JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 325:2023

STANDARD FOR SAFETY

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

Approved American National Standard

ANSI/UL 325-2023

SCC FOREWORD

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UL Standard for Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems, ANSI/CAN/UL 325

Seventh Edition, Dated May 19, 2017

Summary of Topics

This revision of ANSI/CAN/UL 325 dated February 21, 2023 includes the following changes in requirements:

– Revision of the Glossary Definition of Entrapment to Change "Object" to "Person" is Caught; 4.8

– Bifold Gates; 4.34A, Figure 4.1, 4.34B, Figure 4.2, Figure 4.3, 26.11, Table 32.1, Table 32.2, 32.1.24A, 32.2.1.1, 32.2.1.3, Section 32.2.5, 37.2.1, 37.2.3, 39.1.1.1, 39.1.1.2, Figure 39.7, 39.1.3.1, Figure 39.10, Figure 39.11, 60.8.4, Table B.1

– Reference Corrections to Include Vehicular Gate Operators; 17.1, 46.2.1

– Type B1 Test Clarification; 32.1.7, 32.2.1.2, 37.3.2

– Editorial Interconnection Cable Reference Correction; 54.1

– Puncture Resistance Test Clarification to Include Gates; 55.1 – 55.3

– CGI Changes; 60.8.4, Table B.1

– Revision of the Important Safety Instructions to add "Severe" Injury to WARNING; 60.8.5, Table B.1

– Revision of the Important Safety Instructions to Change Reference from "Emergency" Release to "Manual" Release; 60.8.5, Table B.1

– Editorial Revision of Table B.1

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 4, 2022 and August 3, 2022.

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

Future Effective Date (USA)	References
TBD	39.1.1
TBD	60.8.4, Table B.1 (60.8.4)
TBD	39.2.1
TBD	62.2.1, Figure 62.1, Figure 62.2 and Figure 62.3

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ANSI/CAN/UL 325:2023

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Seventh Edition

May 19, 2017

This ANSI/UL Standard for Safety consists of the Seventh Edition including revisions through February 21, 2023.

The most recent designation of ANSI/UL 325 as an American National Standard (ANSI) occurred on February 21, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

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.

This standard has been designated as a National Standard of Canada (NSC) on February 21, 2023.

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Preface (UL)

This is the Seventh Edition of the ANSI/CAN/UL 325, Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of SCC and ANSI for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 325 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

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This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Door, Drapery, Gate, Louver, and Window Operators and Systems, STP 325.

This list represents the STP 325 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

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INTRODUCTION

1 Scope

1.1 These requirements cover electric operators for doors, draperies, gates, louvers, windows, exterior awnings 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 and the Canadian Electrical Code, Part I, C22.1.

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 National Fire Protection Association Life Safety Code, NFPA 101, and covered by these requirements are intended for installation in accordance with the International Building Code.

1.5 These requirements do not address active fire alarm functionality, which is addressed in NFPA 80.

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 Normative References

3.1 Products covered by this Standard shall comply with the reference installation codes and Standards noted in Annex A as appropriate for the country where the product is to be used. When the product is intended for use in more than one country, the product shall comply with the installation codes and Standards for all countries where it is intended to be used.

3.2 For undated references to standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this standard was approved. For dated references to standards, such reference shall be considered to refer to the dated edition and all revisions to that edition up to the time when this standard was approved.

3.3 For products intended for use in Canada general requirements are given in CSA Standard C22.2 No. 0, General Requirements – Canadian Electrical Code, Part II.

4 Glossary

4.1 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.

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

4.3 COMBINATION SECTIONAL OVERHEAD GARAGE DOOR OPERATOR SYSTEM – A door and operator combination where the door and hardware are an integral part of an operator, the operator does not exert a driving force on the door in the closing direction, and may provide for inherent secondary entrapment protection for compliance with the requirements of this Standard.

4.4 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 buildings accessible by or servicing the general public.

4.5 COMMERCIAL/INDUSTRIAL DOOR OPERATOR (OR SYSTEM) – A door operator (or system) intended for vehicular traffic and/or securing entrances or exits to commercial or industrial buildings areas. Some examples include multi-family housing units (three or more single-family units), hotels, garages, retail stores, or loading docks including, but not limited to, sliding, swing, bifold, accordion, sectional, and rolling door systems. Doors used to secure store fronts and intended for pedestrian use, but usually operated only at the start and end of the business day are included. Doors used solely for pedestrian access and egress which open and close for each pedestrian or group of pedestrians are not covered by this definition.

4.6 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.

4.7 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.

4.8 ENTRAPMENT – The condition when a person is caught or held in a position that increases the risk of injury.

4.9 EXTERIOR AWNING – A plastic, canvas, or metal porch or shade supported by a frame and often retractable, placed over a storefront, doorway, window, or the side of a recreational vehicle.

4.10 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.

4.11 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.

4.12 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 accessible by or intended to service the general public.

4.13 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.

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

4.15 LIGHT DUTY (COMMERCIAL/INDUSTRIAL) DOOR OPERATOR (OR SYSTEM) – A commercial/industrial door operator (or system) intended and marked for limited or restricted duty. Doors used to secure store fronts and intended for pedestrian use, but usually operated only at the start and end of the business day are included. Doors used solely for pedestrian access and egress which open and close for each pedestrian or group of pedestrians are not covered by this definition.

4.16 LINE OF SIGHT – Visible and not more that 15m (50 ft) distance between the control and the door.

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

4.18 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.

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

4.20 RESIDENTIAL VEHICULAR GATE OPERATOR – CLASS I – A vehicular gate operator (or system) intended for use in garages or parking areas associated with a residence of one-to four single families .

4.21 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.

4.22 SENSING AN OBSTRUCTION – The detection of an obstruction resulting in commanding a door or gate operator to react, for example, opening a relay in response to detecting an obstruction by an edge sensor. In the event the obstruction is communicated to the operator control via electronic transmission, including wireless communication, sensing an obstruction occurs at the initial detection of the obstruction.

4.23 SLIDE GATE ENTRAPMENT ZONE – Locations between a moving gate and a counter opposing edge or surface where entrapment is possible up to 1.8 m (6 ft) above grade. Such locations occur if during any point in travel the gap between a moving gate and fixed counter opposing edges or surfaces is less than 406 mm (16 in).

4.24 SWING GATE ENTRAPMENT ZONE –Locations between a moving gate or moving, exposed operator components and a counter opposing edge or surface where entrapment is possible up to 1.8 m (6 ft) above grade. Such locations occur if during any point in travel:

a) The gap between the bottom of a moving gate and the ground is greater than 101.6 mm (4 in) and less than 406 mm (16 in); or

b) The distance between the center line of the pivot and the end of the wall, pillar, or column to which it is mounted when in the open or closed position exceeds 101.6 mm (4 in). Any other gap between a moving gate and fixed counter opposing edges or surfaces or other fixed objects is less than 406 mm (16 in) (examples are walls, curbs, berms or other immovable objects).

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

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

4.27 UNATTENDED OPERATION, RESIDENTIAL GARAGE DOOR OPERATOR – Operation without the user within the line-of-sight of the door.

4.28 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.

4.29 VERTICAL PIVOT GATE ENTRAPMENT ZONE – Locations between a moving gate or exposed operator components and a counter opposing edge or surface where entrapment is possible. Such locations occur when the gap between a moving gate and fixed counter opposing edges or surfaces, other than the ground or floor at the bottom of the gate, is greater than 57.2 mm (2.25 in) and less than 406 mm (16 in) on the public side of the gate, or on the private side of the gate is greater than 101.6 mm (4 in) and less than 406 mm (16 in), or when the gap between a moving gate and fixed counter opposing edges or surfaces at the bottom of the gate is less than 406 mm (16 in).

4.30 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.

4.31 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.

4.32 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.

4.33 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.

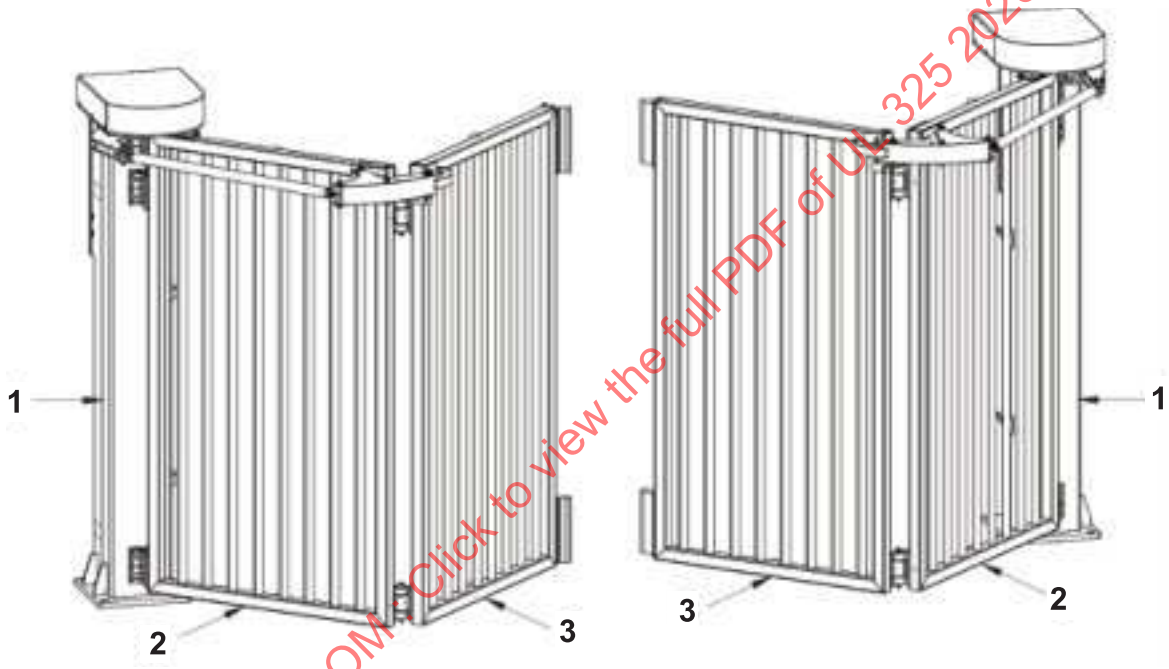
4.34 VERTICAL LIFT GATE ENTRAPMENT ZONE – Locations between a moving gate or exposed operator components and a counter opposing edge or surface where entrapment is possible up to 2.4 m (8 ft) above grade. Such locations occur when the gap between a moving gate and fixed counter opposing edges or surfaces, other than the ground or floor at the bottom of the gate, is greater than 101.6 mm (4 in)

and less than 406 mm (16 in) or when the gap between a moving gate and fixed counter opposing edges or surfaces at the bottom of the gate is less than 406 mm (16 in).

4.34A VEHICULAR BIFOLD GATE OPERATOR (OR SYSTEM) – A vehicular gate operator (or system) that controls a multi-panel gate for which the panels fold together horizontally to the side of the roadway or opening when the gate opens, and unfolds across the roadway or opening when the gate closes. A system may consist of one operator with associated driven panels or two operators each with their own associated driven panels. It is intended for use for vehicular entrance or exit to a drive, parking lot, or the like.

Figure 4.1

Pair Bifold Gate



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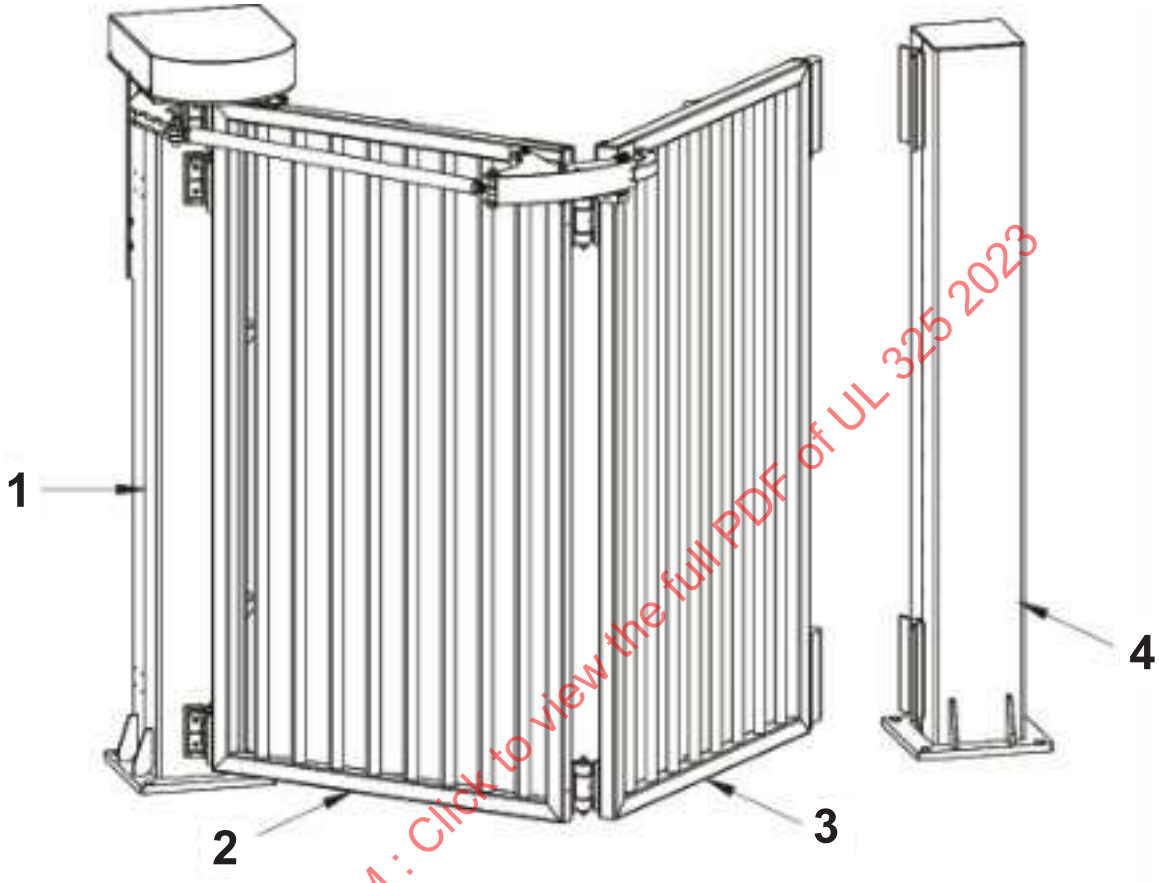
1. Hinging Structure Post / Column / Pillar
2. Panel A
3. Panel B

Figure 4.2

Single Bifold Gate



1. Hinging Structure (Post / Column / Pillar)
2. Panel A
3. Panel B
4. Catch Structure (Post / Column / Pillar)

4.34B VEHICULAR BIFOLD GATE ENTRAPMENT ZONE – Locations between a moving bifold gate or moving, exposed operator components and a counter opposing edge or surface where entrapment is possible up to 1.8 m (6 ft) above grade. Such locations occur if during any point in travel:

a) The gap between the bottom of a moving gate and the ground is greater than 101.6 mm (4 in) and less than 406 mm (16 in);

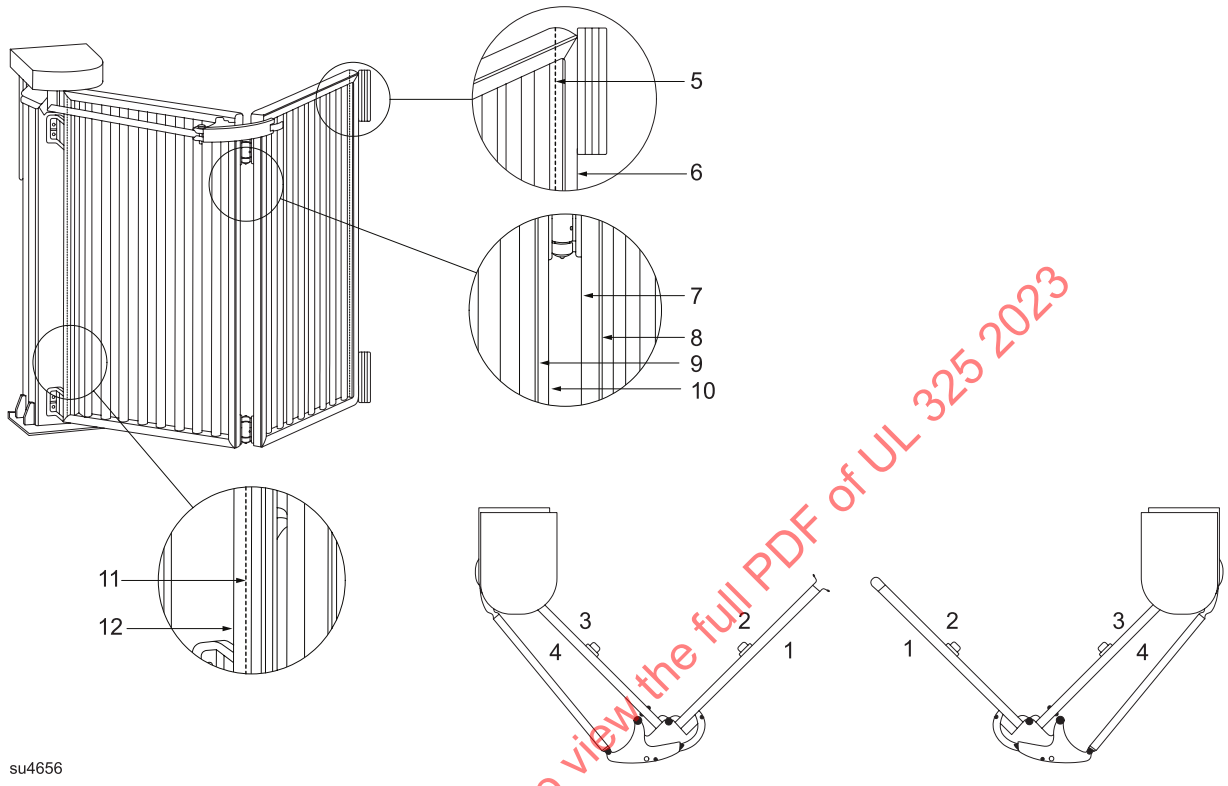
b) The distance between the center line of the pivot and the end of the wall, pillar, or column to which it is mounted when in the open or closed position exceeds 101.6 mm (4 in). Any other gap between a moving gate and fixed counter opposing edges or surfaces or other fixed objects is less than 406 mm (16 in) (examples are walls, curbs, berms or other immovable objects).

c) The gap between two hinged panels (items 2 and 3 in Figure 4.3) inside the “V” shaped area is less than 406 mm (16 in) at any point in travel.

d) The gap formed by vertical panel members/frames at the hinge point (between edges 7/8 and 9/10 in Figure 4.3) is at any point in travel equal to or greater than 57.2 mm (2-1/4 in) and less than 406 mm (16 in).

