7)	1.438	1.070
81	(27.2)	1.450	1.080
82	(27.8)	1.460	1.085
83	(28.3)	1.470	1.095
84	(28.9)	1.480	1.100
85	(29.4)	1.490	1.110
86	(30.0)	1.501	1.120
87	(30.6)	1.513	1.130
88	(31.1)	1.524	1.141
89	(31.7)	1.534	1.150
90	(32.2)	1.546	1.160

#### 48 Accelerated Aging Test of Gaskets

48.1 Rubber compounds forming gaskets that are depended upon for protection from rain shall have physical properties as specified in Table 48.1, before and after conditioning for 168 h in an air-circulating oven at 70°C (158°F).

**Table 48.1**  
**Physical properties of gasket-accelerated aging test**

	Before accelerated aging	After accelerated aging
Recovery— Maximum set when 2-in (50.8-mm) gauge marks are stretched to 5 in (127 mm), held for 2 min, and measured 2 min after release	1/2 in (12.7 mm)	—
Elongation — Minimum increase in distance between 2-in gauge marks at break	250 percent [2 to 7 in (50.8–179 mm)]	65 percent of original
Tensile Strength — Minimum force at breaking point	850 psi (59 MPa)	75 percent of original

## 49 Tests on Switches and Controls

49.1 A switch or other device that controls a motor of an appliance, shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the appliance. There shall be no electrical or mechanical breakdown of the device nor undue pitting or burning of the contacts, and the fuse in the grounding connection shall not open.

*Exception No. 1: A switch that has been investigated and found to be acceptable for the application.*

*Exception No. 2: A switch so interlocked that it will never have to break the locked-rotor motor current.*

49.2 In a test to determine whether or not the switch or other control device performs acceptably in the overload test mentioned in 49.1, the appliance is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage – 43.1.5 – with the rotor of the motor locked in position. During the test, exposed dead metal parts of the appliance are to be connected to ground through a 3-A plug fuse, and the connection is to be such that any single-pole, current-rupturing device will be located in the ungrounded conductor of the supply circuit. If the appliance is intended for use on direct current, or on direct current as well as alternating current, the exposed dead metal parts of the appliance are to be connected so as to be positive with respect to a single-pole, current-rupturing control device. The device is to be operated at a rate of not more than 10 cycles per min, except that a faster rate of operation may be employed if agreeable to those concerned.

49.3 A switch or other device that controls a solenoid, a relay coil, or the like shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation as described in 49.4. There shall be no electrical or mechanical malfunction of the device, nor undue burning or pitting of the contacts, and the fuse in the grounding connection shall not open.

*Exception: A switch or other device that has been investigated and found to be acceptable for the application.*

49.4 In a test to determine if a switch or other control device complies with the requirement in 49.3, the appliance is to be connected to a supply circuit of rated frequency and 110 percent of maximum rated voltage. The load on the device under test is to be the same as that which it is intended to control in normal service. During the test, exposed dead metal parts of the appliance are to be connected to ground through a 3-A plug fuse. The device is to be operated at a rate of not more than 10 cycles per min, except that a faster rate of operation may be employed if agreeable to those concerned.

49.5 A mechanical switch or a relay used in an entrapment protection circuit of an operator shall withstand 100,000 cycles of operation controlling a load no less severe (voltage, current, power factor, inrush, and similar ratings) than it controls in the operator, and shall function normally upon completion of the test.

49.6 In the event malfunction of a switch or a relay (open or short) described in 49.5 results in loss of any entrapment protection required by 31.1.1, 32.2.1, 32.2.6, 32.2.7, or 32.3.1, the door or gate operator shall become inoperative at the end of the opening or closing operation; or for a door operator only, the door operator shall move the door to, and stay within, 1 ft (305 mm) of the uppermost position.

49.7 An electromechanical interlock employed as described in 33.1(d) and 33.1(e) shall withstand 10,000 cycles of operation, controlling a load not less than that controlled in the product, and shall function as intended upon completion of the test.

## **50 Strain-Relief Test**

50.1 When tested in accordance with 50.2, the strain-relief means provided on the flexible cord shall withstand for 1 min, without displacement a direct pull of 35 lbf (155.69 N) applied to the cord with the supply cord conductors severed immediately adjacent to the terminals or splices within the appliance. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the supply cord conductors as to indicate that stress would have been applied to the connections.

50.2 A 35 lb (15.9 kg) weight is to be suspended from the cord and supported by the appliance so that the strain-relief means will be stressed from any angle that the construction of the appliance permits.

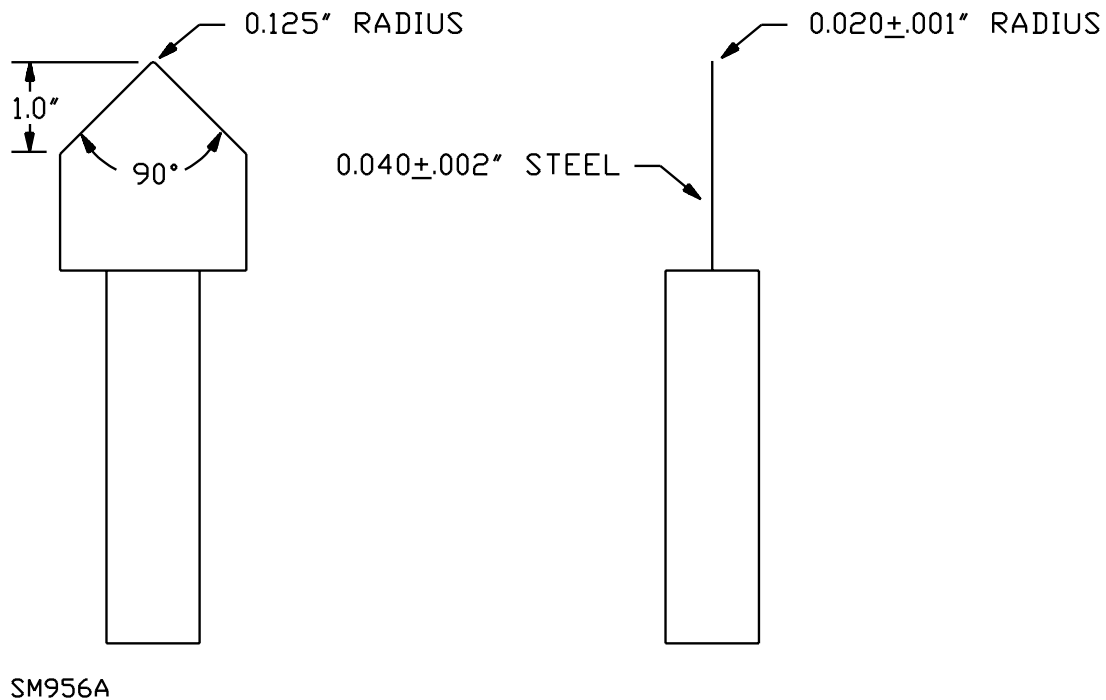
## **51 Puncture Resistance Test**

51.1 After being subjected to the test described in 51.2, an elastomeric material that is a functional part of an edge sensor shall:

- a) Not be damaged in a manner that would adversely affect the intended operation of the edge sensor, and
- b) Maintain enclosure integrity if it serves to reduce the likelihood of contamination of electrical contacts.