Figure 4.3

Bifold Gate Edges and Panels



1. Panel B, outside horizontal bottom edge
2. Panel B, inside horizontal bottom edge
3. Panel A, inside horizontal bottom edge
4. Panel A, outside horizontal bottom edge
5. Panel B, inside vertical leading edge
6. Panel B, outside vertical leading edge
7. Panel B, inside vertical hinge edge
8. Panel B, outside vertical hinge edge
9. Panel A, outside vertical hinge edge
10. Panel A, inside vertical hinge edge
11. Panel A, inside column vertical hinge edge
12. Panel A, outside column vertical hinge edge

NOTE: Inside and Outside edges refer to their relationship to the “V” that is created by the opening movement of a bifold gate, for example between A and B panels in Figure 4.1 and Figure 4.2.

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

4.36 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.

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

4.38 WIRELESS CONTROL, PORTABLE – A wireless control, as described in 4.37, that is portable in nature with an intended function only for manual activating the moving member by transmitting input to the operator.

5 Components

5.1 Except as indicated in 5.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. See Annex A for a full list of normative references. A component shall comply with the Canadian or U.S. Standard(s) as appropriate for the country where the product is to be used. When a product is intended for use in more than one country, a component shall comply with the appropriate component Standard(s) for the countries in which it is being used.

5.2 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.

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

5.4 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.

6 Units of Measurement

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

7 References

7.1 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

8 General

8.1 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.

8.2 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.

9 Frame and Enclosure

9.1 For an unreinforced flat surface, cast metal shall not be less than 3.2-mm (1/8-in) thick, except that malleable iron may be not less than 2.4-mm (3/32-in) thick, and die-cast metal may be not less than 2.0-mm (5/64-in) thick. Corresponding thicknesses of not less than 2.4, 1.6, and 1.2 mm (3/32, 1/16, and 3/64 in), 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.

9.2 An enclosure of sheet metal shall be evaluated 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 0.66 mm (0.026 in) if uncoated or 0.74 mm (0.029 in) if galvanized or of nonferrous sheet metal having a thickness of less than 0.91 mm (0.036 in) is not acceptable.

Exception: Minimum thickness is not specified for an area that is relatively small or a surface that is curved or otherwise reinforced.

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

9.4 The effects of the following factors shall be determined for compliance of a nonmetallic enclosure or an enclosure of magnesium with 8.2:

a) Mechanical strength,

b) Resistance to impact,

c) Moisture-absorption properties,

d) Combustibility, and

e) Resistance to distortion at temperatures to which the material is subjected under conditions of normal or abnormal use.

9.5 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.

9.6 The requirement in 9.5 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 is provided with impedance protection that complies with the requirements in the Standards referenced in Annex A, Ref, No. 5, 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.

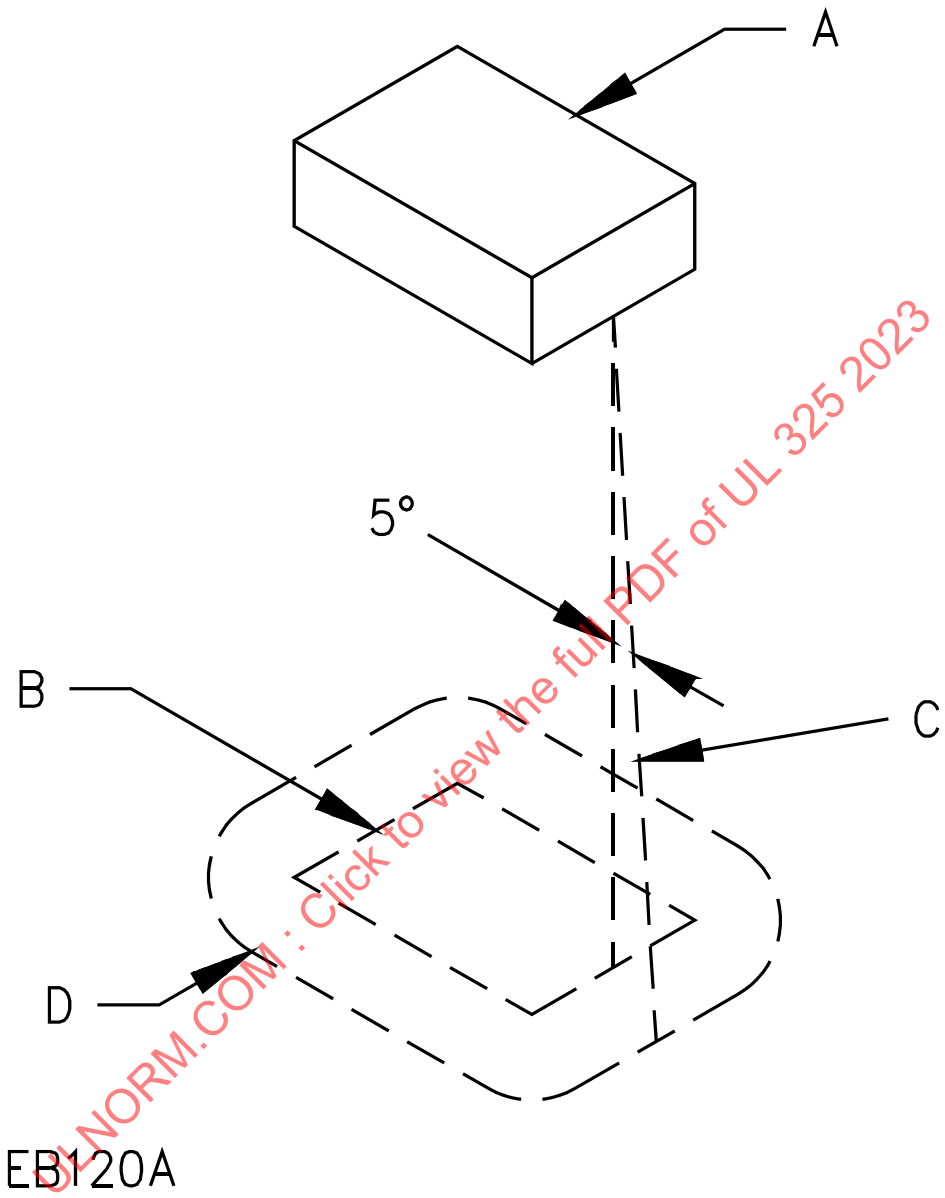
b) Under wiring, unless it is neoprene, cross-linked or thermoplastic-insulated.

9.7 The requirements in 9.5 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.

9.8 The barrier mentioned in 9.6 shall be horizontal, shall be located as illustrated in Figure 9.1, 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 9.1

Location and extent of barrier



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.

10 Accessibility of Uninsulated Live Parts and Film-Coated Wire

10.1 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 15.4.2.

a) For an opening that has a minor dimension (see 10.5) less than 25.4 mm (1 in), such a part or wire shall not be contacted by the probe illustrated in Figure 10.1.

b) For an opening that has a minor dimension of 25.4 mm (1 in) or more, such a part or wire shall be spaced from the opening as specified in Table 10.1.

Exception: A motor need not comply with these requirements if the integral enclosure of the motor complies with the requirements in 10.2.

Table 10.1
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

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

[a] See 10.5.

[b] Between 19.1 mm (3/4 in) and 54 mm (2-1/8 in), interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 25.4 mm (1 in) applied to a motor only.

[d] More than 54 mm (2-1/8 in), but not more than 152 mm (6 in).

10.2 With respect to an integral enclosure of a motor as mentioned in the exception to 10.1:

a) An opening that has a minor dimension (see 10.5) less than 19.1 mm (3/4 in) is acceptable if:

1) Film-coated wire cannot be contacted by the probe illustrated in Figure 10.3;

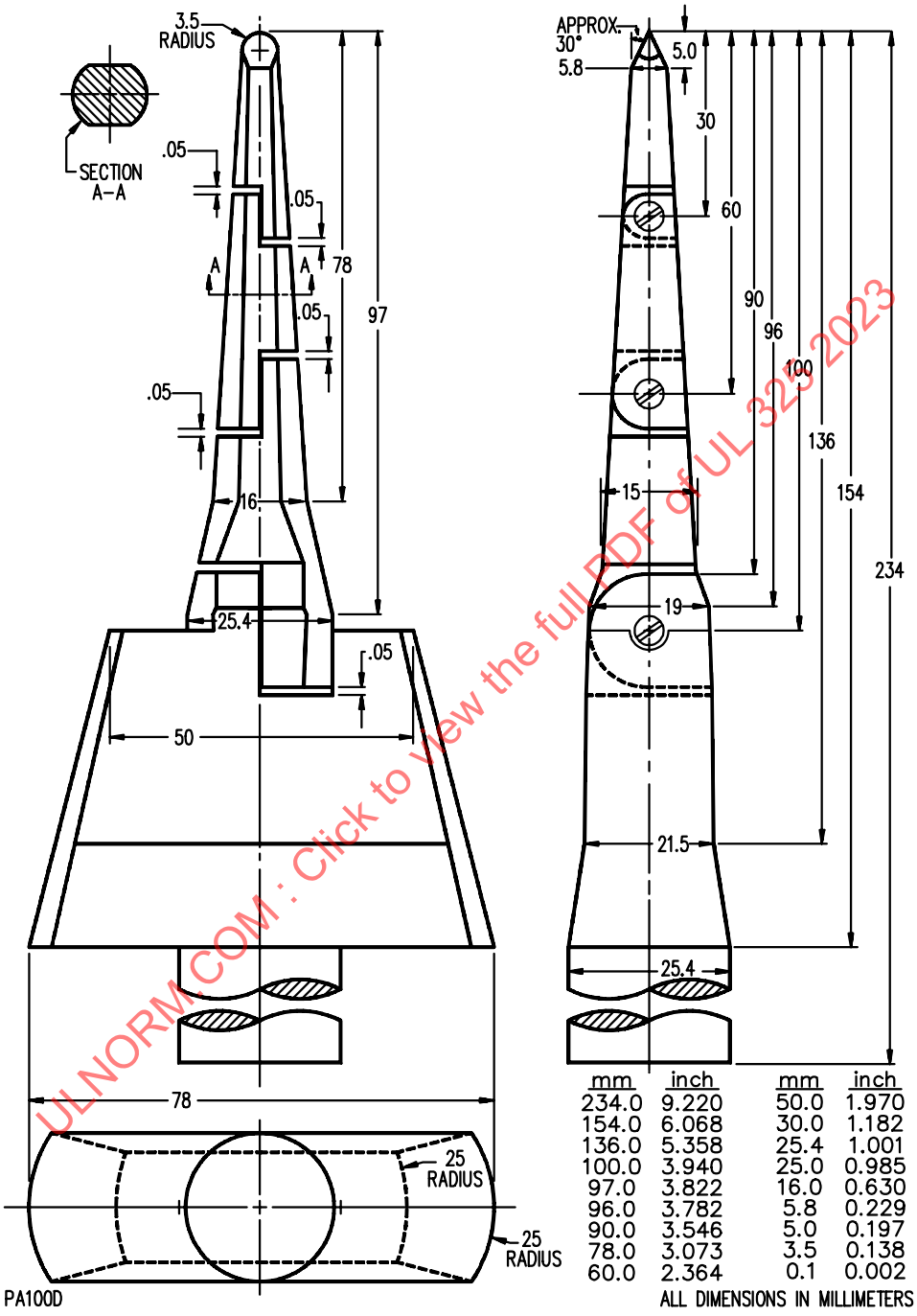
2) In a directly accessible motor (see 10.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 10.4; and

3) In an indirectly accessible motor (see 10.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 10.2.

b) An opening that has a minor dimension of 19.1 mm (3/4 in) or more is acceptable if a part or wire is spaced from the opening as specified in Table 10.1.

Figure 10.1

Articulate probe with web stop



mm	inch	mm	inch
234.0	9.220	50.0	1.970
154.0	6.068	30.0	1.182
136.0	5.358	25.4	1.001
100.0	3.940	25.0	0.985
97.0	3.822	16.0	0.630
96.0	3.782	5.8	0.229
90.0	3.546	5.0	0.197
78.0	3.073	3.5	0.138
60.0	2.364	0.1	0.002

ALL DIMENSIONS IN MILLIMETERS

Figure 10.2

Probe for uninsulated live parts

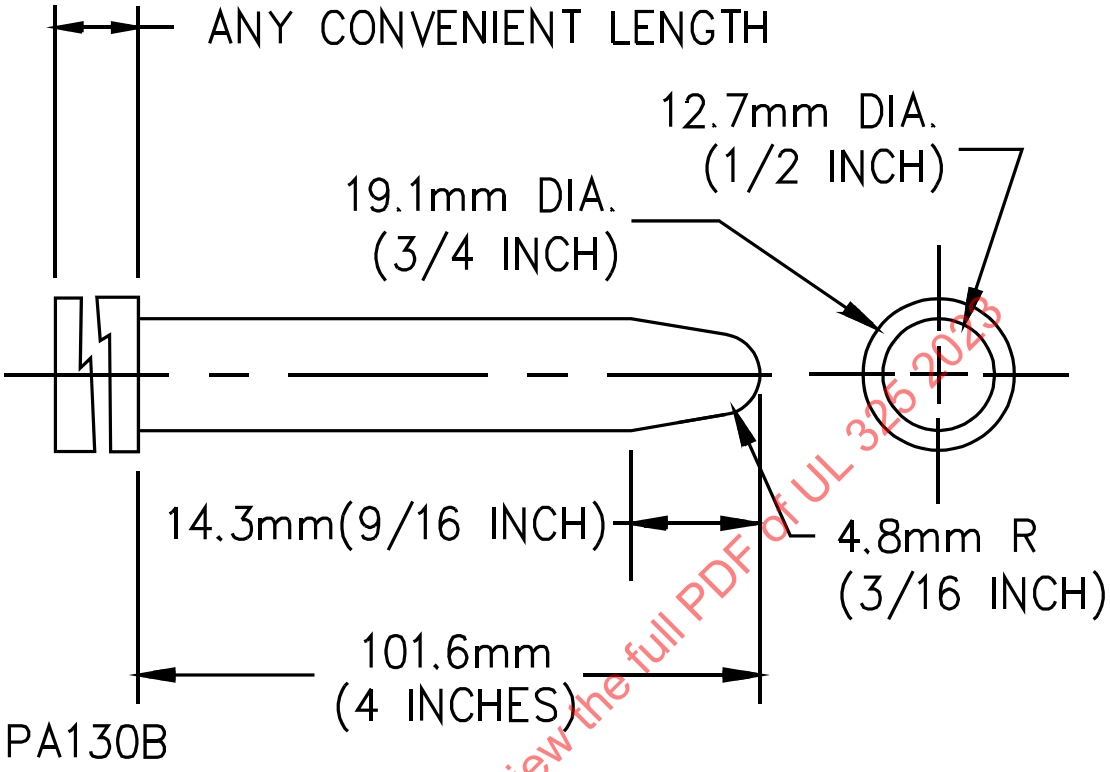


Figure 10.3

Probe for film-coated wire

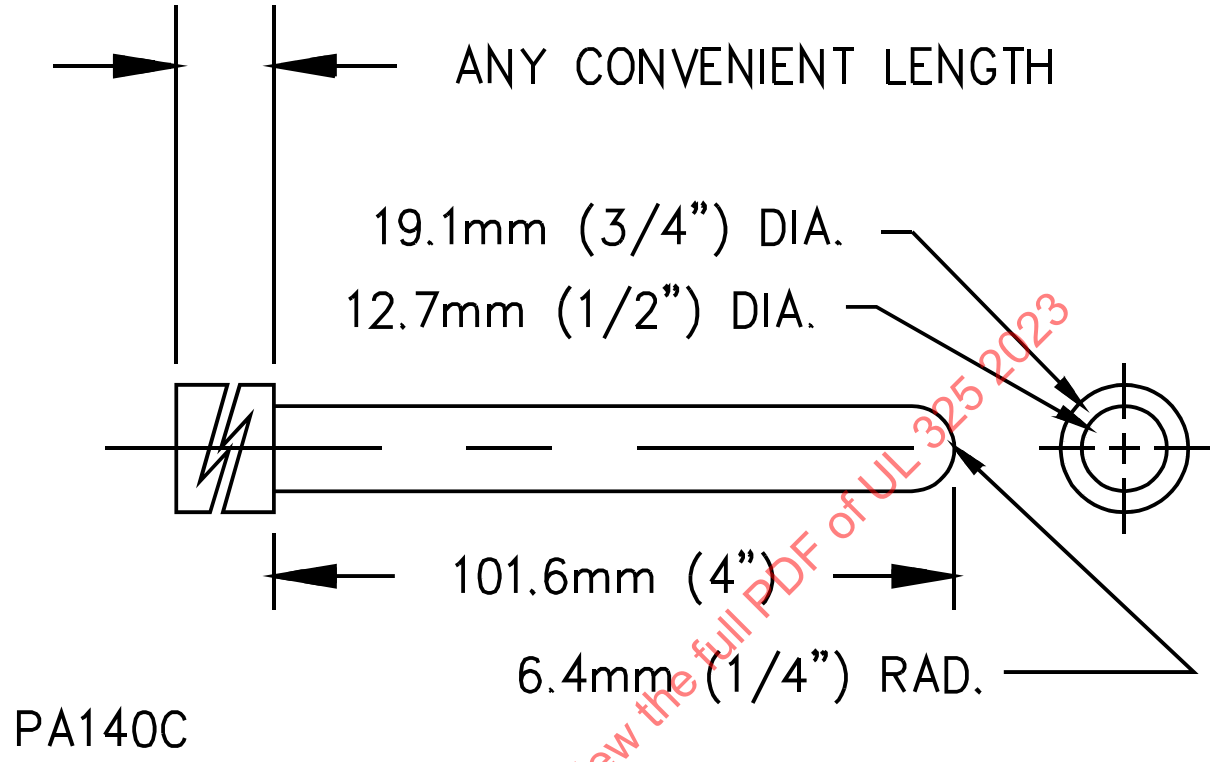
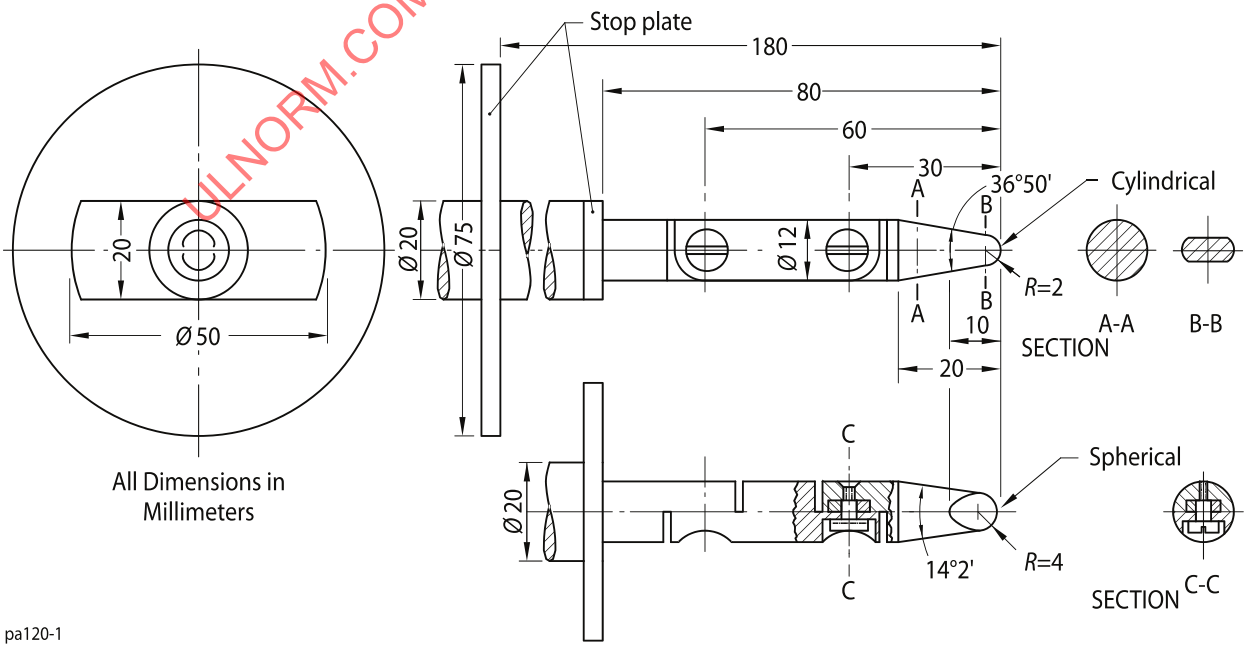


Figure 10.4

International electrotechnical commission (IEC) articulate accessibility probe with stop plate

Courtesy of IEC



10.3 The probes mentioned in 10.1 and 10.2 and illustrated in Figure 10.1, Figure 10.2, Figure 10.3, and Figure 10.4 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 Figure 10.1 and Figure 10.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

10.4 The probes mentioned in 10.1 and 10.2 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.

10.5 With reference to the requirements in 10.1 and 10.2, 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.

10.6 With reference to the requirements in 10.2, an indirectly accessible motor is a motor that is accessible by the probe illustrated in Figure 10.1 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 10.7 (a) and (b), or will be located higher than 2.44 m (8 ft) above the floor when the operator is installed as intended and is marked in accordance with 63.5.1. A directly accessible motor is a motor that can be contacted by the probe illustrated in Figure 10.1 without opening or removing any part and will be located 2.44 m (8 ft) or less above the floor when the operator is installed as intended.

10.7 During the examination of a product to determine whether it complies with the requirements in 10.1 or 10.2, 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.

10.8 With reference to the requirements in 10.1 and 10.2, insulated brush caps are not required to be additionally enclosed.

11 Mechanical Assembly

11.1 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.

11.2 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.

11.3 Means for preventing the turning mentioned in 11.2 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.

12 Protection Against Corrosion

12.1 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 are not required to have protection against corrosion 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: This requirement does not apply to bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like.

Exception No. 3: This requirement does not apply to the sheath of a heating element that is not an immersion-type element.

12.2 An enclosure of an appliance intended for outdoor installation shall be protected against corrosion as indicated in Table 12.1 and 12.7 – 12.12 or by other coating that has been shown by investigation to provide at least equivalent protection. See 9.1 and 9.2 for the required enclosure thickness.

Table 12.1
Protection against corrosion

Type of enclosure		1.4 mm (0.053 in) or thicker sheet steel, protection as specified in	Sheet steel thinner than 1.4 mm (0.053 in), protection as specified in
A.	Outer enclosure protecting motors, wiring, or enclosed live parts	12.9	12.8
B.	Outer enclosure that is the sole enclosure of live parts	12.8	12.8
C.	Outer enclosure that does not enclose electrical parts	12.9	12.9
D.	Interior enclosure protecting live parts other than motors and which is not provided with outer enclosure complying with item B	12.9	12.8

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

12.4 The requirements in 12.5 – 12.12 do not apply to a metal part, such as a decorative grille, that is not required to form a part of the enclosure.

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

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

12.7 An enclosure of cast iron at least 3.2-mm (1/8-in) 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.

12.8 To comply with Table 12.1 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, 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.

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 0.015 mm (0.00061 in) on each surface with a minimum thickness of 0.014 mm (0.00054 in). The thickness of the coating shall be established by the Metallic-Coating-Thickness Test, Section 50. An annealed coating shall also comply with 12.12.

c) A zinc coating conforming with 12.9 (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 0.025-mm (0.001-in) thick on both surfaces. The thickness of coating shall be established by the Metallic-Coating-Thickness Test, Section 50.

e) A cadmium coating not less than 0.019-mm (0.00075-in) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.013-mm (0.0005-in) 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 50, and the paint shall be as specified in (c).

12.9 To comply with Table 12.1 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 ASTM Designation A653/A653M, 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 ASTM Designation A90/A90M. An A60 (alloyed) coating shall also comply with 12.12.

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 0.010 mm (0.00041 in) on each surface with a minimum thickness of 0.008 mm (0.00034 in). The thickness of the coating shall be established by the Metallic-Coating-Thickness Test, Section 50. An annealed coating shall also comply with 12.12.

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 12.8.

12.10 With reference to 12.8 and 12.9, 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 12.8(a) or 12.9(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.

12.11 If tests are required, the test specimens of a finish as described in 12.7 or 12.10 or 12.8(c) or 12.9(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.

12.12 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.

13 Power-Supply Connections

13.1 General

13.1.1 An appliance shall have provision for permanent connection of a wiring system unless otherwise noted in either 13.3, 13.4, 13.5, 13.7, 13.8, or 13.9.

13.1.5 Where supply cords are permitted by either 13.3, 13.4, 13.5, or 13.7, a detachable supply cord may be provided when:

a) The appliance inlet complies with the requirements referenced in Annex A, Ref. No. 8;

b) Installation instructions comply with 60.1.13; and

c) Markings required by this standard are not provided only on a cord tag.

13.1.6 Where an operator is provided with multiple sources of supply, such as a standby battery, the terminals of the appliance inlet, with the detachable supply cord removed shall not exceed 42.4 Vpeak, 30 Vrms, or 60 Vdc with all other sources of supply connected.

13.2 Cord-connected operators

13.2.1 Strain relief

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

13.2.1.2 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.

13.2.1.3 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.

13.2.2 Bushings

13.2.2.1 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.

13.3 Drapery operators

13.3.1 A cord-connected drapery operator shall be provided with a length of flexible cord and an attachment plug for connection to the supply circuit. When provided with a power-supply cord, provision for permanent connection of a wiring system is not required.

13.3.2 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.

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

13.3.4 The length of the flexible cord shall not be less than 0.305 m (1 ft) nor more than 3.05 m (10 ft).

13.3.5 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.

13.3.6 The attachment plug shall be of the polarized type if the product is not provided with a grounding type attachment plug – see 25.1.

13.4 Residential garage door operators

13.4.1 With reference to 13.1.1, 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 through the supply cord greater than 15 A under a locked-rotor condition including the current draw of lamps and external devices;

c) Be constructed of an 18 AWG minimum flexible cord of Type SJT or heavier duty;

d) Not be longer than 1.83 m (6 ft); and

e) Incorporate a grounding conductor and be terminated with a grounding type attachment plug.

13.4.2 With reference to 13.1.1, a residential garage door operator supplied with a flexible cord for connection to a supply circuit shall additionally comply with 13.4.3 – 13.4.6, unless provided with instructions according to 60.4.3 and markings according to 63.3.4.

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

13.4.4 The cord shall enter the wiring compartment through a 22.2-mm (7/8-in) 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.

13.4.5 The power-supply cord shall be connected to the internal wiring by:

a) A device – terminal block, pressure cable connector, or the like – that will readily accommodate permanent wiring having a rated ampacity acceptable for the appliance; or

b) Individual leads, such that after removal of the power-supply cord, permanent wiring to internal leads inside the wiring compartment complying with 13.6.2.19 can be made.

13.4.6 The internal wiring terminals and leads for connection to the power supply shall be identified in accordance with 13.6.2.12, 13.6.2.13, 13.6.2.16, and 13.6.2.17.

13.5 Residential and commercial pedestrian door operators

13.5.1 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 13.5.2 – 13.5.5, and

b) Is provided with instructions in accordance with 60.2.4 and 60.2.5.

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

13.5.3 The construction of the wiring compartment shall comply with the requirements in 13.4.3 and 13.4.4.

13.5.4 The internal power-supply cord connections shall comply with the requirements in 13.4.5.

13.5.5 The internal wiring terminals and leads shall comply with the requirements in 13.4.6.

13.6 Permanently connected appliances

13.6.1 Terminal compartments

13.6.1.1 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.

13.6.1.2 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.

13.6.1.3 The compartment mentioned in 13.6.1.2 shall be located so that during conduit connections thereto, internal wiring and electrical components will not be exposed to mechanical abuse or stress.

13.6.1.4 A conduit opening for connection of conduit to a terminal compartment shall accommodate conduit of the trade size determined in accordance with Table 13.1.

Table 13.1
Trade size of conduit

Wire size, AWG	Number of wires	Conduit trade size, in	Metric designator
14	2, 3, 4, 5, or 6	1/2	16
12	2, 3, or 4	1/2	16
12	5 or 6	3/4	21
10	2 or 3	1/2	16
10	4, 5, or 6	3/4	21
8	2, 3, or 4	3/4	21
8	5 or 6	1	27
6	2 or 3	3/4	21
6	4	1	27
6	5 or 6	1-1/4	35

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.

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

13.6.2 Wiring terminals and leads

13.6.2.1 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.

13.6.2.2 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 63.1.13.

13.6.2.3 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 10 AWG or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

13.6.2.4 A wiring terminal shall be prevented from turning.

13.6.2.5 A wire-binding screw shall thread into metal.

13.6.2.6 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 14 AWG conductor.

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

13.6.2.7 A 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.

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

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

13.6.2.9 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.

13.6.2.10 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 13.6.2.1 and 13.6.2.6 under the head of the screw or the washer.

13.6.2.11 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.

13.6.2.12 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.

13.6.2.13 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 63.2.5. 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.

13.6.2.14 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.

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

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

13.6.2.17 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.

13.6.2.18 The requirements in 13.6.2.16 and 13.6.2.17 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.

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

Exception: A lead may be less than 152-mm (6-in) long if it is evident that the use of a longer lead might result in a risk of fire or electric shock.

13.6.2.20 A lead intended to be spliced in the field to a power-supply conductor shall not be smaller than 18 AWG and the insulation, if rubber or thermoplastic, shall not be less than 0.8-mm (1/32-in) thick.

13.6.2.21 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 63.2.7.

13.7 Exterior shutter and exterior awning operators

13.7.1 An exterior shutter and exterior awning operator having a flexible cord and an attachment plug 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, and

c) Comply with the requirements in 13.7.2 – 13.7.6.

13.7.2 The power-supply cord may be 3 conductors (hot, neutral, and ground) or 4 conductors (direction 1, direction 2, neutral, and ground).

13.7.3 The flexible cord shall be Type SJTW or heavier duty cord not longer than 2 m (6.6 ft) for an exterior shutter operator and not longer than 8 m (26 ft) for an exterior awning motor. The cord shall incorporate a grounding conductor and be terminated with a grounding type attachment plug when a plug is provided.

13.7.4 The attachment plug, if provided, shall be rated for use at a current not less than the rated current of the operator and at a voltage equal to the rated voltage of the operator.

13.7.5 The power-supply cord may be permanently connected to the internal wiring of the operator with no removal possible. If permanent wiring to the wiring system is needed, the attachment plug, if provided, can be removed to expose the individual insulated conductors.

13.7.6 The power-supply cable may be removable from the head of operator by means of a device – molded connector or the like. If permanent wiring to the wiring system is needed, the attachment plug, if provided, can be removed to expose the individual insulated conductors.

13.7.7 If removal of the power-supply cord is required, per the instructions, for making permanent wiring connections inside the operator, the operator shall additionally comply with 13.4.3 – 13.4.6.

13.8 Light-duty commercial door operators

13.8.1 With reference to 13.1.1, a light duty commercial 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 through the supply cord 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 13.4.2 – 13.4.6.

13.9 Direct plug-in accessories

13.9.1 An accessory device, such as an unattended operation control accessory, configured for direct plug-in instead of power supply cord or permanent wiring, shall comply with Supplement SB.

14 Live Parts

14.1 Other than as noted in 14.2 and 15.4.2, 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.

14.2 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 5.1.

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

14.3 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.

14.4 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.

15 Internal Wiring

15.1 General

15.1.1 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 15.1.5 and 15.1.6. The design shall be such as to prevent damage to the cord resulting from contact with the door or building.

15.1.2 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.

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

Exception: The type of wiring insulation is not specified if the electrical source complies with 15.4.3 or the source and cable combination complies with Interconnection Cable Overload Test of Section 54.

15.1.4 *Deleted*

15.1.5 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 15.1.1 is considered to exist if, when judged as though it were enameled wire, the wiring would be acceptable according to 10.2. 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.

15.1.6 Type SJT, SJTO, ST, or STO cord – not longer than 305 mm (12 in) 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 15.1.1.

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

15.1.8 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.

15.1.9 With reference to 15.1.8, 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.

15.1.10 A nominal 2.8 mm (0.110-in), 3.2 mm (0.125-in), 4.8 mm (0.187-in), 5.2 mm (0.205-in), or 6.4 mm (0.250-in) wide quick-connect terminal shall comply with the requirements for quick-connect terminals in the Standards for Electrical Quick Connect Terminals referenced in Annex A, Ref. No. 9. 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 Standards for Electrical Quick Connect Terminals referenced in Annex A, Ref. No. 9.

15.2 Protection of wiring

15.2.1 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.

15.2.2 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.

15.2.3 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 cable used for external interconnection as mentioned in 15.1.1 shall be provided with bushings and strain relief in accordance with 13.2.1.1 – 13.2.2.1 and Strain-Relief Test, Section 53 unless the construction is such that the cord will be protected from stress or motion.

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

15.3 Splices and connections

15.3.1 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.

15.3.2 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.

15.3.3 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.

15.3.4 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.

15.4 Secondary circuits

15.4.1 Other than as noted in 15.4.2 and 15.4.4, secondary circuits are judged under the requirements for line-voltage circuits.

15.4.2 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 24.2 do not apply; and

d) The dielectric voltage-withstand test potential is as specified in 47.1(d).

15.4.3 A Class 2 transformer used as a supply for a Class 2 circuit shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, referenced in Annex A, Ref. No. 10, and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, referenced in Annex A, Ref. No. 11.

15.4.4 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 63.2.7.

Exception: The type of wiring insulation is not specified if the source and cable combination complies with Interconnection Cable Overload Test of Section 54.

15.4.5 A fuse or circuit protector used to limit the power as specified in 15.4.4 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.

15.4.6 The wiring in the secondary circuits mentioned in 15.4.2 and 15.4.4 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.

15.4.7 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.

15.4.8 Cable supplied with the operator for connection of a Class 2 circuit to an external device, and cable supplied with an external device intended for connection to a Class 2 circuit of an operator shall be:

a) Type CL2, CL2P, CL2R, or CL2X complying with the Standard for Power-Limited Circuit Cables, referenced in Annex A, Ref. No. 12, or

b) Other cable with equivalent or better electrical, mechanical, and flammability ratings; or

c) Cable that is a factory-connected integral part of a Class 2 power supply complying with the Standard for Class 2 Power Units, referenced in Annex A, Ref. No. 13, or a Class 2 transformer complying with the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, referenced in Annex A, Ref. No. 11, or an LPS (Limited Power Source) supply complying the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, referenced in Annex A, Ref. No. 14.

16 Electrical Insulation

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

16.2 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.

16.3 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.

17 Motors

17.1 A motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, referenced in Annex A, Ref. No. 15, and shall be capable of handling the maximum normal load of the

appliance as described in 46.2.1 – 46.11.1 without introducing a risk of fire, electric shock, or injury to persons.

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

17.3 With reference to the requirements in 17.2, enameled wire is not required to be additionally treated to prevent absorption of moisture.

17.4 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.

18 Overload Protection

18.1 A motor shall incorporate thermal or overload protection for running-overload (heating) and locked-rotor conditions complying with the requirements in 18.2.

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.

Exception No. 4: A motor supplied from a low power circuit complying with Supplement SA need not be provided with overload protection.

18.2 Motor-overload protection required for a product in accordance with 18.1 shall consist of one of the following:

a) Thermal protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, referenced in Annex A, Ref. No. 5.

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, referenced in Annex A, Ref. No. 5, 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 (a).

d) Electronic protection integral to the motor shall comply with the Standard for Electronically Protected Motors, referenced in Annex A, Ref. No. 16, or the requirements in Supplement SA.

e) Electronic protection complying with the tests of standards referenced in Annex A, Ref. No. 17 and the circuit requirements of Supplement SA.

18.3 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.

18.4 An overload- or overcurrent-protective device shall not open the circuit during normal operation of the appliance, except as noted in 46.4.1, 46.7.2, and 46.7.3.

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

18.6 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.

18.7 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.

18.8 Unless the appliance is marked in accordance with 63.1.17, 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 18.6.

18.9 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.

18.10 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.

19 Switches and Controls

19.1 A switch shall be located or protected so that it shall not be normally exposed to mechanical damage during use.

19.2 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.

19.3 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.

19.4 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.

19.5 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.

19.6 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.

19.7 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: This requirement does not apply to an appliance marked in accordance with 63.1.8 or 63.1.9.

19.8 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.

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

19.10 An appliance control containing solid-state components that complies with the applicable requirements in the Standard for Solid-State Controls for Appliances, referenced in Annex A, Ref. No. 18, is acceptable for use in equipment covered by this standard. Compliance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, and/or the applicable Part 2 standard, referenced in Annex A, Ref. No. 19 fulfills these requirements.

Exception: A control or electronic circuit that complies with Supplement SA is considered to fulfill this requirement.

19.11 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.

19.12 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.

19.13 If a three-button switch or control is provided with a commercial/industrial door operator (or system), one button shall be a stop button.

20 Heating Elements

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

21 Lampholders, Light Emitting Diodes (LED) Light Sources, and Lighting Ballasts

21.1 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.

21.2 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.

21.3 A light emitting diode (LED) light source that serves as a source of illumination shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use In Lighting Products, referenced in Annex A, Ref. No. 20. Individual light emitting diodes mounted on the printed wiring board of a control and intended for indicating purposes shall be evaluated with the control.

Exception: An LED light source and its driver supplied by a Class 2 circuit need not comply with this requirement.

21.4 Lighting ballasts shall comply with the Standard for Fluorescent-Lamp Ballasts, referenced in Annex A, Ref. No. 21, or the Standard for High-Intensity-Discharge Lamp Ballasts, referenced in Annex A, Ref. No. 22.

22 Receptacles

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

22.2 The face of a receptacle shall:

a) Be flush with or project beyond a nonconductive surrounding surface, or

b) Project at least 0.31 mm (0.015 in) beyond a conductive surrounding surface.

22.3 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.

22.4 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.

23 Capacitors

23.1 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.

23.2 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 µF.

24 Spacings

24.1 Other than noted in 15.4.2, 24.6, and 24.9, 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 24.1.

Table 24.1
Spacings at field-wiring terminals

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

[a] Applies to the sum of the spacings involved where an isolated dead part is interposed.

[b] A spacing of not less than 9.5 mm (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.

24.2 Spacings in a motor shall comply with the spacing requirements in the Standard for Rotating Electrical Machines – General Requirements, referenced in Annex A, Ref. No. 15.

24.3 Other than at field-wiring terminals and as noted in 15.4.2 and 24.6, 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 24.2. 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 24.2
Spacings at other than field-wiring terminals

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

[a] 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.