51.2 A sample of the edge sensor is to be installed in the intended manner on a representative door edge. The probe described in Figure 51.1 is to be applied with a 20 lbf (89 N) to any point on the sensor that is 3 in or less above the floor when the door is fully closed. For each type of door, the force is to be applied in the direction specified in the Edge Sensor Normal Operation Test, Figure 36.1. The test is to be repeated on three locations on each surface of the sensor being tested.

**Figure 51.1**  
**Puncture probe**



51.3 The test is to be repeated on an additional sample cooled to a temperature of 0.0°C (32.0°F) and maintained at this temperature for 3 h. While the sample is still cold, it is to be subjected to the puncture resistance tests described in 51.1 and 51.2.

## 52 Permanence of Marking Tests

52.1 A marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive that, upon investigation, is found to be acceptable for the application. Ordinary usage, handling, storage, and the like of a product are considered in the determination of the permanence of a marking.

52.2 Unless rated for the application, a pressure-sensitive label or a label that is secured by cement or adhesive and that is required to be permanent shall comply with the applicable requirements in the Standard for Marking and Labeling Systems, UL 969. The label shall be evaluated for exposure to:

- a) High humidity,
- b) Occasional exposure to water, and
- c) Minimum temperature of minus 40°C (minus 40°F).

A label used on a product or device anticipated to be exposed to the weather shall be evaluated for outdoor use.

### 53 Dead Load Test

53.1 A horizontal track assembly as described in 33.1 (h) shall not deflect more than 1/240th of the vertical distance from the top of the track to the ground when measured before and after the door has been in the horizontal position for at least 24 h. The distance is to be measured from the point on the track corresponding to the center of the door when in the horizontal position. Twist, deflection, or deformation of the track shall not interfere with the operation of the door. The installation instructions shall specify the locations where the horizontal track is to be supported in accordance with 56.9.1.

## MANUFACTURING AND PRODUCTION TESTS

### 54 Dielectric Voltage-Withstand Test

54.1 Each appliance shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 Hz, between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized.

54.2 The production-line test shall be in accordance with either Condition A or Condition B of Table 54.1.

54.3 The appliance may be in a heated or unheated condition for the test.

54.4 The test shall be conducted when the appliance is complete – fully assembled – and with the primary switch in the on position. It is not intended that the appliance be unwired, modified, or disassembled for the test.

*Exception No. 1: A part, such as a snap cover or a friction-fit knob, that would interfere with conducting the test need not be in place.*

*Exception No. 2: The test may be conducted before final assembly if the test represents that for the completed appliance.*

*Exception No. 3: The primary switch need not be in the on position if the testing means applies full test potential between primary wiring and dead metal parts with the switch not in the on position.*

**Table 54.1**  
**Production-line test conditions**

Appliance rating	Condition A		Condition B	
	Potential, V	Time, s	Potential, V	Time, s
250 V or less with a motor rated 1/2 horsepower (373 W) or less	1000	60	1200	1
More than 250 V with a motor rated more than 1/2 horsepower (373 W)	1000+2V <sup>a</sup>	60	1200+2.4V <sup>a</sup>	1
<sup>a</sup> Rated voltage.				

54.5 For an appliance employing a solid-state component that can be damaged by the dielectric potential, the test required by 54.1 may be conducted before the component is electrically connected. However, a random sampling of each day's production is to be tested at the potential specified in Table 54.1, but the circuitry may be rearranged for the purpose of this test to minimize the likelihood of solid-state-component damage while retaining representative dielectric stress of the circuit.

54.6 The test equipment shall include a transformer having an essentially sinusoidal adequate output.

54.7 If the output of the test equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential, and an audible or visual indication of breakdown. In the event of breakdown, manual reset of an external switch is required or an automatic reject of the unit under test is to result.

54.8 When the output of the test equipment transformer is 500 VA or larger, the test potential shall be indicated by one of the following:

- a) A voltmeter in the primary circuit or in a tertiary winding circuit,
- b) A selector switch marked to indicate the test potential, or
- c) A marking in a readily visible location to indicate the test potential of equipment having a single test potential output.

When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as a power-on lamp to indicate that the manually reset switch has been reset following a tripout.

54.9 Test equipment other than that described in 54.6 – 54.8 may be used if found to accomplish the intended factory control.

54.10 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the appliance are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal.

*Exception: An appliance – resistive, high-impedance winding, and the like – having circuitry not subject to excessive secondary-voltage build-up in case of electrical breakdown during the test may be tested with a single-pole primary switch, if used, in the off position, or with only one side of the primary circuit connected to the test equipment when the primary switch is in the on position, or when a primary switch is not used.*

## **55 Grounding Continuity Test**

55.1 Each appliance that has a power-supply cord having a grounding conductor shall be tested, as a routine production-line test, to determine that grounding continuity exists between the grounding blade of the attachment plug and an accessible dead metal part of the appliance that is likely to become energized.

55.2 Only a single test need be conducted if the accessible metal selected is conductively connected by design to all other accessible metal.

55.3 Any indicating device, such as an ohmmeter, a battery-and-buzzer combination, or the like, may be used to determine compliance with the requirement in 55.1.



## INSTRUCTION MANUAL

### 56 Details

#### 56.1 General

56.1.1 An appliance shall be provided with an instruction manual. The instruction manual shall give instructions for the installation, operation, and user maintenance of the appliance.

56.1.2 The installation instructions shall specify the need for a grounding-type receptacle for connection to the supply and shall stress the importance of proper grounding.

56.1.3 The installation instructions shall inform the installer that permanent wiring is to be employed as required by local codes, and instructions for conversion to permanent wiring shall be supplied.

*Exception: For a product constructed in accordance with the Exception to 12.4.1(c), this requirement does not apply.*

56.1.4 For equipment having a 2-blade polarized attachment plug, the following instructions, or the equivalent, shall be provided: "To reduce the risk of electric shock, this equipment has a polarized plug (one blade is wider than the other). This plug will fit in a polarized outlet only one way. If the plug does not fit fully in the outlet, reverse the plug. If it still does not fit, contact a qualified electrician to install the proper outlet. Do not change the plug in any way."