[b] For a motor rated 1/3 horsepower (250 W output) or less, these spacings may not be less than 1.6 mm (1/16 in).

[c] Film-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 2.4 mm (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.

24.4 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.

24.5 In applying Table 24.1 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.

24.6 The spacing requirements in 24.1 – 24.5 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.

24.7 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 1.2 mm (3/64 in) 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 24.1 or Table 24.2, whichever is applicable.

24.8 In the application of 47.1 and Table 24.2 to a motor not rated in horsepower, use is to be made of the appropriate table of the National Electrical Code, referenced in Annex A, Ref. No. 1, 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.

24.9 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 24.2 when such connectors, eyelets, and the like are in such position that minimum spacings – opposite polarity and to dead metal – exist.

24.10 An insulating lining or barrier of vulcanized fiber or similar materials employed where spacings would otherwise be insufficient shall not be less than 0.8-mm (1/32-in) 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 0.4-mm (1/64-in) 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.

25 Grounding

25.1 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.

25.2 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.

25.3 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

26 General

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

26.2 An appliance is considered to comply with the requirement in 26.1 if some means is provided to prevent the motor from restarting when the protector closes.

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

26.4 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.

26.5 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.

26.6 Software for use in an inherent secondary entrapment protection device shall comply with the Standard for Software in Programmable Components, referenced in Annex A, Ref. No. 23.

Exception: A control or electronic circuit that complies with Supplement SA is considered to fulfill this requirement.

26.7 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, referenced in Annex A, Ref. No. 24, including environmental and stress tests appropriate to the intended usage of the end-product.

Exception: A control or electronic circuit that complies with Supplement SA is considered to fulfill this requirement.

26.8 The following test parameters are to be used in the investigation of the circuit covered by 26.7, for compliance with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 or Safety functions incorporating electronic technology, CSA 22.2 No. 0.8:

a) With regard to electrical supervision of critical components, an operator being inoperative with respect to closing movement of the door, or the closing or opening movement of the gate, 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, λ_p shall not be greater than 6 failures/10^6 hours for the entire system. For external secondary entrapment protection devices or systems that are sold separately, λ_p shall not be greater than 0 failures/10^6 hours. For internal secondary entrapment protection devices whether or not they are sold separately, λ_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 or system that is sold separately, and that has a λ_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 or systems λ_p does not exceed 6 failures/10^6 hours. See 63.3.5 – 63.3.7.

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.

26.9 In the evaluation of entrapment protection circuits used in residential garage door operators, the critical condition flow chart shown in Figure 26.1 shall be used to:

a) To conduct a failure-mode and effect analysis (FMEA),

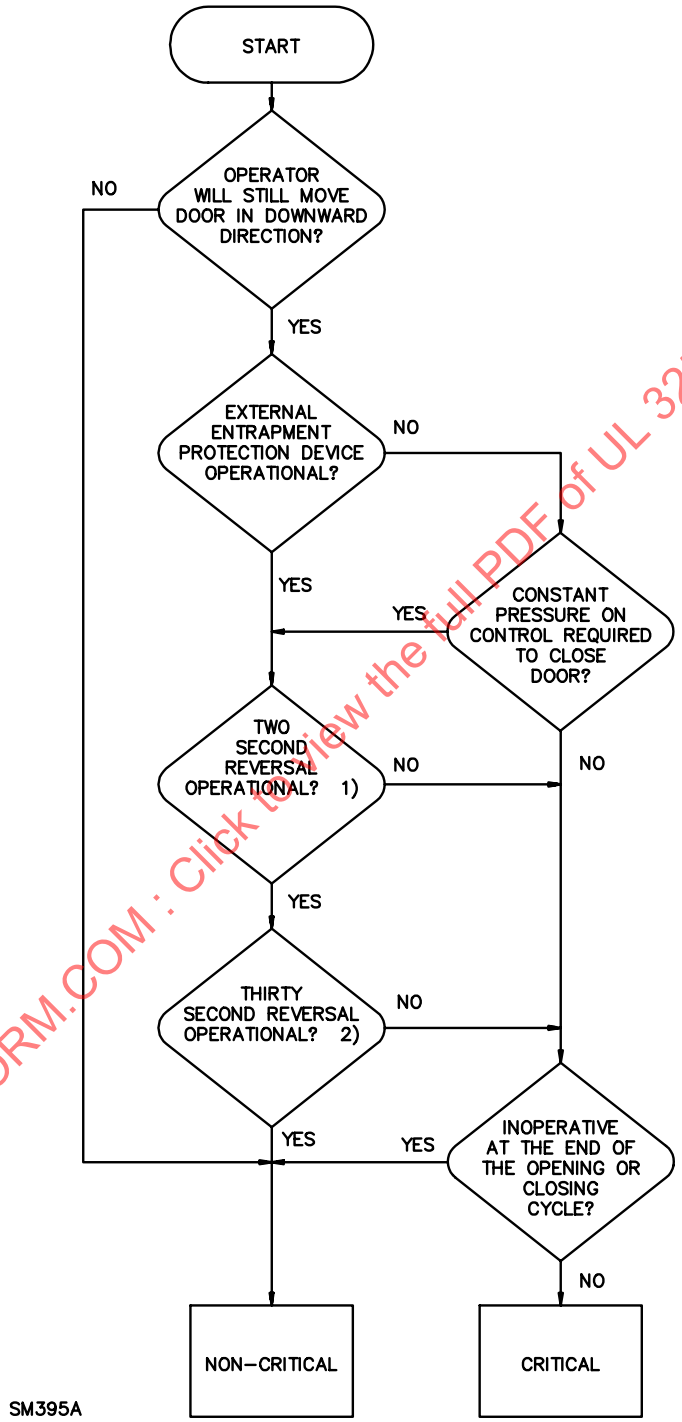
b) In investigating the performance during the Environmental Stress Tests, and

c) During the Power Cycling Tests in accordance with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 or Safety functions incorporating electronic technology, CSA 22.2 No. 0.8.

d) During evaluation of the circuit to the requirements in Supplement SA.

Figure 26.1

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



NOTES –

1) See 33.2.2.1.

2) See 33.2.2.8.

26.10 The conditions specified in 26.11 and 26.12 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 or Safety functions incorporating electronic technology, CSA 22.2 No. 0.8.

d) Evaluation of the circuit to the requirements in Supplement SA.

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.

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

a) The entrapment protection devices shall be operational,

b) An alarm shall be present and functional for an operator with a Type A entrapment protection device,

c) Monitor for the presence and correct operation of an external entrapment protection device,

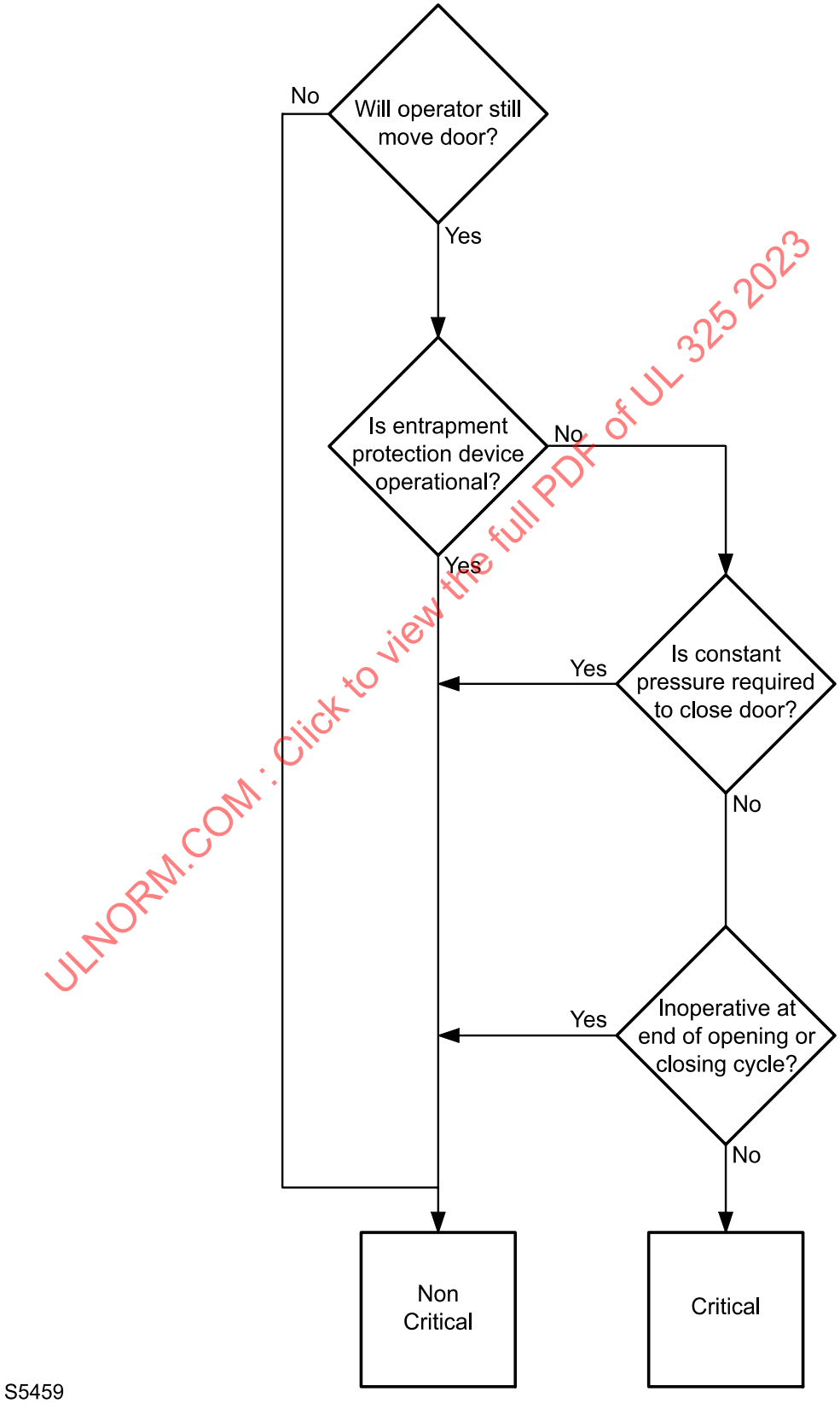
d) A Class I or II operator for a horizontal slide gate or vertical lift gate shall not result in gate movement that exceeds that specified in 32.1.24, and

e) A Class I or II operator for a horizontal bifold gate, shall not result in gate leading edge movement that exceeds that specified in 32.1.24 for the last 16 inches of panel travel in the closing direction.

26.12 In the evaluation of entrapment protection circuits used in commercial/industrial door operators, the critical condition flow chart shown in Figure 26.2 shall be used.

Figure 26.2

Critical condition flow chart for commercial/industrial door operators entrapment protection devices and functions



27 Pressure Vessels and Parts Subject to Pressures

27.1 General

27.1.1 Other than as noted in 27.1.2, a pressure vessel having an inside diameter of more than 152 mm (6 in) and subject to a pressure of more than 103.5 kPa (15 psig) 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 27.1.3.

27.1.2 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 27.1.3.

27.1.3 Other than as noted in 27.1.4 – 27.1.6, 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.

27.1.4 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 27.1.3 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 27.1.7.

27.1.5 A test need not be performed to determine whether a part complies with the requirements in 27.1.3 if study and analysis indicate that the strength of the part is adequate for the purpose as a result of its material and dimensions.

27.1.6 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 27.1.3 if the wall thickness of the tubing is not less than the value specified in Table 27.1.

Table 27.1
Wall thickness for copper and steel tubing

Outside diameter,		Minimum wall thickness,		Maximum pressure, kPa (PSIG)					
				Seamless copper		Butt-welded steel		Seamless steel	
mm	(in)	mm	(in)						
9.5	(3/8 or smaller)	0.41	(0.016)	447	(500)	4136	(600)	6895	(1000)
12.7	(1/2)	0.41	(0.016)	2758	(400)	3310	(480)	5515	(800)
15.9	(5/8)	0.41	(0.016)	2206	(320)	2647	(384)	4412	(640)
15.9	(5/8)	0.53	(0.021)	2896	(420)	3475	(504)	5791	(840)
19.1	(3/4)	0.53	(0.021)	2482	(360)	2979	(432)	4964	(720)
19.1	(3/4)	0.63	(0.025)	2896	(420)	3475	(504)	5791	(840)
25.4	(1)	0.53	(0.021)	1793	(260)	2151	(312)	3585	(520)
25.4	(1)	0.63	(0.025)	2206	(320)	2647	(384)	4412	(640)

27.1.7 If a test is necessary to determine whether a part complies with requirements in 27.1.3 and 27.1.4, 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.

27.2 Pressure-relief devices

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

27.2.2 Pressure-relief devices – see 27.2.8 – fusible plugs, soldered joints, nonmetallic tubing, or other pressure-relief means, or the equivalent, may be employed to comply with the requirement in 27.2.1.

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

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

27.2.5 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.

27.2.6 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.

27.2.7 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.

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

27.2.9 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.

28 Moving Parts

28.1 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.

28.2 The effects of the following factors shall be determined for compliance of an exposed moving part with 28.2:

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.

28.3 A belt or a chain on a door 1.83 m (6 ft) or more above the floor or a door operator intended to be mounted 1.83 m (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.

28.4 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 28.5, or

b) Shall not permit passage of a 25.4-mm (1-in) diameter probe having a hemispherical tip applied with a force of 13.34 N (3 lbf) and shall be spaced from the moving part as indicated in 28.5.

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 10.2.

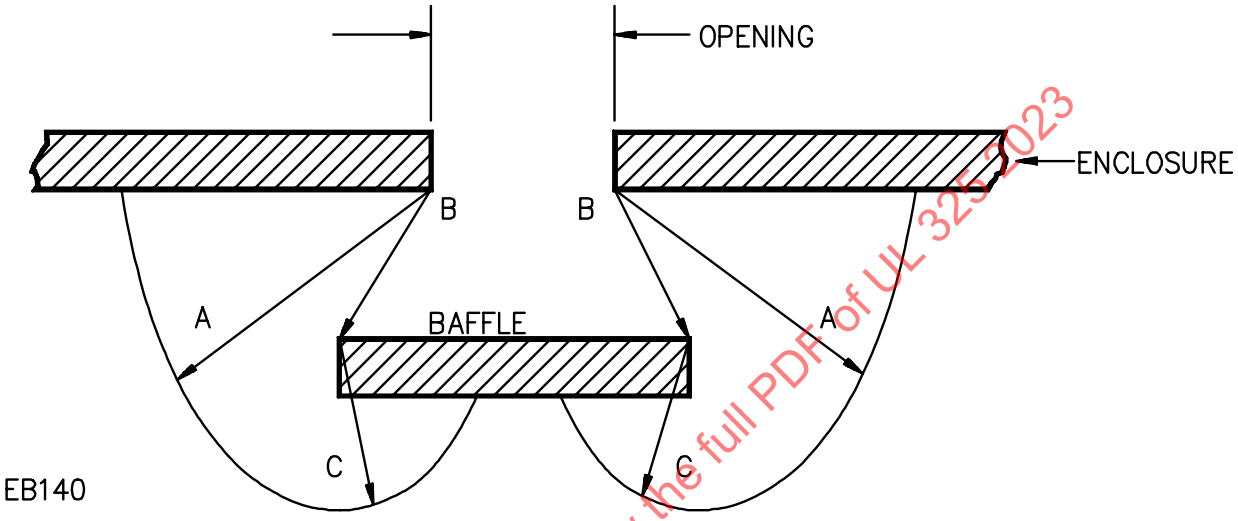
Exception No. 2: Exposed moving parts of an industrial door that are located more than 2.44 m (8 ft) above the floor are not required to be guarded or enclosed.

Exception No. 3: Exposed moving parts of an industrial door operator that is intended to be mounted more than 2.44 m (8 ft) above the floor are not required to be guarded or enclosed if the operator is marked in accordance with 63.5.1.

28.5 A baffle as mentioned in 28.4(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 28.1, is not less than 8D minus 12.7 mm (1/2 in), where D is the minor dimension of the opening in inches but not less than 6.4 mm (1/4 in). No distance is specified between a moving part and an opening having a minor dimension less than 6.4 mm (1/4 in).

Figure 28.1

Measurement around a baffle



A – Minimum distance from opening to moving part as specified in 28.5.

B – Distance from opening to edge of baffle.

C – A minus B.

29 Surface Temperatures

29.1 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 29.1.

Table 29.1
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)

29.2 With reference to the requirement in 29.1, 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 (77°F). The appliance is to be at room temperature at the beginning of the test.

30 Pedestrian Doors and Door Operators

30.1 General

30.1.1 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.

30.2 Panic hardware

30.2.1 Panic hardware provided on any type of pedestrian door shall comply with the Standard for Panic Hardware, referenced in Annex A, Ref. No. 26.

30.3 Interruption of power

30.3.1 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.

30.3.2 Unless compliance with 30.3.1 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 30.3.1 if the force required to open the door manually is not more than 222.4 N (50 lbf). 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.

30.4 Entrapment

30.4.1 A commercial or residential single-horizontally-sliding door or a center-parting sliding pedestrian door that is either remotely or automatically actuated or both – see 30.1.1:

a) Shall not develop kinetic energy in excess of 9.49 J (7 ft-lbf),

b) If it develops kinetic energy of more than 3.39 J (2-1/2 ft-lbf), 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 133.4 N (30 lbf) applied in either direction on either part of a center-parting door to prevent the door from closing.

30.4.2 The kinetic energy specified in 30.4.1 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 50.8 mm (2 in) from one jamb to a point 50.8 mm (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 25.4 mm (1 in) from either jamb to a point 25.4 mm (1 in) from the center meeting line of the door.

30.4.3 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 30.1.1:

a) Shall not close with a force greater than 133.4 N (30 lbf) at the latch side of the closing stile, and

b) Shall not close through the final 10 degrees in less than 1.5 s.

30.4.4 To comply with the requirements in 30.4.3(a), the free leaf of a double-leaf door having one leaf jammed shall not have a closing force greater than 133.4 N (30 lbf) at the latch side of the closing stile.

30.4.5 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 30.4.1, 30.4.3, and 30.4.6; and

c) Shall be marked in accordance with 63.3.8.

30.4.6 A commercial or residential single folding pedestrian door or center parting folding door that is either remotely or automatically actuated, or both – see 30.1.1:

a) Shall not close with a force greater than 133.4 N (30 lbf) from the leading edge of the fold swing panel, and

b) Shall not close through the final 10 degrees in less than 1.5 s.

30.5 Glazing material

30.5.1 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, referenced in Annex A, Ref. No. 27. Glazing material for other pedestrian doors shall also comply with the same standard, except that single strength or heavier glass may be used for those portions of doors involving a glazed area of less than 0.9 m^2 (1 ft^2) and having no dimension greater than 457 mm (18 in).

30.6 Clearance

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

a) Less than 6.4-mm (1/4-in) wide with the door in any position, or

b) At least 19.1-mm (3/4-in) 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.

31 Commercial/Industrial Door Operators and Systems

31.1 Entrapment

31.1.1 A commercial/industrial door operator shall comply with one of the following:

a) Shall be constructed so that:

1) The operator requires constant pressure on a control to close the door, and

2) The operator stops or reverses direction of the door when constant pressure on a control is removed prior to the operator reaching its close limit, and

3) The operator limits a portable transmitter or automatic actuation device, when supplied, to function only to cause the operator to open the door; and

4) It is not possible to make simple modifications by adding, suppressing or changing the connection of wires in the internal control circuit(s) to allow any other method of operation that does not require constant pressure on a control to close the door without also complying with 31.1.1(b).

or,

b) Shall be constructed to comply with one of the following:

1) Shall require the connection of an external entrapment protection device as described in 31.2; or

2) Shall be provided with any other external device that provides entrapment protection equivalent to 1.

31.2 External entrapment protection

31.2.1 An external entrapment protection device provided with, or as an accessory to, a commercial/industrial door operator (or system) shall consist of:

a) A contact type sensor (edge sensor or equivalent) installed on the leading edge of the door that when activated, as tested per 39.1.2, causes an operator closing a door to reverse direction of the door and prevents an operator from closing an open door, or

b) A non-contact type sensor (photoelectric sensor or equivalent) that when activated causes an operator closing a door to reverse direction of the door and prevents an operator from closing an open door, or

c) Any other device that provides entrapment protection equivalent to (a) or (b).

Exception: During the process of closing a door in response to a fire condition, commercial/industrial door operators (systems) are not required to comply with this provision.

31.2.2 For a commercial/industrial door operator to comply with 31.2.1, it shall monitor for the presence and correct operation of the device at least once during each close cycle. Should the device not be present, or a fault condition occur, that precludes the sensing of an obstruction, including an interruption of the wireless signal to the wireless device or an open or short circuit in the wiring that connects the external entrapment device to the operator and the device's supply source, the operator shall function in one of the following conditions:

a) A closing door shall open to the full open position or the user-defined normal open position and an open door shall not close for a period of more than 1 second from the initiation of the run, or

Exception: The door operator is not required to return the door to the full open position when an alternate entrapment protection system senses an obstruction or a control is actuated to stop the door during the upward travel.

b) Shall function as described in 31.1.1(a).

31.2.3 An external entrapment protection device as mentioned in 31.2.1 shall comply with the applicable requirements specified in Sections 35 – 39 of this standard.

31.2.4 An external entrapment protection device or system, when employing a wireless control, shall comply with 31.2.3 when installed at its farthest distance from the operator as recommended in the installation instructions.

32 Class I, II, III, and IV Vehicular Gate Operators and Systems

32.1 General entrapment protection provisions

32.1.1 A vehicular gate operator or vehicular barrier (arm) operator shall:

a) Have provisions for (see 63.3.5), or be supplied with, a minimum of two independent entrapment protection means as specified in Table 32.1 for each entrapment zone; and

b) Operate only after installation and enabling of the minimum number of acceptable entrapment protection means, as specified in Table 32.2; and

c) Be supplied with instructions regarding entrapment protection means in accordance with 60.8.2 – 60.8.4.

Exception: An operator for a vehicular barrier (arm) that is not intended to move toward a rigid object closer than 406 mm (16 in), 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 60.8.4 is not required to be provided with means to protect against entrapment and is not required to comply with 32.1 – 32.2. An operator for a vehicular barrier (arm) that includes a single folding supporting post hinged to the barrier (arm) is permitted in accordance with this exception.

Table 32.1
Protection against entrapment

Gate operator category	
Horizontal slide, vertical lift, vertical pivot, and horizontal bifold	**Swing and vehicular barrier (arm)**
Entrapment protection types[a]	**Entrapment protection types[a]**
A, B1, B2 or D	A, B1, B2, C or D

Note – The same type of device shall not be utilized for both entrapment protection means. Use of a single device to cover both the opening and closing directions is in accordance with the requirement.

[a] Entrapment protection types:

Type A – Inherent entrapment protection system. See 32.1.6.

Type B1 – Non-contact sensor (photoelectric sensor or the equivalent). See 32.1.7 – 32.1.15.

Type B2 – Contact sensor (edge device or the equivalent). See 32.1.8 and 32.1.17 – 32.1.19.

Type C – Inherent force limiting, inherent adjustable clutch or inherent pressure relief device. See 32.1.21 and 32.2.1.1(b).

Type D – Actuating device requiring continuous pressure to maintain opening or closing motion of the gate. See 32.1.22 and 32.1.23.

Table 32.2
Minimum Quantity of Entrapment Protection Means

	Opening	Closing
Horizontal Slide Gate	2	2
Horizontal Swing Gate	2*	2*
Vertical Pivot Gate	2	2
Vertical Lift Gate	1	2
Horizontal Bifold Gate	2	2

* For a horizontal swing gate operator, at least two independent entrapment protection means are required in each direction of travel. Except, if there is no entrapment zone in one direction of travel, only one means of entrapment protection is required in that direction of travel; however, the other direction must have two independent entrapment protection means.

32.1.2 A vehicular gate operator or vehicular barrier (arm) operator shall be supplied with an audio alarm complying with 32.1.3 and 32.1.4. 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.

32.1.3 An audio alarm specified in 32.1.2 shall comply with the applicable requirements in All Devices, Section 35, and Audio Alarms, Section 40.

32.1.4 The audio alarm signals for the alarm specified in 32.1.2 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, and a sound level at least 100 dB at nominal operating voltage of the operator or accessory.

32.1.5 The measurement for the sound level of at least 100 dB shall be measured from the outside of the operator, or from the outside of the accessory if the audio alarm is provided as a separate device. The measurement shall be taken from a distance of 305 mm (1 ft) measured horizontally from the operator or device, at any height up to 1.83 m (6 ft) from the ground distance, and from any side of the device or operator. One measurement of 100 dB from any measurement location described is considered acceptable.

32.1.6 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Type A in Table 32.1 to comply with 32.1.1 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 50.8 mm (2 in). 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 control. An alarm shall comply with 32.1.2.

32.1.7 A gate operator utilizing entrapment protection designated Type B1 in Table 32.1 by having provision for connection of, or providing with the operator, a non-contact sensor (photoelectric sensor or equivalent) to comply with 32.1.1 shall, upon sensing an obstruction in the direction of travel of the gate when tested per 37.1 or 37.2 as applicable, 37.3 and 37.4:

a) Stop or reverse the gate within a maximum of 2 s,

b) Stop the gate, or stop and initiate reversal of the gate upon sensing a second sequential obstruction,

c) While sensor(s) is actuated, result in a gate at rest remaining at rest unless activated by a fixed control functioning with constant pressure as required by 32.1.23, and

d) Return to normal operation when the sensor is no longer actuated.

32.1.8 A gate operator installed in accordance with the manufacturer's instructions utilizing external entrapment protection designated Types B1 or B2 in Table 32.1 to comply with 32.1.1 by having provision for connection of such device(s), or providing such device(s) with the operator, shall monitor for the presence of every device at least once during each open and close cycle. Upon monitoring, should any device not be present, or a fault condition occur that precludes the sensing of an obstruction, including an interruption of the wireless signal to the wireless device or an open or short circuit in the wiring that connects the external entrapment device to the operator and the device's supply source, the operator shall function with constant pressure as required by 32.1.23 for the direction of travel being protected, or shall only be able to be moved manually as required by 32.1.25. Compliance with this section shall be verified by test per 32.2.1.4.

Exception: Emergency access controls only accessible by authorized personnel (e.g. fire, police, EMS) may override entrapment protection means as specified in 32.1.8.

32.1.9 For the purposes of 32.1.8, one open and close cycle is considered to be a complete sequence of: Open (fully or partially), Stop/Pause, Close (fully or partially), Stop/Pause.

32.1.10 With regard to connection points of an operator that are required to monitor external entrapment protection devices, it shall not be possible to make simple modifications in the field by adding, suppressing, or changing either on the operator or external entrapment protection device(s), to bypass, interfere with, or otherwise defeat the monitoring function:

a) The connection of wires;

b) Terminals;

c) Switches;

d) Jumpers; or

e) Components supplied with the operator or external entrapment protection device.

32.1.11 The installation manual and the user manual shall not provide instructions for which the stated purpose of the instructions is to reprogram, reconfigure, or reset the monitored outputs such that they do not comply with the minimum requirements in Table 32.2 except to revert to original factory settings.

32.1.12 The operator shall not be provided with resistors installed or intended for installation across the terminals that are intended for monitored external entrapment protection devices and the manufacturer shall not recommend the use or installation of such resistors.

32.1.13 A component, such as a resistor, capacitor, etc. required for monitoring shall be permanently installed at the factory by the manufacturer of the entrapment protection device.

32.1.14 A gate operator utilizing a non-contact sensor for entrapment protection in accordance with 32.1.1 shall be supplied with instructions on the placement of the sensors for each entrapment zone in compliance with 60.8.3 and 60.8.4.

32.1.15 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 35, External Entrapment Protection Devices with Wireless Control, Section 36, and Photoelectric Sensors, Section 37. A separately supplied sensor shall comply with 63.3.5, 63.3.6, and 63.3.7.

32.1.16 A non-contact external entrapment protection device or system, when employing a wireless control, shall comply with 32.1.15 when installed at its farthest distance from the operator as recommended in the installation instructions.

32.1.17 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Type B2 in Table 32.1 by having provision for connection of, or providing with the operator, a contact sensor (edge sensor or equivalent) to comply with 32.1.1 shall, upon sensing an obstruction in the direction of travel of the gate when tested per 39.1.3:

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 50.8 mm (2 in),

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 activated by a fixed control functioning with constant pressure as required by 32.1.23, 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.

32.1.18 A gate operator utilizing a contact sensor for entrapment protection to comply with 32.1.1 shall be supplied with instructions on the placement of the sensors for each entrapment zone in compliance with 60.8.3 and 60.8.4.

32.1.19 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 35, External Entrapment Protection Devices with Wireless Control, Section 36, and Edge Sensors, Section 39. A separately supplied sensor shall comply with 63.3.5, 63.3.6, and 63.3.7.

32.1.20 A contact external entrapment protection device or system, when employing a wireless control, shall comply with 32.1.19 when installed at its farthest distance from the operator as recommended in the installation instructions.

32.1.21 A swing-gate operator utilizing entrapment protection designated Type C in Table 32.1 to comply with 32.1.1 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) Inherent pressure relief devices and inherent adjustable clutches shall be readily accessible for inspection and repair and not readily rendered inoperative.

32.1.22 A gate operator utilizing entrapment protection designated Type D in Table 32.1 by having a provision for connection of, or providing with the operator, a continuous pressure actuation device to

comply with 32.1.1 shall be constructed so that a portable wireless control shall not operate the gate. Also see 60.8.4(e) and 62.1.6.

32.1.23 A gate operator installed in accordance with the manufacturer's instructions utilizing entrapment protection designated Type D in Table 32.1 to comply with 32.1.1 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.

32.1.24 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 0.3 m/s (1 ft/s) with the operator exerting a pull force of 333.6 N (75 lbf) and when connected to a supply circuit of maximum rated voltage and rated frequency.

32.1.24A A Class I or Class II horizontal bifold-gate operator (or system) shall not result in a gate speed greater than 0.3 m/s (1 ft/s) during the last 406 mm (16 in) of panel travel while closing with the operator exerting a pull force of 333.6 N (75 lbf) when connected to a supply circuit of maximum rated voltage and rated frequency. The speed is measured in the closing direction at the vertical leading edge of the inner bifold panel (item 5 of Figure 4.3) over any 305 mm (1 ft) increment of horizontal travel where the gate speed is fastest.

32.1.25 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.

32.1.26 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.

32.2 Entrapment protection (Types A, B2, and C)

32.2.1 General

32.2.1.1 When Types A, B2, or C entrapment protection devices are used as the entrapment protection provisions, a gate operator shall, upon contact with the obstruction specified in 32.2.2 – 32.2.5:

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 50.8 mm (2 in) 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 sustained force greater than 177.9 N (40 lbf) 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 Type C device can be adjusted during use, user maintenance or installation, the Type C device is to be adjusted to the maximum setting. The measurement is to be made at the minimum length of the gate recommended by the manufacturer, at least 2 seconds after contact.

A gate operator shall be tested in accordance with all applicable requirements specified in 32.2.2 – 32.2.5 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.

32.2.1.2 *Deleted*

32.2.1.3 A gate operator is to be tested for compliance with 32.2.1.1 for 50 open-and-close cycles of operation using the location representative of the greatest risk of entrapment as determined in 32.2.2.3, 32.2.3.3, 32.2.4.3, and 32.2.5.3. 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.

32.2.1.4 The operator shall be tested in various configurations representing the minimum number of external entrapment protection devices specified by the operator manufacturer up to the maximum number specified.

32.2.2 Vehicular horizontal slide-gate and vertical lift-gate, and vertical pivot-gate operators

32.2.2.1 With reference to 32.2.1.1, a 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid rectangular object not less than 152-mm (6-in) long is to be fixed in an immobile position with the longitudinal axis perpendicular to the edge of the gate. The 41.3-mm (1-5/8-in) 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 and vertical lift gates, the same object is then to be arranged to contact the moving gate at various points along the trailing edge of the gate. For vertical pivot gates, the same object is to be arranged to contact the gate at various points in the pivot area representative of the greatest risk of entrapment except where guarded in the rear pivot edge area per instructions in 60.8.4.

32.2.2.2 The test described in 32.2.2.1 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 305 mm (1 ft) from the fully open, the midpoint, and less than 305 mm (1 ft) from the fully closed positions of the gate.

32.2.2.3 As a result of the tests specified in 32.2.2.1 and 32.2.2.2, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 32.2.1.3.

32.2.3 Vehicular swing-gate operators

32.2.3.1 With reference to 32.2.1.1, a solid rectangular object as described in 32.2.2.1 is to be fixed in an immobile position and tangential to the arc with the 41.3-mm (1-5/8-in) 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.

32.2.3.2 The test described in 32.2.3.1 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 305 mm (1 ft) from the fully open, the starting of the gate, the mid-arc, and less than 305 mm (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.

32.2.3.3 As a result of the tests specified in 32.2.3.1 and 32.2.3.2, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 32.2.1.3.

32.2.4 Vehicular vertical barrier (arm) operators

32.2.4.1 With reference to 32.2.1.1, a solid rectangular object as described in 32.2.2.1 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.

32.2.4.2 The test described in 32.2.4.1 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 305 mm (1 ft) from the fully open, the starting of the gate, the mid-arc, and less than 305 mm (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.

32.2.4.3 As result of the tests specified in 32.2.4.1 and 32.2.4.2, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 32.2.1.3.

32.2.5 Vehicular bifold gate operators

32.2.5.1 With reference to 32.2.1.1, a 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid rectangular object not less than 152-mm (6-in) long is to be fixed in an immobile position as follows for each entrapment zone:

a) With the 41.3-mm (1-5/8-in) side of the obstruction positioned across the gate opening perpendicular to a straight line across the opening. The 41.3-mm (1-5/8-in) side of the obstruction facing the inner bifold panel, outside vertical leading edge is to contact the moving gate at various points of gate travel in the closing direction along the leading edge of the gate at various points up to 1.8 m (6 feet) above grade.(see Figure 4.3, edge 6).

b) The same object is then to be arranged to contact the moving gate at various points of gate travel in the opening direction along the inner bifold panel, outside vertical leading at various points up to 1.8 m (6 feet) above grade, (see Figure 4.3, edge 5).

c) The same object is then to be oriented vertically and the 41.3 mm (1-5/8-in) side arranged to contact various spots within the “V” shaped area between the folding panels, (see Figure 4.3 edges 2, 3).

d)The same object is to be arranged in a vertical orientation and made to contact the outer column gate panel along the outer column panel, outside horizontal bottom edge at various points at the bottom of the gate panel (see Figure 4.3 edge 4).

e) An object 25 mm (1 inch) greater than the width of the smallest opening between the gate panel edges at the hinge area is then to be placed in the hinge area (see Figure 4.3 edges 7/8 and 9/10) when the gate is in the fully open position. As the gate closes, the object shall remain in position such that the gate edges in the hinge area contact the object.

32.2.5.2 With reference to the tests in 32.2.5.1 (a) and (b), the various locations shall include, and not be limited to, less than 305 mm (1 ft) from the fully open, the midpoint, and less than 305 mm (1 ft) from the fully closed positions of the gate. At each of these locations, the vertical height of the obstruction shall be placed at minimum, but not limited to, the following locations:

a) Within 2 inches of the bottom rail or edge;

b) Within 2 inches of the top rail or edge, or 6 ft above grade, whichever is lower; and

c) At the midpoint of the vertical height of the gate panel, or 2 ft above grade, whichever is lower.

32.2.5.3 As result of the tests specified in 32.2.5.1, one location within the path of the gate representative of the greatest risk of entrapment is to be determined for the test specified in 32.2.1.3.

33 Residential Garage Door Operator and Door Operator Systems

33.1 General

33.1.1 A residential garage door operator system shall be supplied with primary inherent entrapment protection that complies with the requirements as specified in 33.2.1.1.

33.1.2 In addition to the primary inherent entrapment protection as required by 33.1.1, a vertically moving residential garage door operator shall comply with one of the following:

a) Shall be constructed to:

1) Require constant pressure on a control intended to be installed and activated within line of sight of the door 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 33.3.1, and 33.3.3 – 33.3.5, as applicable to vertically moving doors; or

c) Shall be provided with an inherent secondary entrapment protection device as described in 4.13, 33.3.1, and 33.3.6, and is:

1) A combination sectional overhead garage door operator system as described in 4.3 and 33.1.3, and

2) For use only with vertically moving garage doors.

With respect to 33.1.2(c)(1), trolley-driven operators do not meet the definition of 4.3.

33.1.3 In the case of a vertically moving combination sectional overhead garage door operator system, the door shall comply with the requirements in Specifications for Sectional Overhead Type Doors, referenced in Annex A, Ref. No. 28.

33.1.4 In addition to the primary inherent entrapment protection as required by 33.1.1, a horizontally sliding residential garage door operator shall comply with one of the following:

a) Shall be constructed to:

1) Require constant pressure on a control to close the door,

2) Reverse direction and open the door a minimum of 50.8 mm (2 in) when constant pressure on a control is removed prior to operator reaching its position limit, and

3) Stop the door if a second obstruction is detected in the reverse direction.

b) Shall be provided with a means for connection of an external secondary entrapment protection device for each leading edge as described in 33.3.2 – 33.3.5, as applicable for horizontally moving doors.

33.2 Inherent primary entrapment protection

33.2.1 General

33.2.1.1 A vertically moving residential garage door operator system shall be supplied with primary inherent entrapment protection that complies with the requirements as specified in 33.2.2.1 – 33.2.2.10. A horizontally sliding residential garage door operator system shall be supplied with primary inherent entrapment protection that complies with the requirements as specified in 33.2.3.1 – 33.2.3.10.

33.2.2 Inherent primary entrapment protection, vertically moving doors

33.2.2.1 For a vertically moving residential garage door operator system, other than for the first 305 mm (1 ft) of door travel from the full upmost position, both with and without any secondary 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 33.2.2.3. 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 33.2.2.2 – 33.2.2.10.

Exception No. 1: The door operator is not required to return the door to, and stop the door at, the full upmost position when the operator senses a second obstruction during the upward travel.

Exception No. 2: The door operator is not required to return the door to, and stop the door at, the full upmost position when a control is actuated to stop the door during the upward travel – but the door can not be moved downward until the operator reverses the door a minimum of 50.8 mm (2 in).