56.1.5 For equipment having a grounding-type attachment plug, the following instructions, or the equivalent, shall be provided: "To reduce the risk of electric shock, this equipment has a grounding type plug, that has a third (grounding) pin. This plug will only fit into a grounding type outlet. If the plug does not fit into the outlet, contact a qualified electrician to install the proper outlet. Do not change the plug in any way."

56.1.6 Information shall be supplied with a gate operator for:

- a) The required installation and adjustment of all devices and systems to effect the primary and secondary protection against entrapment (where included with the operator) as specified in Table 31.1, and
- b) The intended connections for all devices and systems to effect the primary and secondary protection against entrapment as specified in Table 31.1. The information shall be supplied in the instruction manual, wiring diagrams, separate instructions, or the equivalent.

56.1.7 Where a minimum letter height is specified, the height of the largest letter shall be used to determine letter height, unless stated otherwise. Numbers and all other letters shall be proportional.

## 56.2 Pedestrian doors and door operators

56.2.1 A pedestrian door operator that is to be sold without the door shall be provided with instructions in the instruction manual specifying the method of wiring required so that the device operates in accordance with 29.4.1 and 29.4.3.

56.2.2 If a pedestrian door is provided with means for connecting a switch other than a conventional mat switch, proximity indicator, or the like, or the use of such a switch is mentioned in the installation instructions, the instruction manual shall specify that the switch is to be installed in a location from which operation of the door can be observed by the person operating the switch.

56.2.3 The instruction manual for a pedestrian door that does not have its glass sections installed at the factory shall specify that the glazing material employed is to comply with the requirement in 29.5.1.

56.2.4 The installation instructions provided with a residential or commercial pedestrian door operator that is intended for connection to the source of supply by a flexible cord shall:

- a) Inform the installer of the appropriate location of the receptacle for the power-supply cord; and
- b) Indicate how the cord is to be routed and that the cord should not be:
  - 1) Routed through doorways, window openings, walls, ceilings, floors, or the like;
  - 2) Attached or otherwise secured to the building structure; or
  - 3) Concealed behind walls and the like.

56.2.5 Both the installation instructions and the operating manual provided with a residential or commercial pedestrian door operator that is intended for connection to the source of supply by a flexible cord shall include a statement that warns against the risks associated with allowing the cord to become entrapped in moving parts of the operator, door, or system.

## 56.3 Residential garage doors and door operators

56.3.1 Instructions that clearly detail installation and adjustment procedures required to effect proper operation of the safety means included shall be provided with each door operator.

56.3.2 A residential garage door or door operator shall be provided with complete and specific instructions for the correct adjustment of the control mechanism and the need for periodic checking and, if needed, adjustment of the control mechanism so as to maintain satisfactory operation of the door.

56.3.3 The instruction manual shall include the important instructions specified in 56.4.1 and 56.5.1. All required text shall be legible and contrast with the background. Upper case letters of required text shall be no less than 5/64-in (2.0-mm) high and Lower case letters shall be no less than 1/16-in (1.6-mm) high. Headings such as "IMPORTANT INSTALLATION INSTRUCTIONS", "IMPORTANT SAFETY INSTRUCTIONS", "SAVE THESE INSTRUCTIONS" and the words "WARNING - To reduce the risk of severe injury or death to persons:" shall be in letters no less than 3/16-in (4.8-mm) high.

56.3.4 The instructions listed in 56.4.1 and 56.5.1 shall be in the exact words specified or shall be in equally definitive terminology to those specified. No substitutes shall be used for the word "WARNING". The items may be numbered. The first and last items specified in 56.5.1 shall be first and last respectively. Other important and precautionary items considered appropriate by the manufacturer may be inserted.

56.3.5 The instructions listed in 56.4.1 shall be located immediately prior to the installation instructions. The instructions listed in 56.5.1 shall be located immediately prior to user operation and maintenance instructions. In each case, the instructions shall be separate in format from other detailed instructions related to installation, operation and maintenance of the appliance. All instructions, except installation instructions, shall be a permanent part of the manual(s).

#### **56.4 Installation instructions**

56.4.1 The installation instructions shall include the following or equivalent text:

##### **IMPORTANT INSTALLATION INSTRUCTIONS**

**WARNING** – To reduce the risk of severe injury or death:

1. READ AND FOLLOW ALL INSTALLATION INSTRUCTIONS.
2. Install only on a properly balanced garage door. An improperly balanced door has the potential to inflict severe injury. Have a qualified service person make repairs to cables, spring assemblies, and other hardware before installing the opener.
3. Remove all ropes and remove or make inoperative all locks connected to the garage door before installing opener.
4. Where possible, install the door opener 7 feet or more above the floor. For products having an emergency release, mount the emergency release 6 feet above the floor.
5. Do not connect the opener to source of power until instructed to do so.
6. Locate the control button: (a) within sight of door, (b) at a minimum height of 5 feet so small children are not able to reach it, and (c) away from all moving parts of the door.
7. Install the Entrapment Warning Label next to the control button in a prominent location. Install the Emergency Release Marking. Attach the marking on or next to the emergency release.
8. After installing the opener, the door must reverse when it contacts a 1-1/2-inch high object (or a 2 by 4 board laid flat) on the floor.

## 56.5 User instructions

56.5.1 The user instructions shall include the following or equivalent text:

### IMPORTANT SAFETY INSTRUCTIONS

WARNING – To reduce the risk of severe injury or death:

1. READ AND FOLLOW ALL INSTRUCTIONS.
2. Never let children operate or play with door controls. Keep the remote control away from children.
3. Always keep the moving door in sight and away from people and objects until it is completely closed. NO ONE SHOULD CROSS THE PATH OF THE MOVING DOOR.
4. Test door opener monthly. The garage door MUST reverse on contact with a 1-1/2-inch high object (or a 2 by 4 board laid flat) on the floor. After adjusting either the force or the limit of travel, retest the door opener. Failure to adjust the opener properly increases the risk of severe injury or death.
5. For products having an emergency release, when possible, use the emergency release only when the door is closed. Use caution when using this release with the door open. Weak or broken springs are capable of increasing the rate of door closure and increasing the risk of severe injury or death.
6. KEEP GARAGE DOORS PROPERLY BALANCED. See owner's manual. An improperly balanced door increases the risk of severe injury or death. Have a qualified service person make repairs to cables, spring assemblies, and other hardware.
7. SAVE THESE INSTRUCTIONS.