33.2.2.2 The test shall be performed on a representative operating system installed in accordance with the manufacturer's installation instructions with the operator exerting a force in accordance with 46.3.1.

33.2.2.3 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 25.4-mm (1-in) 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 No. 1: 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 305 mm (1 ft) of each end of the door.

Exception No. 2: With reference to 49.6.1 and Exception No. 2 of 33.2.2.1, 33.2.2.7, and 33.2.2.8; a 102 mm (4 in) high by 152 mm (6 in) wide by a minimum of 152 mm (6 in) long solid rectangular object is to be placed on the floor of the test installation to provide a 102 mm (4 in) high obstruction when operated from a partially open position.

33.2.2.4 An operator is to be tested for compliance with 33.2.2.1, 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 33.2.2.6. 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.

33.2.2.5 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 33.2.2.3, at the maximum setting or at the setting that represents the most severe operating condition.

33.2.2.6 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 63.3.1.

33.2.2.7 An operator, employing an inherent entrapment protection control that measures or 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 system shall measure or monitor the position of the door at increments not greater than 25.4 mm (1 in).

Exception No. 1: 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 during the upward travel.

Exception No. 2: The door operator is not required to return the door to, and stop the door at, the full upmost position when a control is actuated to stop the door during the upward travel – but the door can not be moved downward until the operator reverses the door a minimum of 50.8 mm (2 in).

33.2.2.8 An operator, using an inherent entrapment protection system that does not measure or 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 No. 1: 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 during the upward travel.

Exception No. 2: The door operator is not required to return the door to, and stop the door at, the full upmost position when a control is actuated to stop the door during the upward travel – but the door can not be moved downward until the operator has reversed the door a minimum of 50.8 mm (2 in). When the door is stopped manually during its descent, the 30 s shall be measured from the resumption of the close cycle.

33.2.2.9 To determine compliance with 33.2.2.7 or 33.2.2.8, an operator is to be subjected to 10 open-and-close cycles of operation while connected to the door or doors specified in 33.2.2.4 and 33.2.2.6. 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 33.2.2.1 and 33.3.1 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.

33.2.2.10 During the closing cycle of 33.2.2.9, the system providing compliance with 33.2.2.1 and 33.2.2.7 or 33.2.2.1 and 33.2.2.8 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.

33.2.3 Inherent primary entrapment protection, horizontally sliding doors

33.2.3.1 For a horizontally sliding residential garage door operator system, both with and without any external entrapment protection device functional, the operator of a closing residential garage door shall initiate reversal of the door within 2 s of contact with the obstruction as specified in 33.2.3.3. After reversing the door, the operator shall open the door a minimum of 50.8 mm (2 in) from the edge of the obstruction. Compliance shall be determined in accordance with 33.2.3.2 – 33.2.3.10.

Exception No. 1: The door operator is not required to open the door a minimum 50.8 mm (2 in) when the operator senses a second obstruction during the reversing travel.

Exception No. 2: The door operator is not required to open the door a minimum 50.8 mm (2 in) when a control is actuated to stop the door during movement towards the open position – but the door can not be moved towards the closed position until the operator reverses the door a minimum of 50.8 mm (2 in).

33.2.3.2 The test shall be performed on a representative operating system installed in accordance with the manufacturer's installation instructions with the operator exerting a force in accordance with 46.3.1.

33.2.3.3 A solid object with a width of 25.4-mm (1-in) is to be placed on the floor and rigidly supported within the bottom track and then repeated with the solid object placed on the floor and rigidly supported external to the track. The test shall then be repeated with the solid object rigidly supported at heights of 305 mm (1 ft), 914 mm (3 ft), 1524 mm (5 ft), and within 305 mm (1 ft) of the top edge. With reference to 49.6.1 and Exception No. 2 of 33.2.3.1, 33.2.3.7, and 33.2.3.8; a 102 mm (4 in) high by 152 mm (6 in) wide by a minimum of 152 mm (6 in) long solid rectangular object is to be placed on the floor of the test installation to provide a 102 mm (4 in) high obstruction when operated from a partially open position with the test repeated with the bottom edge of the obstruction rigidly supported at heights of 305 mm (1 ft), 914 mm (3 ft), 1524 mm (5 ft), and within 305 mm (1 ft) of the top edge.

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 305 mm (1 ft) of each end of the door opening.

33.2.3.4 An operator is to be tested for compliance with 33.2.3.1 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 33.2.3.6. 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.

33.2.3.5 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 33.2.3.3 at the maximum setting or at the setting that represents the most severe operating condition.

33.2.3.6 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 63.3.1.

33.2.3.7 An operator, employing an inherent entrapment protection control that measures or 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 fully open position in the event the inherent door operation "profile" of the door differs from the originally set parameters. The system shall measure or monitor the position of the door at increments not greater than 25.4 mm (1 in).

Exception No. 1: The door operator is not required to open the door a minimum 50.8 mm (2 in) when an inherent entrapment circuit senses an obstruction during the reversing travel.

Exception No. 2: The door operator is not required to open the door a minimum 50.8 mm (2 in) when a control is actuated to stop the door during the opening direction – but the door can not be moved in the closing direction until the operator reverses the door a minimum of 50.8 mm (2 in).

33.2.3.8 An operator, using an inherent entrapment protection system that does not measure or monitor the actual position of the door, shall initiate reversal of the door and shall open the door a minimum 50.8 mm (2 in) when the closed position limit device is not actuated within 30 s or less following the initiation of the close cycle.

Exception No. 1: The door operator is not required to open the door a minimum 50.8 mm (2 in) when an inherent entrapment circuit senses an obstruction during the reversing travel.

Exception No. 2: The door operator is not required to open the door a minimum 50.8 mm (2 in) when a control is actuated to stop the door during the opening direction – but the door can not be moved in the closing direction until the operator has reversed the door a minimum of 50.8 mm (2 in). When the door is stopped manually during its closing, the 30 s shall be measured from the resumption of the close cycle.

33.2.3.9 To determine compliance with 33.2.3.7 or 33.2.3.8, an operator is to be subjected to 10 open-and-close cycles of operation while connected to the door or doors specified in 33.2.3.4 and 33.2.3.6. 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 33.2.3.1 and 33.3.2 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 position limiting device.

33.2.3.10 During the closing cycle of 33.2.3.9, the system providing compliance with 33.2.3.1 and 33.2.3.7 or 33.2.3.1 and 33.2.3.8 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.

33.3 Secondary entrapment protection

33.3.1 For a vertically moving door operator, 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, returns the door to, and stops the door at the fully open position, 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 as tested per 39.1.1.1, results in an operator that is closing a door to reverse direction of the door, returns the door to, and stops the door at the fully open position, and the sensor prevents an operator from closing an open door; or

c) An inherent door sensor independent of the system used to comply with 33.2 that, when activated, results in an operator that is closing a door to reverse direction of the door, returns the door to, and stops the door at the fully open position, and the sensor prevents an operator from closing an open door.

Exception No. 1: The door operator is not required to return the door to, and stop the door at, the fully open position when an inherent entrapment circuit senses an obstruction during the opening travel.

Exception No. 2: The door operator is not required to return the door to, and stop the door at, the fully open position when a control is actuated to stop the door during the opening travel – but the door cannot be moved towards the closing direction until the operator has reversed the door a minimum of 50.8 mm (2 in).

33.3.2 For horizontal sliding garage door operators, 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 or opening a door to reverse direction of the door for a minimum of 50.8 mm (2 in); or

b) An external edge sensor installed on the edge of the door that, when activated as tested per 39.1.1.2, results in an operator that is closing or opening a door to reverse direction of the door for a minimum of 50.8 mm (2 in).

33.3.3 With respect to 33.3.1 and 33.3.2, the operator shall monitor for the presence and correct operation of the device at least once during each close cycle. Should the device not be present, or a fault condition occur that precludes the sensing of an obstruction, including an interruption of the wireless signal to the wireless device or 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) For a vertically moving door, the closing door shall open and an open door shall not close more than 305 mm (1 ft) below the upmost position;

b) For a horizontally sliding door, the door shall not move in the opening or closing direction; or

c) The operator shall function as required by 33.1.2(a).

33.3.4 An external entrapment protection device or system, when employing a wireless control, shall comply with 33.3.5 when installed at its farthest distance from the operator as recommended in the installation instructions.

33.3.5 An external entrapment protection device shall comply with the applicable requirements in Sections 35 – 39 of this Standard.

33.3.6 An inherent secondary entrapment protection device described in 33.1.2(c) shall comply with the applicable requirements in Inherent Secondary Force Activated Door Sensors, Section 49, independent of the primary entrapment protection. The independent primary and secondary entrapment protection devices shall not use the same detection means nor measure the same physical properties.

33.4 Additional features

33.4.1 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 1.83 m (6 ft) above the garage floor when the operator is installed according to the instructions specified in 60.3.1 and 60.4.1(4). The means shall be constructed so that a hand firmly gripping it and applying a maximum of 223 N (50 lbf) of force shall detach the operator with the door obstructed in the closing position. The obstructing object, as described in 33.2.2.3 and 33.2.3.3, is to be located in several different positions. A marking with instructions for detaching the operator shall be supplied. The marking shall comply with 61.1 – 61.2 and 61.10, as applicable.

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) 50.8 mm (2 in) of travel; and

b) The door is capable of being moved to the 50.8-mm (2-in) point from any position between closed and the 50.8-mm (2-in) point.

33.4.2 Actuation of a control that initiates movement of a door shall stop and may reverse the door on the closing cycle. On the opening cycle, actuation of a control shall stop the door but not reverse it.

33.4.3 A residential garage door operator when tested as described in 45.1 shall have a maximum appliance current draw, excluding lamps or external devices, of not more than 5 A.

33.4.4 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 10.7.

33.5 Unattended operation

33.5.1 General

33.5.1.1 A residential garage door operator or system may permit unattended operation per 4.27 to close a garage door, provided the operator system complies with the additional requirements of 33.5.2 – 33.5.5.

Exception: Unattended operation shall not be permitted on one-piece garage doors or swinging garage doors. An operator intended for use with both sectional doors and one-piece or swinging doors that has an unattended operation close feature shall identify that the unattended operation closing feature is only permitted to be enabled when installed with a sectional door by complying with:

a) The installation instructions of 60.4.2;

b) The markings of 61.8; and

c) The carton markings of 63.3.2 when the carton references the unattended operation close feature.

33.5.2 Operator system

33.5.2.1 The operator system shall require one or more intentional actions to enable unattended operation, such as setting a power head switch or wall-control switch. For an accessory requiring installation and set-up in order to enable unattended operation, the installation and set-up may be considered satisfying this requirement.

33.5.3 Alarm signal

33.5.3.1 The operator system shall provide an audible and visual alarm signal.

33.5.3.2 The alarm shall signal for a minimum of 5 seconds before any unattended closing door movement.

33.5.3.3 The audible signal shall be heard within the confines of a garage. The audio alarm signals for the alarm specified in 33.5.3.1 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 second or one continuous tone, a sound level at least 45 dB 3.05 m (10 ft) in front of the device over the voltage range of operation.

33.5.3.4 The visual alarm signal of 33.5.3.1 shall be visible within the confines of a garage using a flashing light of at least 40 watt incandescent or 360 lumens. The flash rate shall be at least once per second, with a duration of 100 ms to 900 ms, for the duration of the alarm.

33.5.4 Controls

33.5.4.1 During the pre-motion signaling period defined in 33.5.3.2, activation of any user door control (e.g. wall control, wireless remote, keypad) shall prevent the pending unattended door movement. Door movement resulting from activation of a user door control is not prohibited.

33.5.4.2 Upon activation of a user door control during unattended door movement, the door shall stop, and may reverse the door on the closing cycle. On the opening cycle, activation of a user door control shall stop the door but not reverse it.

33.5.4.3 If an unattended door travelling in the closing direction is stopped and reversed by an entrapment protection device, the operator system shall be permitted one additional unattended operation attempt to close the door.

33.5.4.4 After two attempts per 33.5.4.3, the operator system shall suspend unattended operation. The operator system shall require a renewed, intended input, via user door control (e.g. wall control, wireless remote, keypad) other than the unattended activation device, prior to re-enabling unattended operation.

33.5.5 Entrapment protection

33.5.5.1 For a moving door, entrapment protection shall comply with 33.2 and 33.3.

33.6 Unattended operation control accessory

33.6.1 General

33.6.1.1 A residential garage door operator control accessory shall be permitted to be supplied separate from the operator, and per 4.27 may permit unattended operation to close a garage door, provided the control accessory complies with the additional requirements of 33.6.2 – 33.6.6.

Exception: Unattended operation shall not be permitted on one-piece garage doors or swinging garage doors. A control accessory that has an unattended operation close feature shall identify that the unattended operation closing feature is only permitted to be enabled when installed with a sectional door by complying with:

a) The installation instructions of 60.4.2;

b) The markings of 61.8; and

c) The carton markings of 63.3.2.

33.6.2 Operator system

33.6.2.1 The control accessory shall require one or more intentional actions to enable unattended operation to function when connected to an operator system, such as setting a power head switch or wall-control switch. For an accessory requiring installation and set-up in order to enable unattended operation, the installation and set-up may be considered satisfying this requirement.

33.6.3 Alarm signal

33.6.3.1 The control accessory alone or in combination with the operator system shall provide an audible and visual alarm signal.

33.6.3.2 The alarm shall signal for a minimum of 5 seconds before any unattended closing door movement, or before any door movement if the next direction of door travel cannot be determined.

33.6.3.3 The audible signal shall be heard within the confines of a garage. The audio alarm signals for the alarm specified in 33.6.3.1 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 second or one continuous tone, a sound level at least 45 dB 3.05 m (10 ft) in front of the device over the voltage range of operation.

33.6.3.4 The visual alarm signal of 33.6.3.1 shall be visible within the confines of a garage using a flashing light of at least 40 watt incandescent or 360 lumens.

33.6.3.5 When the visual alarm or the audio alarm, or both, are external to the control accessory and are not part of main operator unit, the control accessory shall monitor for the connection of and proper operation of both the visual and audible alarms, prior to initiating door travel.

33.6.4 Controls

33.6.4.1 During the pre-motion signaling period defined in 33.6.3.2, activation of any user door control (e.g. wall control, wireless remote, keypad) shall prevent the pending unattended door movement. Door movement resulting from activation of a user door control is not prohibited.

33.6.4.2 Upon activation of a user door control during unattended door movement:

a) The operator shall function in the same manner as if the control accessory were not present;

b) The control accessory shall not interfere with, override, or alter the normal operation of the operator; and

c) The door shall stop, and may reverse the door on the closing cycle. On the opening cycle, activation of a user door control shall stop the door but not reverse it.

33.6.4.3 If an unattended door travelling in the closing direction is stopped and reversed by an entrapment protection device, the control accessory alone or in combination with the operator system shall be permitted one additional unattended operation attempt to close the door.

33.6.4.4 After two attempts per 33.5.4.3, the control accessory alone or in combination with the operator system shall suspend unattended operation. The control accessory alone or in combination with the operator system shall require a renewed, intended input, via user door control (e.g. wall control, wireless remote, keypad) other than the unattended activation device, prior to re-enabling unattended operation.

33.6.5 Entrapment protection

33.6.5.1 The control accessory shall not interfere with, override, or alter any entrapment protection features of the operator or system per 33.2 and 33.3. A control accessory that only provides a momentary signal (wired or wireless) to start the door is considered to comply with this requirement.

33.6.5.2 A control accessory shall only be used with an operator when the combination of the operator and the control accessory comply with the applicable entrapment protection features including:

a) Inherent Primary Entrapment Protection, in accordance with 33.2;

b) Secondary Entrapment Protection, in accordance with 33.3.

33.6.5.3 A control accessory shall be marked to indicate “For use only with garage door operators complying with UL 325, manufactured after _____.”, or “For use only with the following garage door operators:_____.” The date (e.g. “1993”, “February 21, 2008”) or the additional information provided in the blank shall be added by the accessory manufacturer such that the combination of the control and operator(s) it is intended for use with complies with 33.6.5.2. This marking shall appear on the packaging and on the product, and shall be repeated in the instructions accompanying the accessory.

33.6.5.4 To comply with 33.6.5.2, a control accessory shall comply with one or more of the following:

a) Not be capable of operating when connected to an operator that is not compliant with 33.6.5.2;

b) Be restricted to function only with specific operators, such that the combination of the control and the operator are compliant with 33.6.5.2;

c) Provide additional functionality to an operator or system such that when operating via the control accessory, the combination of the control accessory and the operator complies with 33.6.5.2;

d) Be marked to indicate as indicated in 33.6.5.3.

33.6.6 Instructions and markings

33.6.6.1 The control accessory shall be provided with instructions as follows:

a) Instructions per Section 60, as applicable.

b) Instructions that repeat any warning or cautionary product markings and field labels required below.

33.6.6.2 The control accessory shall be provided with markings as follows:

a) Markings on the product per Section 63, as applicable.

b) In lieu of 63.3.2, the product package shall be marked with the following or equivalent: "WARNING: To reduce the risk of injury to persons – Only enable [+] feature when installed with sectional door.", where + is the unattended operation closing function , or “WARNING: To reduce the risk of injury to persons – Do not use this device with one-piece doors or swinging doors.”

c) On the package or the product – any other markings related to use of the control with specific operators, per 33.6.5.4.

33.6.6.3 The control accessory shall be provided with a label for field installation as required by 61.3 – 61.7, including but not limited to 61.7(b)(5).

34 Vertically Moving Combination Rigid One-Piece Overhead Residential Garage Door and Operator System

Note: Section 34 applies only to products produced and sold as a system, with rigid one-piece overhead door and the door operator together, as defined in 4.2. Section 34 does not apply to a residential garage door operator as defined in 4.19 that is manufactured and intended for sale separate from the door, and that may be intended for installation on a standard one-piece door in the field.

34.1 A vertically moving 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 152 mm (6 in) per second.

b) The system shall be supplied with two additional independent secondary entrapment protection devices complying with Secondary Entrapment Protection, 33.3. 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 37, 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 33.4.1. Instead, the means shall be located 1.52 m (5 ft) above the floor, shall not require a torque of more than 6.78 N-m (5 ft-lb) 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 61.1 – 61.2 and 61.10, as applicable.

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 52, 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 52, 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 28.

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 57.

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

35 All Devices

35.1 General

35.1.1 An external entrapment protection device shall perform its intended function when tested in accordance with 35.1.2 – 35.1.4.

35.1.2 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.

35.1.3 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 2.13-m (7-ft) wide door and maximum 6.10-m (20-ft) wide door.

35.1.4 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.

35.1.5 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.

35.2 Current protection test

35.2.1 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.

35.2.2 To determine compliance with 35.2.1, 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.

35.2.3 After restoring the connections in the intended manner:

a) A photoelectric sensor shall comply with the Normal Operation tests per 37.1 or 37.2, as applicable, and

b) An edge sensor shall comply with the applicable Normal Operation test, per 39.1.

35.3 Water exposure tests

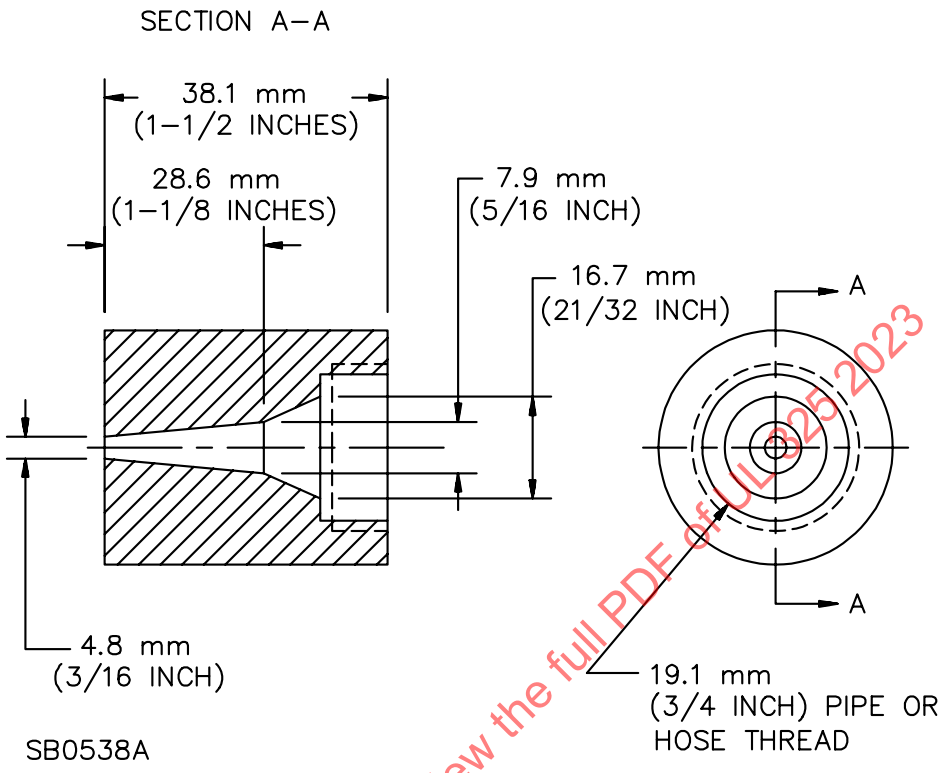
35.3.1 Splash test

35.3.1.1 An external entrapment protection device intended to be installed inside a garage 914 mm (3 ft) or less above the floor shall withstand indirect water spray as described in 35.3.1.2 without resulting in a risk of electric shock and shall function as intended per 35.3.1.3. After exposure to the water spray, the external surface of the device is to be dried before determining its functionality.

35.3.1.2 External entrapment protection devices are to be indirectly sprayed using a hose having the free end fitted with a nozzle as illustrated in Figure 35.1 and connected to a water supply capable of maintaining a flow rate of 19 L (5 gal) 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 3.05 m (10 ft) horizontally to the device. The water is to be sprayed for 1 min.

Figure 35.1

Nozzle



35.3.1.3 After drying the external surface of the device:

a) A photoelectric sensor shall comply with the Normal Operation Tests per 37.1 or 37.2, as applicable, and

b) An edge sensor shall comply with the applicable Normal Operation Test, per 39.1.

c) There shall be no water on uninsulated live parts of a line voltage circuit.

35.3.2 Rain test

35.3.2.1 External entrapment protection devices Types B1 and B2, and D when intended for outdoor use, shall comply with the water spray of the Insulation Resistance Test and Dielectric Voltage-Withstand Test (Repeated), Section 48. After the test:

a) A line voltage device shall comply with 48.1,

b) A photoelectric sensor shall comply with the Normal Operation Tests per 37.1 or 37.2, as applicable, and

c) An edge sensor shall comply with the applicable Normal Operation Test, per 39.1.

35.4 Ultraviolet light exposure test

35.4.1 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, referenced in Annex A, Ref. No. 4.

35.5 Resistance to impact test

35.5.1 An external entrapment protection device employing a polymeric or elastomeric material as a functional part shall be subjected to the impact test specified in 35.5.2. 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, per 35.5.4, at room temperature.

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.

Exception: If a part is cracked or broken, as an alternative, it may be subjected to the Water Exposure Tests, Section 35.3 after the impact test. After the water exposure tests, the device shall either:

a) Operate as intended per 35.5.4; or

b) Shut down safely (i.e. provide an obstruction signal to the door/gate operator).

35.5.2 Samples of the external entrapment protection device are to be subjected to the Resistance to Impact Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, referenced in Annex A, Ref. No. 4. The external entrapment protection device is to be subjected to 6.8 J (5 ft-lbf) impacts. Three samples are to be tested, each sample being subjected to three impacts at different points.

35.5.3 In lieu of conducting the room temperature test described in 35.5.2, each of three 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 ±2.0°C (minus 31.0 ±3.6°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°C (32.0°F) and maintained at this temperature for 3 h. While the sample is still cold, the samples shall be subject to the test described in 35.5.2, and shall comply with 35.5.1(a). After determining compliance with 35.5.1(a), the sample shall be allowed to return to room temperature, and then shall comply with 35.5.1(b).

35.5.4 To determine compliance with 35.5.1(b):

a) A photoelectric sensor shall comply with the Normal Operation tests per 37.1 or 37.2, as applicable, and

b) An edge sensor shall comply with the applicable Normal Operation test, per 39.1.

36 External Entrapment Protection Devices with Wireless Control

36.1 Initial test set-up

36.1.1 For a wireless device intended to be powered by a non-rechargeable battery, a fully charged battery shall be installed per the instructions or markings on the product. See 60.1.11.

36.1.2 An entrapment protection device or system employing a wireless control, or separately supplied for, shall be installed per the manufacturer's instructions.

36.2 Radiated immunity test

36.2.1 An external entrapment protection device when employing wireless control shall operate as specified in 31.2, 32.1.7, 32.1.17, or, 33.3.1 – 33.3.5 as applicable; or is rendered inoperative (any case in

which the operator will not complete a full cycle, open and close, of travel) when tested in accordance with 36.2.2.

36.2.2 Compliance to 36.2.1 is verified by simulating an obstruction during the period of the electric field strength test of 26.7.

36.3 Battery test for wireless devices

36.3.1 An external entrapment protection device when employing a battery powered wireless control shall operate as specified in 31.2, 32.1.7, 32.1.17, or, 33.3.1 – 33.3.5 as applicable; or is rendered inoperative (any case in which the operator will not complete a full cycle, open and close, of travel) when tested in accordance with 36.3.2.

36.3.2 Compliance with 36.3.1 shall be verified with battery charge at the following levels:

a) Fully charged, and

b) Discharged per the manufacturer's recommendations to the wireless device's lowest operational voltage.

36.3.3 An external entrapment protection device employing a battery powered wireless device operating under conditions with a fully discharged battery or when the battery is discharged sufficiently to cause the device or system to render the moving door or gate inoperative, shall be considered a single point fault for complying with 26.9, 26.10, 31.2.2, 32.1.8, and 33.3.3.

36.4 Ambient light test for wireless device with IR communication

36.4.1 An external entrapment protection device, when employing an IR communication shall operate as specified in 31.2, 32.1.7, 32.1.17, or, 33.3.1 – 33.3.5 as applicable; or is rendered inoperative (any case in which the operator will not complete a full cycle, open and close, of travel) when subjected to ambient light impinging at an angle of 15 to 20 degrees from the axis of the beam when tested in accordance with 36.4.2.

36.4.2 An external entrapment protection device when employing an IR communication shall be set up at maximum range per 36.1. The ambient light test described in 37.4.2 shall be conducted with the light source impinging on each IR receiver, one at a time that is part of the wireless control system between the external entrapment protection device and the operator.

37 Photoelectric Sensors

37.1 Normal operation test (doors, vertical lift gates, and vertical pivot gates)

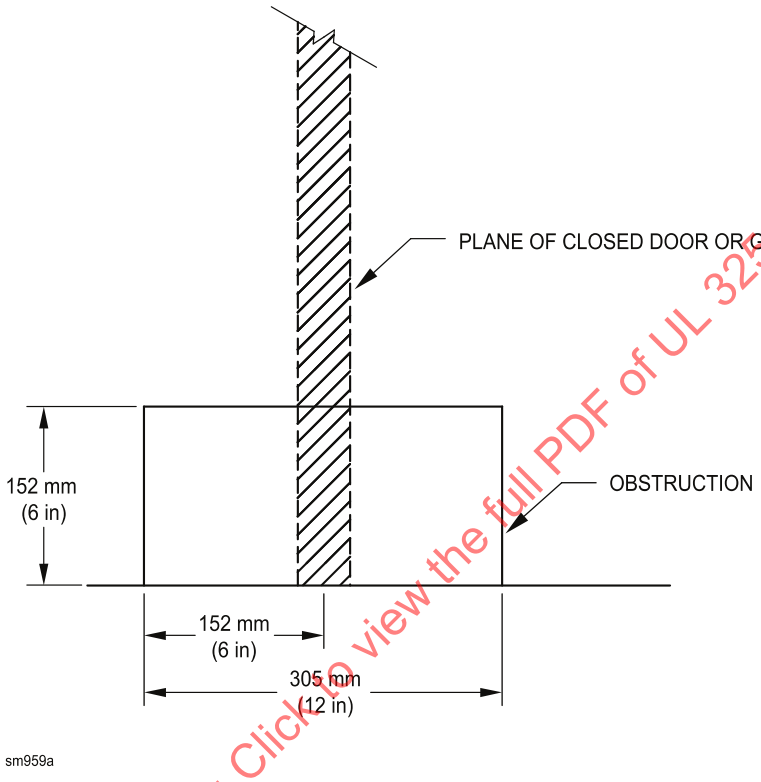
37.1.1 When installed as described in 35.1.1 – 35.1.4, a photoelectric sensor of a vertically moving door or gate shall sense an obstruction as described in 37.1.3 that is to be placed on a level surface below the door or gate. The sensor is to be tested with the obstruction at a total of five different locations over the width of the door or gate opening. The locations shall include distances 25.4 mm (1 in) from each end, 305 mm (1 ft) from each end, and the midpoint.

37.1.2 When installed as described in 35.1.1 – 35.1.4, a photoelectric sensor of a horizontally moving residential garage door shall be tested per 37.1.3 that is to be placed on a level surface within the path of the moving door. The sensor is to be tested with the obstruction at a total of five different locations over the height of the door or gate opening. The locations shall include distances 25.4 mm (1 in) from each end, 305 mm (1 ft) from each end, and the midpoint.

37.1.3 The obstruction noted in 37.1.1 and 37.1.2, shall consist of a white vertical surface, 152-mm (6-in) high by 305-mm (12-in) long. The obstruction is to be centered in the opening perpendicular to the plane of the door or gate when in the closed position. See Figure 37.1.

Figure 37.1

Stationary obstruction



37.2 Normal operation test (all other gates)

37.2.1 When installed as described in 35.1.1 – 35.1.4, a photoelectric sensor shall sense an obstruction as described in 37.2.2 that is placed on a level surface in the path of the leading edge of the gate. Except for a bifold gate operator or system, 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 25.4 mm (1 in) from each end, 305 mm (1 ft) from each end, and the midpoint. The 305 mm (1 ft) side of the obstruction is to be centered across the gate opening perpendicular to a straight line across the opening. See 37.2.3 for a bifold gate operator or system.

37.2.2 The obstruction used for the test is to consist of a white vertical surface, 698-mm (27-1/2-in) high by 305-mm (12-in) wide. The obstruction is to be placed on the ground in accordance with 37.2.1.

Exception: For a gate that is wider than 50.8 mm (2 in), the obstruction shall extend 152 mm (6 in) from the outer faces of the gate.

37.2.3 For a photoelectric sensor intended for use on a bifold gate operator or system, the obstruction shall be placed in accordance with a through d below, as applicable, for the entrapment zones intended to be protected by the sensor(s):

a) When installed as described in 35.1.1 – 35.1.4, a photoelectric sensor shall sense an obstruction as described in 37.2.2 that is placed on a level surface in the path of the leading edge of the gate in

the closing direction (see Figure 4.3, edge 6). 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 25.4 mm (1 in) from each end, 305 mm (1 ft) from each end, and the midpoint. The 305 mm (1 ft) side of the obstruction is to be centered across the gate opening perpendicular to a straight line across the opening.

b) In at least one location along the path travelled by the opening side of the Outer column panel, outside horizontal bottom edge. See Figure 4.3, edge 4. The 305 mm (1 ft) side of the obstruction is to be positioned on a surface perpendicular to gate edge 4, located in the midpoint of Figure 4.1 panel 2 between the post Figure 4.1 item 1 and the hinge edge Figure 4.2 item 9.

c) In at least one location along the path of the opening gate, 2 ft into the “V” area formed by the gate panels (see Figure 4.3, edges 2, 3) measured from the closed gate line. The obstruction is to be oriented so the 305 mm (1 ft) side of the obstruction is parallel to the closed gate line, but 2 ft into the “V” area. The obstruction shall be placed in that location after the gate has been intentionally stopped with a control mid-travel, and then the gate shall be restarted via control in the opening direction.

d) If a photo eye is intended to protect any other entrapment zone(s), the obstruction shall be placed in at least one location for each entrapment zone it is intended to protect.

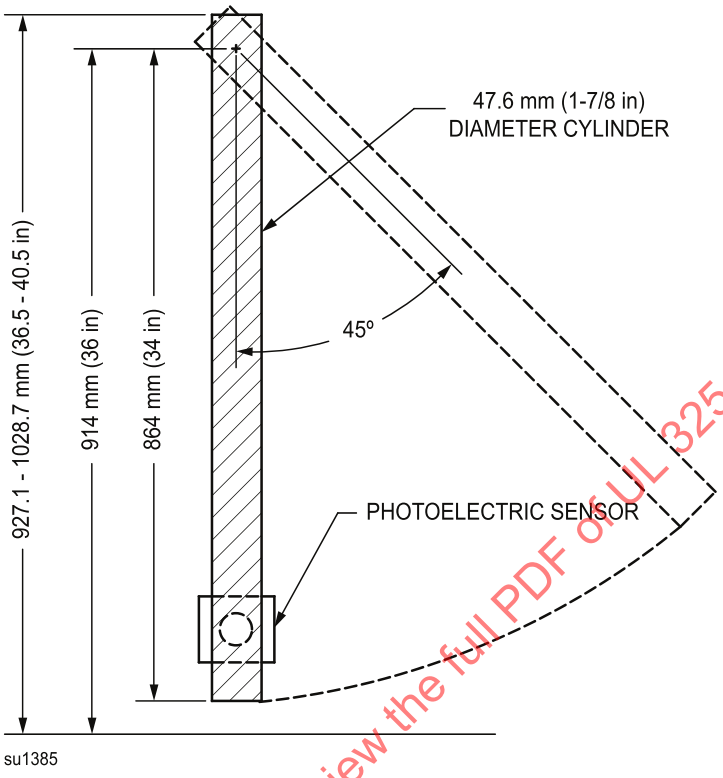
37.3 Sensitivity test

37.3.1 When installed as described in 35.1.1 – 35.1.4, a photoelectric sensor shall sense the presence of a moving object when tested according to 37.3.2.

37.3.2 The moving object is to consist of a 47.6 mm (1-7/8 in) diameter cylindrical rod, 876-mm (34-1/2-in) long, with the axis point being 864 mm (34 in) from the end. The axis point is to be fixed at a point centered directly above the beam of the photoelectric sensor 914 mm (36 in) above the level surface below the door or gate. 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 37.2.

Figure 37.2

Moving obstruction



37.3.3 The test described in 37.3.2 is to be conducted at three points over the width of the door or gate opening, at distances of 305 mm (1 ft) from each end and the midpoint.

37.3.4 When the test fixture in Figure 37.2, prior to conduct of the test, interferes with the photoelectric sensor detection zone, the tests per 37.3.1 – 37.3.3 may be conducted instead per 38.4.

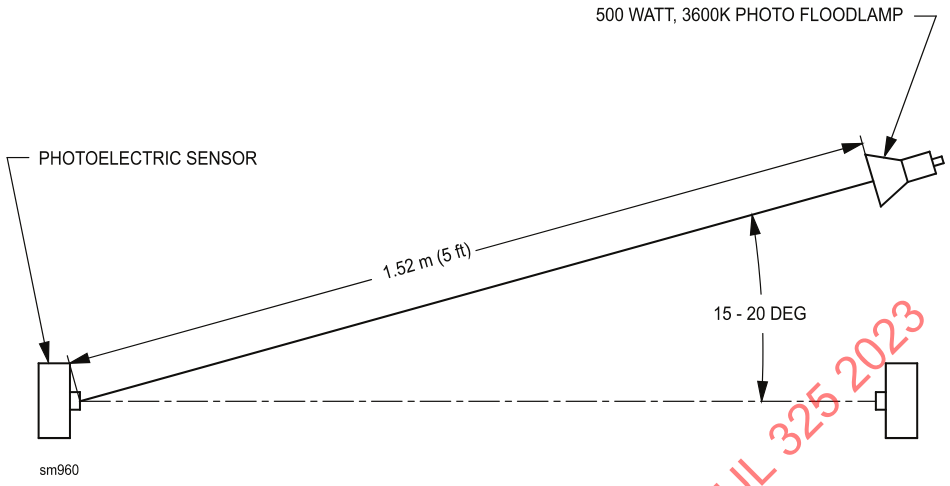
37.4 Ambient light test

37.4.1 A photoelectric sensor shall operate as specified in 33.3.1 and 33.3.3 when subjected to ambient light impinging at an angle of 15 to 20 degrees from the axis of the beam when tested according to 37.4.2 and, if appropriate, 37.4.3.

37.4.2 To determine compliance with 37.4.1, a 500 W incandescent or equivalent minimum rated, 3600 K or lower color rated photo floodlamp is to be energized from a 120-V, 60-Hz source. The lamp is to be positioned 1.52 m (5 ft) 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 37.3.

Figure 37.3

Ambient light test



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

37.4.4 During the conditions in 37.4.2 and 37.4.3:

a) A photoelectric sensor shall comply with the Normal Operation Tests per 37.1 or 37.2, as applicable, and

b) A photoelectric sensor shall comply with the Sensitivity Test per 37.3, and

c) An edge sensor shall comply with the Normal Operation Test, per 39.1.

38 Photoelectric Sensor Vertical Arrays

38.1 A vertical array shall be tested as required by Photoelectric Sensors, Section 37, except as noted in 38.2 – 38.5.

38.2 The array shall comply with the Normal Operation tests in 37.1 and 37.2, with the solid obstruction placed on the floor per 37.1 or the ground per 37.2. In addition, the obstruction shall be placed at various locations over the height of the light curtain array in accordance with the light curtain coverage area per the manufacturer's instructions.

38.3 In conducting the tests in 37.1 and 37.2, when the product includes a blanking function whereby the light array is located directly in-line with the path of the door travel, and the door system is intended to detect any obstruction other than one in the "next" successive position that the door is programmed to travel, the obstruction is placed at any location other than the next successive door position expected by the system.

38.4 The array shall comply with the Sensitivity Test, 37.3, except that the edge of the pendulum nearest to the array is to be located 50.8 mm (2 in) from one side of the plane of the array, rather than directly above one photoelectric sensor pair. For vertical arrays, this test need only be conducted with the test pendulum at the vertical height indicated in 37.3.2.