## 56.6 Industrial and commercial vehicular doors and door operators

56.6.1 A door shall be provided with an adjustable control mechanism and specific instructions describing that adjustment of the control mechanism that allows satisfactory operation of the door. The instructions shall also indicate the need for periodic checking of the control mechanism.

56.6.2 A door operator that is to be sold without the door shall be provided with instructions in the instruction manual specifying the methods of wiring required to maintain operation in accordance with 30.1.1.

56.6.3 Clear instructions for the installation of a reversing-edge switch shall be provided with the operator.

## 56.7 Light duty commercial vehicular doors and door operators

56.7.1 In addition to complying with the requirements in 56.6.1 – 56.6.3, a light-duty commercial vehicular door operator shall be provided with instructions at the beginning of the instruction manual, specifying that the unit is intended for light duty (limited duty, restricted duty, and the like, but not intermittent duty). If the motor protector opens during the Temperature Test, Section 43, the instructions shall include a statement that the rate of operation shall not exceed \_\_\_ cycles of opening and closing per hour. The value inserted in the blank space shall not exceed 50 percent of the number of complete opening and closing cycles noted during the test. See 43.4.1.

## 56.8 Vehicular gate operators (or systems)

56.8.1 A vehicular gate operator shall be provided with the information in the instruction manual that defines the different vehicular gate operator Class categories and give examples of each usage. The manual shall also indicate the use for which the particular unit is intended as defined in Glossary, Section 3. The installation instructions for vehicular gate operators shall include information on the Types of gate for which the gate operator is intended.

56.8.2 A gate operator shall be provided with the specific instructions describing all user adjustments required for proper operation of the gate. Detailed instructions shall be provided regarding user adjustment of any clutch or pressure relief adjustments provided. The instructions shall also indicate the need for periodic checking and adjustment by a qualified technician of the control mechanism for force, speed, and sensitivity.

56.8.3 Instructions for the installation, adjustment, and wiring of external controls and devices serving as required protection against entrapment shall be provided with the operator when such controls are shipped with the operator.

56.8.4 Instructions regarding intended installation of the gate operator shall be supplied as part of the installation instructions or as a separate document. The following instructions or the equivalent shall be supplied where applicable:

- a) Install the gate operator only when:
  - 1) The operator is appropriate for the construction of the gate and the usage Class of the gate,
  - 2) All openings of a horizontal slide gate are guarded or screened from the bottom of the gate to a minimum of 4 feet (1.22 m) above the ground to prevent a 2-1/4 inch (57.2 mm) diameter sphere from passing through the openings anywhere in the gate, and in that portion of the adjacent fence that the gate covers in the open position,
  - 3) All exposed pinch points are eliminated or guarded, and
  - 4) Guarding is supplied for exposed rollers.
- b) The operator is intended for installation only on gates used for vehicles. Pedestrians must be supplied with a separate access opening.
- c) The gate must be installed in a location so that enough clearance is supplied between the gate and adjacent structures when opening and closing to reduce the risk of entrapment. Swinging gates shall not open into public access areas.

- d) The gate must be properly installed and work freely in both directions prior to the installation of the gate operator. Do not over-tighten the operator clutch or pressure relief valve to compensate for a damaged gate.
- e) For gate operators utilizing Type D protection:
- 1) The gate operator controls must be placed so that the user has full view of the gate area when the gate is moving,
  - 2) The placard as required by 58.1.6 shall be placed adjacent to the controls,
  - 3) An automatic closing device (such as a timer, loop sensor, or similar device) shall not be employed, and
  - 4) No other activation device shall be connected.
- f) Controls must be far enough from the gate so that the user is prevented from coming in contact with the gate while operating the controls. Controls intended to be used to reset an operator after 2 sequential activations of the entrapment protection device or devices must be located in the line-of-sight of the gate. Outdoor or easily accessible controls shall have a security feature to prevent unauthorized use.
- g) All warning signs and placards must be installed where visible in the area of the gate. A minimum of two placards shall be installed. A placard is to be installed in the area of each side of the gate and be visible to persons located on the side of the gate on which the placard is installed.
- h) For gate operators utilizing a non-contact sensor in accordance with 31.1.1:
- 1) See instructions on the placement of non-contact sensors for each Type of application,
  - 2) Care shall be exercised to reduce the risk of nuisance tripping, such as when a vehicle, trips the sensor while the gate is still moving, and
  - 3) One or more non-contact sensors shall be located where the risk of entrapment or obstruction exists, such as the perimeter reachable by a moving gate or barrier.
- i) For a gate operator utilizing a contact sensor in accordance with 31.1.1:
- 1) One or more contact sensors shall be located where the risk of entrapment or obstruction exists, such as at the leading edge, trailing edge, and postmounted both inside and outside of a vehicular horizontal slide gate.
  - 2) One or more contact sensors shall be located at the bottom edge of a vehicular vertical lift gate.
  - 3) One or more contact sensors shall be located at the pinch point of a vehicular vertical pivot gate.
  - 4) A hardwired contact sensor shall be located and its wiring arranged so that the communication between the sensor and the gate operator is not subjected to mechanical damage.

5) A wireless contact sensor such as one that transmits radio frequency (RF) signals to the gate operator for entrapment protection functions shall be located where the transmission of the signals are not obstructed or impeded by building structures, natural landscaping or similar obstruction. A wireless contact sensor shall function under the intended end-use conditions.

6) One or more contact sensors shall be located on the inside and outside leading edge of a swing gate. Additionally, if the bottom edge of a swing gate is greater than 6 inches (152 mm) above the ground at any point in its arc of travel, one or more contact sensors shall be located on the bottom edge.

7) One or more contact sensors shall be located at the bottom edge of a vertical barrier (arm).

56.8.5 Instruction regarding intended operation of the gate operator shall be provided as part of the user instructions or as a separate document. The following instructions or the equivalent shall be provided:

#### IMPORTANT SAFETY INSTRUCTIONS

WARNING – To reduce the risk of injury or death:

1. READ AND FOLLOW ALL INSTRUCTIONS.
2. Never let children operate or play with gate controls. Keep the remote control away from children.
3. Always keep people and objects away from the gate. NO ONE SHOULD CROSS THE PATH OF THE MOVING GATE.
4. Test the gate operator monthly. The gate MUST reverse on contact with a rigid object or stop when an object activates the non-contact sensors. After adjusting the force or the limit of travel, retest the gate operator. Failure to adjust and retest the gate operator properly can increase the risk of injury or death.
5. Use the emergency release only when the gate is not moving.
6. KEEP GATES PROPERLY MAINTAINED. Read the owner's manual. Have a qualified service person make repairs to gate hardware.
7. The entrance is for vehicles only. Pedestrians must use separate entrance.
8. SAVE THESE INSTRUCTIONS.

## 56.9 Combination rigid one-piece overhead residential garage door and operator system

56.9.1 The installation instructions provided with a combination rigid one-piece overhead residential garage door and operator system shall specify the locations where attachments to the horizontal track shall be made for the purpose of supporting the track.

### 57 Field Installed Labels

57.1 A residential garage door operator shall be provided with labels for field installation and constructed as specified in 57.3 – 57.9. The labels shall be acceptable for permanent installation. The instruction manual shall specify where the labels are to be located.

57.2 If labels secured by adhesive are used, the instructions shall specify that an additional mechanical means shall be used to secure the labels to surfaces to which the adhesive will not adhere.

57.3 A residential garage door operator shall be provided with a cautionary label intended for permanent installation to identify the possible risk of entrapment. The instruction manual shall direct that the label be affixed near the wall-mounted control button.

57.4 The label required in accordance with 57.3 shall be in a vertical layout with three panels:

- a) A signal word panel,
- b) A pictorial panel, and
- c) A message panel.

Adjacent panels shall be delineated from each other by a bold black line. The entire label shall be surrounded by a black border and shall not be less than 5-in (127-mm) wide by 6-1/4-in (159-mm) long overall.

57.5 The signal word panel as specified in 57.4 shall contain the word "WARNING," in upper case letters, preceded by a safety alert symbol consisting of an orange exclamation mark on a black solid equilateral triangle background with the point of the triangle oriented upward. The word "WARNING" and the safety alert symbol shall be centered on one line and shall be in black letters at least 7/16-in (11.1-mm) high on an orange background.

57.6 The pictorial panel as specified in 57.4 shall be positioned between the signal word panel and the message panel. The pictorial shall be black on a white background and shall clearly depict a child running toward or under a garage door. A red prohibition symbol (slash, oriented from the upper left to the lower right, through a circle) shall be superimposed over, and totally surround, the pictorial. The pictorial shall have an overall diameter of 1-7/8 in (47.6 mm) minimum.

57.7 The message panel specified in 57.4 shall include the following statements and instructions or an equivalent wording:

- a) POSSIBLE RISK AND CONSEQUENCE STATEMENT– "There is a risk of a child becoming trapped under an automatic garage door resulting in severe injury or death."
- b) AVOIDANCE STATEMENTS:
  - 1) "Do not let children walk or run under a closing door."



- 2) "Do not let children operate door operator controls."
- 3) "Always keep a closing door within sight."
- 4) "In the event a person is trapped under the door, push the control button or use the emergency release."

*Exception: For products not having an emergency release, the instructions shall omit "or use the emergency release."*

c) INSTRUCTIONS:

- 1) "Test Door Operator Monthly: Use a 1-1/2-inch high object (or a 2 by 4 board laid flat) on the floor under the closing door. In the event the door does not reverse upon contact, adjust, repair, or replace the operator."
- 2) Additional instructions on not removing or painting over the label, mounting the label adjacent to the wall control, and mounting the wall control out of children's reach shall be supplied. These additional instructions shall be in less prominent lettering than the lettering for item 1.

57.8 The lettering of the message panel described in 57.7 shall be black on a white background and shall be in sans serif letters in combinations of upper case and lower case letters. The upper case letters of the Possible Risk and Consequence Statements and Avoidance Statements shall be 1/8-in (3.2-mm) high minimum. The lettering of the Possible Risk and Consequence Statement shall be in italics, underlined, bold, or the like, and shall be double spaced from the Avoidance Statements so that it is more prominent than the Avoidance Statements. All other instructions shall be in letters less prominent than the Possible Risk and Consequence Statements and shall be separated with at least a single space between individual instructions.

57.9 A residential garage door operator shall be supplied with a cautionary marking attached to, or adjacent at all times to, the means supplied to detach the operator from the garage door. The marking shall include the following statement or the equivalent: "In the event the door becomes obstructed, detach door from operator as follows: (The method to detach the operator shall be shown on the marking)."

*Exception: For a product complying with the Exception to 32.4.1, a cautionary marking is not required.*

## 58 Field Installed Placards

### 58.1 Vehicular gate operators (systems)

58.1.1 A gate operator shall be supplied with a minimum of two placards as described in 58.1.2 – 58.1.5 for field installation. The instruction manual shall specify that the placards are to be installed in the area of the gate. Each placard is to be visible by persons located on the side of the gate on which the placard is installed. The placards shall be made of substantially rigid material, such as vulcanized fiber, thermoplastic, or the equivalent, to provide mechanical strength and durability. See Permanence of Marking Tests, Section 52, for applicable requirements for placards for outdoor use.

58.1.2 A placard required by 58.1.1 shall comply with the standard practices for safety information as prescribed in the Standard for Product Safety Signs and Labels, ANSI Z535.4-1991. There shall be three distinct panels.

- a) A signal word panel,
- b) A pictorial panel, and
- c) A message panel.

Adjacent panels shall be delineated from each other by a bold black line. The entire placard shall be surrounded by a black border and measure at least 8-1/2-in (216-mm) wide by 11-in (280-mm) long overall.

58.1.3 The signal word panel specified in 58.1.2 shall contain the word "WARNING" in upper case letters, preceded by a safety alert symbol consisting of an orange exclamation mark a black solid equilateral triangle background with the point of the triangle oriented upward. The word "WARNING" and the safety alert symbol shall be centered on one line and shall be in letters at least 1-in (25.4-mm) high on an orange background.

58.1.4 The pictorial panel specified in 58.1.2 shall be positioned between the signal word panel and the message panel. The pictorial shall be black on a white background. More than one pictorial is acceptable. The pictorial shall depict a person entrapped between the gate and an immovable object, such as a wall, by the movement of the gate or an equivalent depiction. The direction of the gate movement shall be indicated by an arrow. The pictorial panel shall have a minimum height of 4 in (102 mm).

58.1.5 The message panel specified in 58.1.2 shall include:

- a) A Possible Risk and Consequence Statement indicating that a moving gate has the potential of inflicting serious injury or death. The letters shall be bold, upper and lower case with the first letter of each word in uppercase. The letter height of the uppercase letters shall not be less than 1/2-in (12.7-mm) high, and
- b) Avoidance Statements, in a combination of (1), (2), and (3), or (1), (2), and (4). The letters shall be uppercase and lowercase with the first letter of the first word in a sentence uppercase. Use of uppercase for a single word or phrase for emphasis complies with this requirement. The height of the uppercase letters shall not be less than 1/4-in (6.4-mm) high indicating that:
  - 1) Persons are to keep clear! The gate is able to be moved without prior warning.
  - 2) Do not let children operate the gate or play in the gate area.

3) Persons are to operate the gate only when the gate area is in sight and free of people and obstructions.

4) This entrance is for vehicles only. Pedestrians must use separate entrance.

58.1.6 A gate operator having provision for a continuous pressure actuation device as described in 31.1.14 and 31.1.15 shall additionally be provided with a placard that is marked in letters at least 1/4-in (6.4-mm) high with the word "WARNING" and the following statement or the equivalent: "Moving Gate Has the Potential of Inflicting Injury or Death – Do Not Start Gate Unless Path is Clear."

## MARKING

### 59 Details

#### 59.1 General

59.1.1 Unless specifically indicated otherwise, markings required in 59.1.2 – 59.4.8 and elsewhere in this standard shall be permanent in accordance with Permanence of Marking Tests, Section 52.

59.1.2 An appliance shall be plainly marked, at a location where the marking shall be readily visible – after installation, in the case of a permanently connected appliance – with:

- a) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product is identified – hereinafter referred to as the manufacturer's name,
- b) The catalog number or the equivalent,
- c) The voltage, frequency, and input in amperes or watts, and
- d) The date or other dating period of manufacture not exceeding any three consecutive months. The ampere rating shall be included unless the full-load power factor is 80 percent or more, or, for a cord-connected appliance, unless the rating is 50 W or less. The number of phases shall be indicated when an appliance is for use on a polyphase circuit. The date code repetition cycle shall not be less than 20 years.

*Exception No. 1: The manufacturer's identification is not restricted from being in a traceable code when the appliance is identified by the brand or trademark owned by a private labeler.*

*Exception No. 2: The date of manufacture is not restricted from being abbreviated or in an established or otherwise accepted code.*

59.1.3 If a manufacturer produces or assembles appliances at more than one factory, each finished appliance shall have a distinctive marking, which may be in code, to identify it as the product of a particular factory.

59.1.4 A heating element rated more than 1 A and intended to be replaceable in the field shall be marked with its rating in volts and amperes, or in volts and watts, or with the manufacturer's part number or other means of identification.

59.1.5 An alternating-current rating shall include the frequency expressed in one of the following terms: hertz, Hz, cycles per second, cps, or cycles/second.

59.1.6 A 2-wire, 220 – 240 V appliance intended for connection to a circuit operating at 150 V or less to ground shall be marked with the word "WARNING" and the following or its equivalent: "To Reduce The Risk of Electric Shock – Do not connect to a circuit operating at more than 150 volts to ground."

59.1.7 A 3-wire, 3-phase, 220 – 240 V appliance intended for connection to branch-circuit conductors operating at 150 V or less to ground shall be marked with the word "WARNING" and the following or its equivalent: "To Reduce the Risk of Electric Shock – Do not connect to a circuit operating at more than 150 volts to ground." The marking shall identify the leads or terminals that are to be supplied by circuit conductors of 150 volts or less to ground.

59.1.8 A permanently connected appliance employing a single motor with other loads or more than one motor with or without other loads shall be marked with one of the following:

- a) The minimum circuit ampacity and maximum current rating of the overcurrent-protective device unless both the minimum circuit ampacity and the maximum rating of the overcurrent-protective device are 15 A or less; or
- b) The rating of the largest motor in volts and amperes, and the rating of any other loads in volts and either amperes or watts.

*Exception: The marking need not include the ampere value of a motor rated 1/8 horsepower or less or a nonmotor load 1 A or less, unless either constitutes the principal load.*

59.1.9 Unless investigated for outdoor use or obviously intended for indoor use, an appliance shall be marked: "For indoor use only."

59.1.10 An appliance having field-wiring terminals shall be marked:

- a) "Use Copper Conductors Only" if the terminal is acceptable only for connection to copper wire.
- b) "Use Aluminum Conductors Only" if the terminal is acceptable only for connection to aluminum wire.
- c) "Use Copper or Aluminum Conductors" or "Use Copper, Copper-Clad Aluminum, or Aluminum Conductors" if the terminal is acceptable only for connection to either copper or aluminum wire.
- d) "Use Copper-Clad Aluminum, or Copper Conductors" if the terminal is acceptable only for connection to either copper or copper-clad aluminum wire.

*Exception: The requirement does not apply to field-wiring terminals located in low voltage circuits.*

59.1.11 An appliance intended for permanent connection to a wiring system other than rigid metal conduit or armored cable shall be marked to indicate the system or systems for which it is acceptable. The marking shall be located so that it will be visible when power-supply connections to the appliance are being made.

59.1.12 An appliance other than a commercial or industrial appliance that can be adapted for either of two different supply voltages, shall be provided with a wiring diagram indicating the proper method of power-supply connection for each supply voltage.

59.1.13 If an appliance employs a single motor as its only electric-energy-consuming component, the electrical rating given on the motor nameplate need not be shown elsewhere on the appliance if this nameplate is readily visible after the motor has been installed in the appliance.

59.1.14 If an appliance employs a dual-voltage motor and if the motor nameplate is employed to give the electrical rating of the appliance as indicated in 59.1.13, the appliance shall be additionally marked to indicate the particular voltage for which it is connected when shipped from the factory. If the appliance employs an attachment plug, instructions shall be provided to indicate the type of plug that should be used if the appliance is reconnected for the alternate voltage.

59.1.15 If the design of an appliance contemplates cleaning or servicing – such as the replacement of pilot lamps or fuses– by the user, and if such cleaning or servicing would involve the exposure of a normally enclosed or protected live part to unintentional contact, the appliance shall be plainly marked to indicate that such servicing or cleaning be done with the appliance disconnected from the supply circuit.

59.1.16 Where a minimum letter height is specified for a marking, the height of the largest letter shall be used to determine compliance, unless stated otherwise. Numbers and all other letters shall be proportional.

## 59.2 Components

59.2.1 Each individual heating element or unit that is part of an appliance and that is replaceable in the field shall be marked with its electrical rating in amperes or watts, and also in volts.

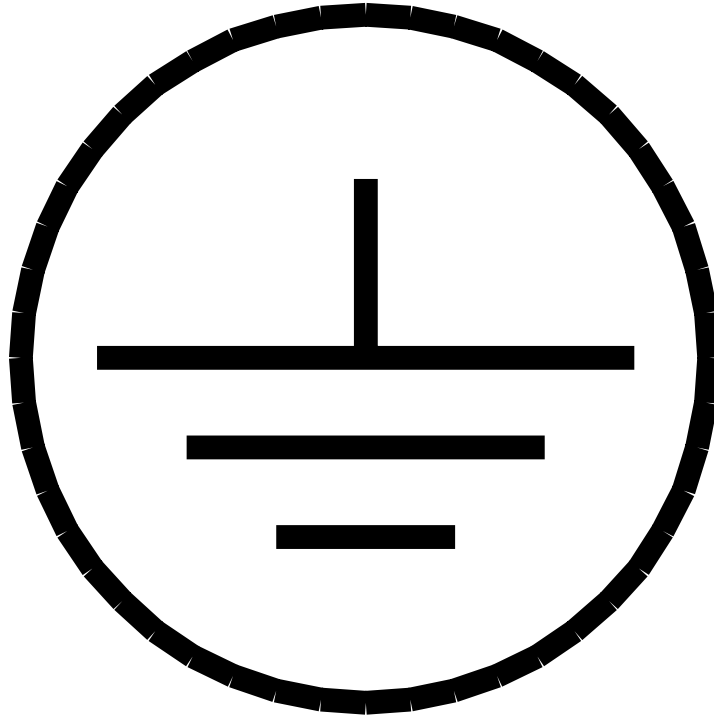
59.2.2 Lampholders for lamps intended to be replaced by the user shall be marked with the maximum wattage rating of the lamp to be used unless they have been tested with a lamp of the largest wattage rating the lampholder can accommodate.

59.2.3 A power receptacle intended for use by the serviceman shall be marked with a voltage and current rating.

59.2.4 A receptacle provided on a door operator for connection of a radio receiver, other than a Class 2 receiver, shall be marked with the words "For use with Model \_\_\_\_\_ radio receiver" or the equivalent.

59.2.5 A pressure wire connector intended for connection of an equipment-grounding conductor shall be identified by being marked "G," "GR," "GND," "Ground," "Grounding," the grounding symbol illustrated in Figure 59.1, a similar marking; or by a marking on the wiring diagram supplied on the appliance.

**Figure 59.1**  
**Grounding symbol**



59.2.6 If any point within a terminal box or wiring compartment of a permanently connected appliance in which the power-supply conductors are intended to be connected, including such conductors themselves, attains a temperature rise of more than 35°C (63°F) during the normal temperature test, the appliance shall be marked "For supply connections use wires rated for at least \_\_\_\_°C (\_\_\_\_°F)" or with an equivalent statement; and the temperature value shall be in accordance with Table 59.1. This statement shall be located at or near the point where the supply connections are to be made, and shall be clearly visible both during and after installation of the appliance.

**Table 59.1**  
**Outlet box marking**

Temperature rise attained during test in terminal box or compartment		Temperature marking	
°C	(°F)	°C	(°F)
36 – 50	(64 – 90)	75	(167)
51 – 65	(91 – 117)	90	(194)

59.2.7 With reference to 12.6.2.21, terminals or leads connected to a Class 2 power source and intended for connection of a Class 2 circuit to an external device shall be supplied with a marking "Class 2 Supply \_\_\_\_ volts" or the equivalent. The marking shall be located at or near the point where the connections are to be made, and shall be clearly visible during installation and inspection of the connections. A single marking for multiple terminals or leads, all connected to a Class 2 power source and intended for connection of a Class 2 circuit to an external device, complies with this requirement.

59.2.8 If an interchangeable fuse (a fuse is interchangeable if any fuse of higher ampere rating will fit the fuseholder) is used to limit secondary-circuit power in accordance with 14.4.5, there shall be a legible and durable marking indicating the ampere rating of the fuse to be used for replacement and located so that it is obvious to which fuse and fuseholder it applies. In addition, the following prominent marking shall be provided (a single marking is acceptable for a group of fuses) "WARNING - For continued protection against fire, replace only with the same type and rating of fuse."

### 59.3 Specific appliances

59.3.1 The carton and the instruction manual for an operator shall be marked with the word "WARNING" and the following or the equivalent: "To reduce the risk of injury to persons – Use this operator only with (a) \_\_\_\_door(s)."

59.3.2 For products with user adjustments, a residential garage door operator shall be marked with the word "WARNING" and the following or equivalent: "Risk of entrapment. After adjusting either the force or limits of travel adjustments, confirm that the door reverses on a 1-1/2-inch (or a 2 by 4 board laid flat) high obstruction on the floor."

59.3.3 A separately supplied accessory, including an external entrapment protection device, intended for installation with an appliance or appliances shall be marked with the manufacturer's name and catalog or model number and the type of appliance or appliances (such as a residential garage door operator) with which it is intended to be used.

59.3.4 An appliance provided with terminals or connectors for connection of a separately supplied accessory, such as an external entrapment protection device, shall be marked to identify the accessory intended to be connected to the terminals or connectors. The accessory identification shall be by manufacturer's name and catalog or model number or other means to allow for the identification of accessories intended for use with the appliance.

59.3.5 With reference to 59.3.3, instructions for installing a separately supplied accessory shall be provided. A statement shall be included in the instructions warning the user that the appliance must be disconnected from the source of supply before attempting the installation of the accessory.

59.3.6 A pedestrian door operator that is to be marketed without the door shall be permanently marked to indicate whether the operator is intended for residential or commercial use or industrial use. The marking shall include the wording "Pedestrian door operator for residential or commercial (or industrial) use."

59.3.7 An industrial door operator shall be marked to indicate that the operator is to be mounted more than 8 ft (2.44 m) above the floor if it has exposed moving parts capable of causing injury to persons or employs a motor deemed indirectly accessible by 9.6 by virtue of its location above the floor.

59.3.8 A commercial or industrial door or window operator shall be marked to indicate the maximum power in foot-pounds per second or the maximum pull in pounds that it is intended to develop.

59.3.9 A commercial drapery operator shall be marked to indicate the maximum weight of draperies with which it is intended to be used, either in total pounds or in pounds per foot of drapery width.

59.3.10 A pedestrian door shall have a permanent marking that is readily visible after installation indicating whether the door is intended for residential or commercial use or industrial use. The marking shall include the wording "Pedestrian door for residential or commercial (or industrial) use."

59.3.11 An industrial or commercial vehicular door or door operator provided with means for the connection of a reversing-edge switch, or the equivalent, shall be marked in letters at least 1/2-in (12.7-mm) high where plainly visible from the floor when the operator is installed, calling attention to the need for the reversing-edge switch. The marking shall include the word "CAUTION" and the following statement or the equivalent: "Connect reversing-edge switch – see installation instructions."

59.3.12 A door or door operator as described in 30.1.1(c) shall be provided with a placard that is marked in letters at least 1/4-in (6.4-mm) high with the word "WARNING" and the following statement or the equivalent: "To Prevent Entrapment – Do not start door downward unless doorway is clear." The placard shall be made of substantially rigid material such as vulcanized fiber, or the equivalent, to provide mechanical strength, and provided with at least two holes for wall mounting.

59.3.13 If the motor protector opens during the Temperature Test, Section 43, on a light-duty, commercial vehicular door or door operator, the appliance shall be permanently marked with the following or equivalent: "To prevent the motor protector from tripping – Do not exceed \_\_\_ door operations per hour," "For light duty only," and "Not for residential use." The number of door operations inserted in the blank shall not exceed 50 percent of the completed opening and closing operations noted during the test. See 43.4.1.

59.3.14 If the motor protector opens during the Temperature Test, Section 43, on a light-duty, commercial vehicular door or door operator, the appliance shall be provided with a separate label or tag for permanent installation adjacent to the door. The label shall be legibly marked with the following or the equivalent: "This door is operated by a light duty operator. To prevent the motor protector from tripping – Do not exceed \_\_\_ operations per hour." The number of operations inserted in the blank shall not exceed 50 percent of the completed opening and closing operations noted during the test. See 43.4.1.

59.3.15 An operator for a system complying with 33.1 shall be marked to indicate the maximum power in foot-pounds per second or the maximum pull in pounds that it is intended to develop.

#### **59.4 Gate operators (or systems)**

59.4.1 A vehicular gate operator shall be permanently marked to specify all intended Classes of applications.

59.4.2 A gate operator shall be permanently marked to indicate the maximum force the operator is intended to exert on the gate or the maximum load with which it is intended to be used.

59.4.3 A gate operator shall be permanently marked with a warning label complying with the Standard for Product Safety Signs and Labels, ANSI Z535.4-1991. The warning label shall consist of three distinct panels: a signal word panel, a pictorial panel, and a message panel, with adjacent panels delineated from each other by a bold black line. The entire label shall be surrounded by a black border.



59.4.4 The signal word panel specified in 59.4.3 shall contain the word "WARNING" in upper case letters preceded by a safety alert symbol consisting of an orange exclamation mark on a black solid equilateral triangle background with the point of the triangle oriented upward. The word "WARNING" and the safety alert symbol shall be centered on one line and shall be in letters at least 1/4-in (6.4-mm) high on an orange background.

59.4.5 The pictorial panel specified in 59.4.3 shall be black on a white background. More than one pictorial may be used. The pictorial or pictorials shall depict a person entrapped between the gate and an immovable object, such as a wall, by the movement of the gate, or an equivalent depiction. The direction of gate movement shall be indicated by an arrow. The pictorial panel shall have a minimum height of 1-3/4 in (44.5 mm).

59.4.6 The message panel specified in 59.4.3 shall include statements as follows:

- a) A Possible Risk and Consequence Statement indicating that a moving gate has the potential of inflicting serious injury or death, and
- b) Avoidance Statements indicating that:
  - 1) Persons are to keep clear! The gate is capable of being moved without prior warning,
  - 2) Do not let children operate the gate or play in the gate area,
  - 3) This entrance is for vehicles only. Pedestrians must use separate entrance,
  - 4) Persons are to read the owner's manual and safety instructions, and
  - 5) For gate operators using Type D entrapment protection, an automatic closing device (such as a timer, loop sensor, or similar device) shall not be employed.

59.4.7 The lettering of the message panel described in 59.4.6 shall be black on a white background and shall be in sans serif letters in combinations of upper case and lower case letters. The upper case letters of the Possible Risk and Consequence Statement shall be in italics, underlined, bold, or a similar font and shall be double spaced from the Avoidance Statements so that it is more prominent than the Avoidance Statements. All other instructions shall be in letters less prominent than the Possible Risk and Consequence Statements and shall be separated with at least a single space between individual instructions.

59.4.8 Provision of safety related instructions and information in addition to the warning marking required by 59.4.3 is acceptable.

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## APPENDIX A

### Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard – UL Standard Designation

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Attachment Plugs and Receptacles – UL 498  
Cables, Power-Limited Circuit – UL 13  
Conduit, Flexible Metal – UL 1  
Conduit, Liquid-Tight Flexible Steel – UL 360  
Cord Sets and Power-Supply Cords – UL 817  
Fittings for Cable and Conduit – UL 514B  
Fuseholders – UL 512  
Fuses, Plug – UL 198F  
Fuses for Supplementary Overcurrent Protection – UL 198G  
Industrial Control Equipment – UL 508  
Marking and Labeling Systems – UL 969  
Motors, Electric – UL 1004  
Motors, Overheating Protection for – UL 2111  
Outlet Boxes, Flush Device Boxes and Covers, Nonmetallic – UL 514C  
Outlet Boxes, Metallic – UL 514A  
Plastic Materials for Parts in Devices and Appliances, Tests for Flammability of – UL 94  
Polymeric Materials – Fabricated Parts – UL 746D  
Polymeric Materials – Long Term Property Evaluations – UL 746B  
Polymeric Materials – Short Term Property Evaluations – UL 746A  
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C  
Printed-Wiring Boards, Electrical – UL 796  
Signal Appliances, Audible – UL 464  
Software in Programmable Components – UL 1998  
Solid-State Controls for Appliances – UL 244A  
Switches, Clock-Operated – UL 917  
Switches, Snap, General-Use – UL 20  
Switches, Special-Use – UL 1054  
Terminal Blocks – UL 1059  
Terminals, Electrical Quick-Connect – UL 310  
Tests for Safety-Related Controls Employing Solid-State Devices – UL 991  
Thermal Cutoffs for Use in Electrical Appliances and Components – UL 1020  
Time-Indicating and -Recording Appliances – UL 863  
Transformers, Class 2 and Class 3 – UL 1585  
Transformers, Specialty – UL 506  
Tubing, Electrical Metallic – UL 797  
Tubing, Extruded Insulating – UL 224  
Wires and Cables, Thermoplastic Insulated – UL 83

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**Superseded requirements for  
the Standard for  
Door, Drapery, Gate, Louver, and Window Operators and Systems**

**UL 325, Fifth Edition**

The requirements shown are the current requirements that have been superseded by requirements in this edition. The numbers in parentheses refer to the new requirements with future effective dates that have superseded these requirements. To retain the current requirements, do not discard the following requirements until the future effective dates are reached.

31.1.20 A vehicular gate operator shall have a means for manual operation so that the gate is capable of being moved independently of the operator. For a Class I, II, or III vehicular gate operator, the means for operation shall be supplied as an integral part of the operator and the operator shall be marked with instructions for manual operation. For a Class IV vehicular gate operator, the use of a nearby keyed release or a remotely located non-keyed release to release the operator from the gate meets the intent of this requirement.

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