38.5 When conducting the Ambient Light Test, 37.4, the position of the light source shall be aligned per 37.4.2 based on the axis of the lowest beam or detection zone. This arrangement shall be used to

determine compliance with 38.4, and with 38.2 with the obstruction at the floor/ground level, which are the only conditions for which the ambient light is required to be applied.

39 Edge Sensors

39.1 Normal operation test

39.1.1 Edge sensor

39.1.1.1 An edge sensor, when installed on a representative door or gate, shall actuate upon the application of a 66.7 N (15 lbf) or less force in the direction of the application when tested at room temperature 25°C ±2°C (77°F ±3.6°F). Additionally, when intended for use when exposed to outdoor temperature, shall actuate at 177.9 N (40 lbf) or less force when tested at -35°C ±2°C (-31°F ±3.6°F).

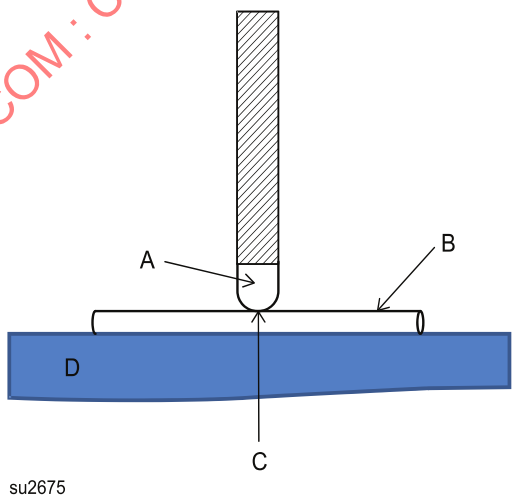
a) For an edge sensor intended to be used on a sectional door, slide gate, or bifold gate, the force is to be applied by the longitudinal edge of a 1-7/8 in (47.6 mm) diameter cylinder placed across the sensor so that the axis is perpendicular to the plane of the door or gate. See Figure 39.1 and Figure 39.2.

b) For an edge sensor intended to be used on a one piece door, swinging door, or swinging or bifold gate, 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 or gate. See Figure 39.3 and Figure 39.4.

c) For an edge sensor that wraps around the leading edge of a swinging one-piece door or a swinging or bifold gate, providing activation in both directions of travel, the force is to be applied so that the axis is at an angle 30 degrees from the direction perpendicular to both the closing direction and the opening direction. See Figure 39.5.

Figure 39.1

Side View – Sectional Door or Vertical Lift/Pivot Gate



A – Edge Sensor

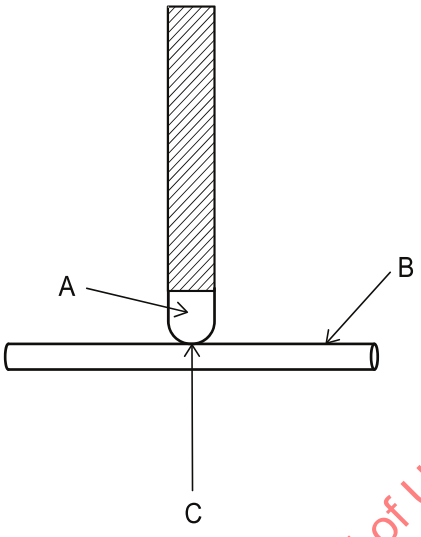
B – 47.625 mm (1-7/8 in) Diameter Cylinder

C – 66.7 N (15 lbf)

D – Ground/Floor

Figure 39.2

Top View – Horizontally Moving Door or Slide Gate



su2676

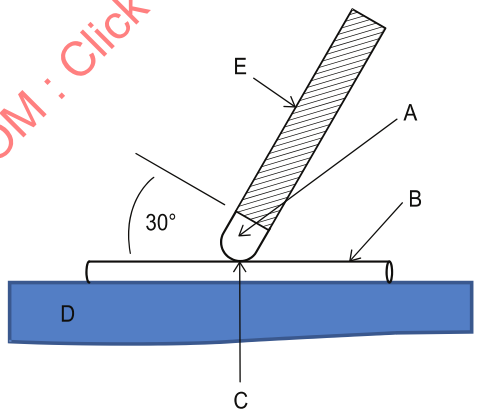
A – Edge Sensor

B – 47.625 mm (1-7/8 in) Diameter Cylinder

C – 66.7 N (15 lbf)

Figure 39.3

Side View – One-Piece Door



su2677

A – Edge Sensor

B – 47.625 mm (1-7/8 in) Diameter Cylinder

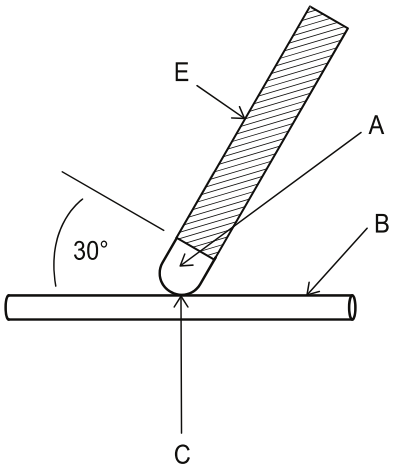
C – 66.7 N (15 lbf)

D – Ground/Floor

E – Outside Surface

Figure 39.4

Top View – Horizontal Swing Gate or Swing Door



su2678

A – Edge Sensor

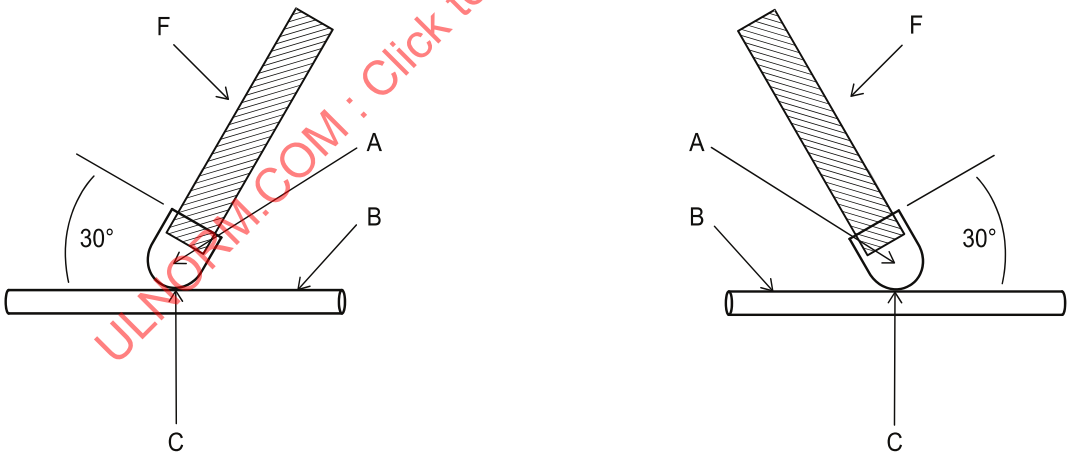
B – 47.625 mm (1-7/8 in) Diameter Cylinder

C – 66.7 N (15 lbf)

E – Outside Surface

Figure 39.5

Top View – Horizontal Swing Gate or Door – Wraparound Edge



su2679

A – Edge Sensor

B – 47.625 mm (1-7/8 in) Diameter Cylinder

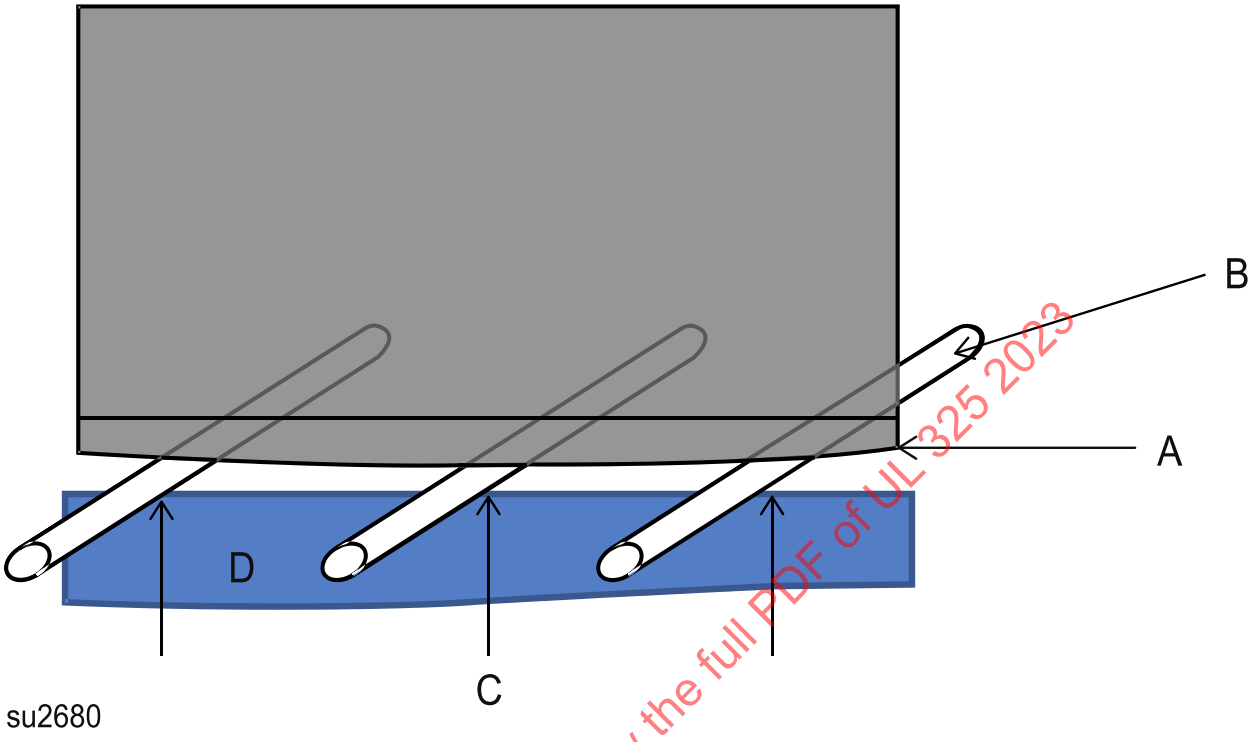
C – 66.7 N (15 lbf)

F – Direction of Travel

39.1.1.2 With respect to the test of 39.1.1.1, the test is to be repeated at various representative points of the edge sensor across the length of the edge sensor. See Figure 39.6 and/or Figure 39.7, as applicable.

Figure 39.6

Front View – Sectional or One-Piece Door or Vertical Lift/Pivot Gate



A – Edge Sensor

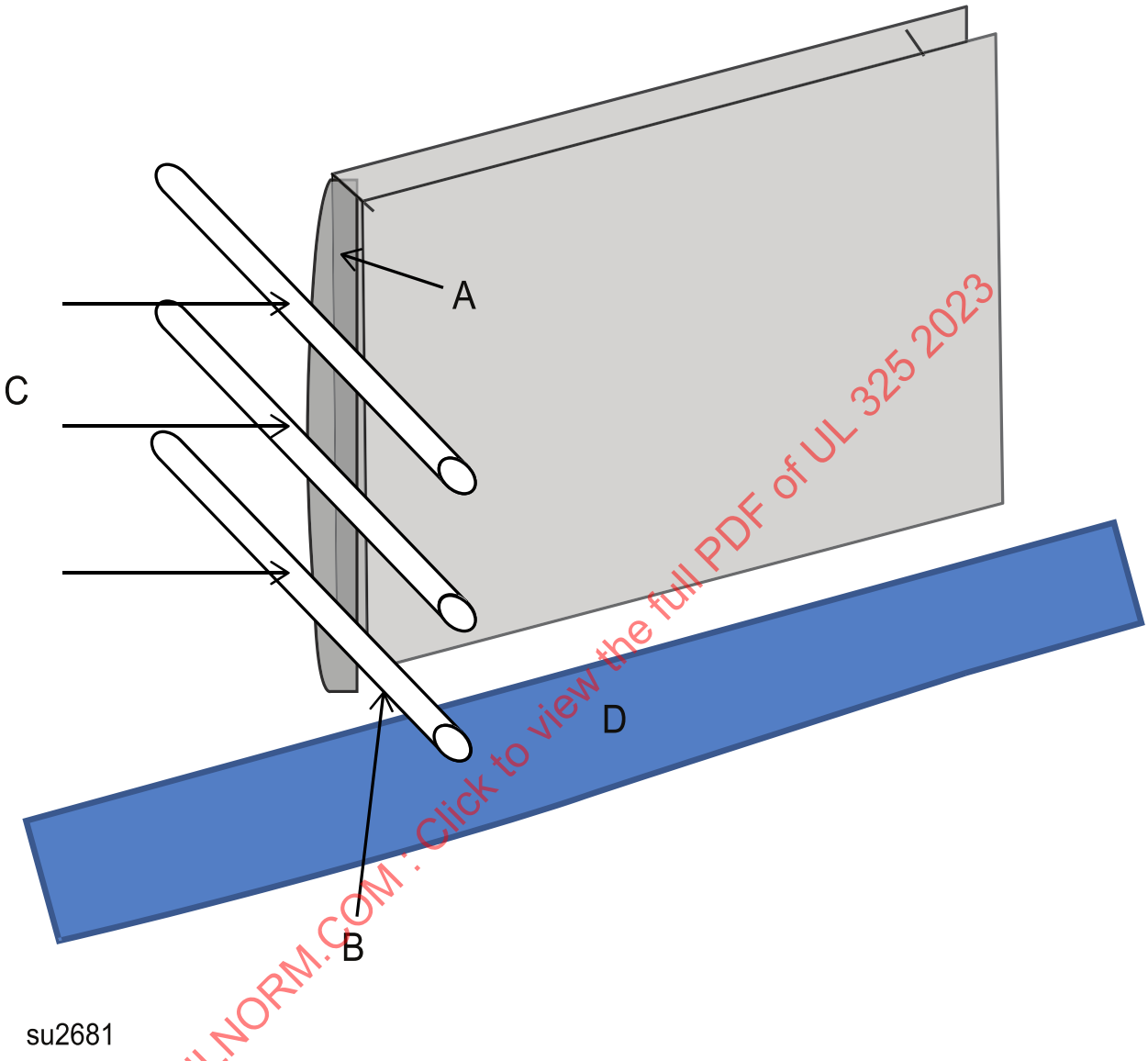
B – 47.625 mm (1-7/8 in) Diameter Cylinder – At various heights, perpendicular or at 30 degree angle, depending on door/gate type.

C – 66.7 N (15 lbf)

D – Ground/Floor

Figure 39.7

Side View – Horizontally Moving Door or Slide Gate or Swinging Door/Gate or Bifold Gate



A – Edge Sensor

B – 47.625 mm (1-7/8 in) Diameter Cylinder – At various heights, perpendicular or at 30 degree angle, depending on door/gate type.

C – 66.7 N (15 lbf)

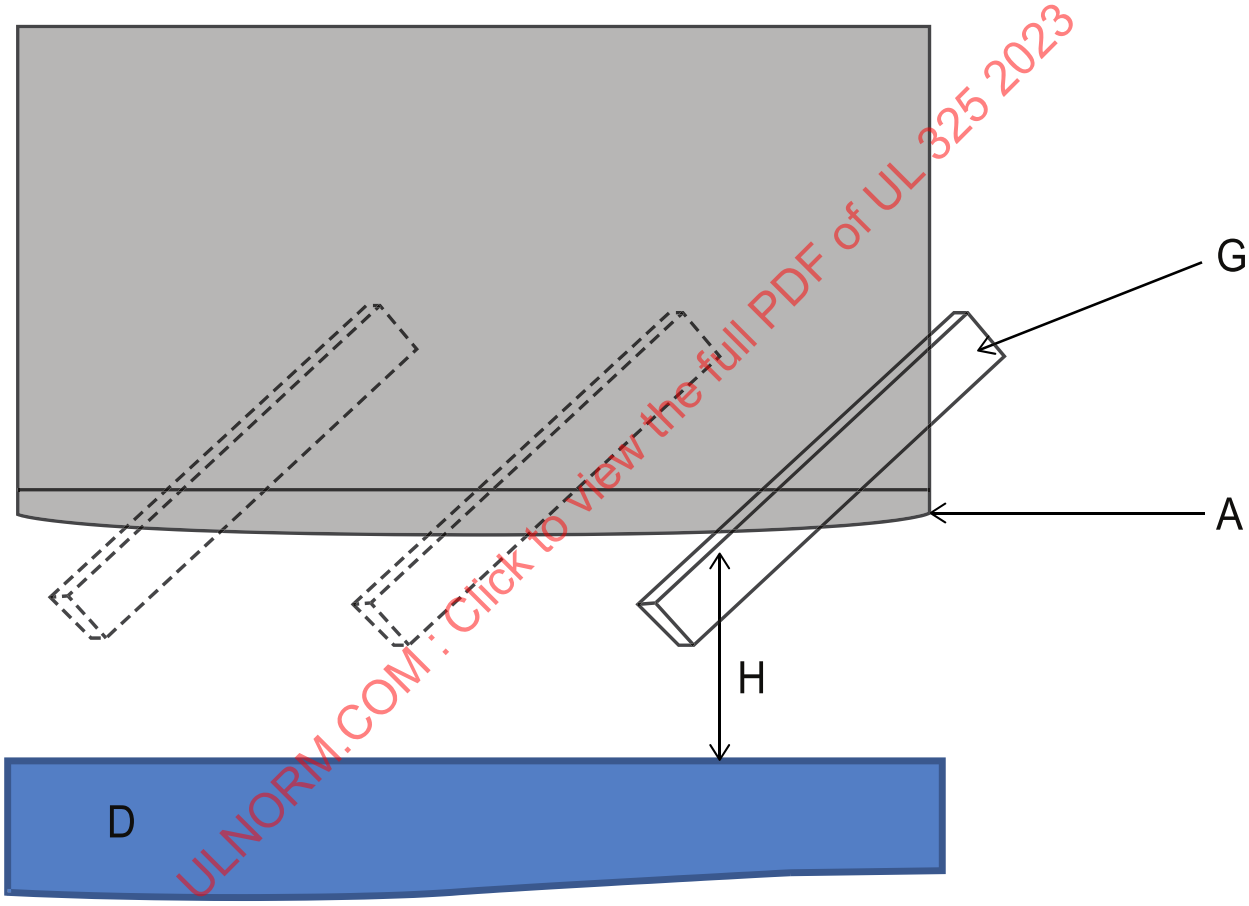
D – Ground/Floor

39.1.2 Commercial/Industrial door operators

39.1.2.1 For commercial/industrial door operators intended to be used with a contact type sensor, with reference to 31.2.1, a 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid rectangular object not less than 152-mm (6-in) long is to be fixed in an immobile position with the longitudinal axis perpendicular to the edge of the door at a distance of 152.4 mm (6 in) from the fully closed position. The 41.3-mm (1-5/8-in) side of the obstruction facing the leading edge is to contact the moving door at various points along the width of the door. See Figure 39.8.

Figure 39.8

Front View – Commercial/Industrial Door Operator



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A – Edge Sensor

D – Ground/Floor

G – 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid object, min. 152.4 mm (6 in) long, placed at various locations along edge of door

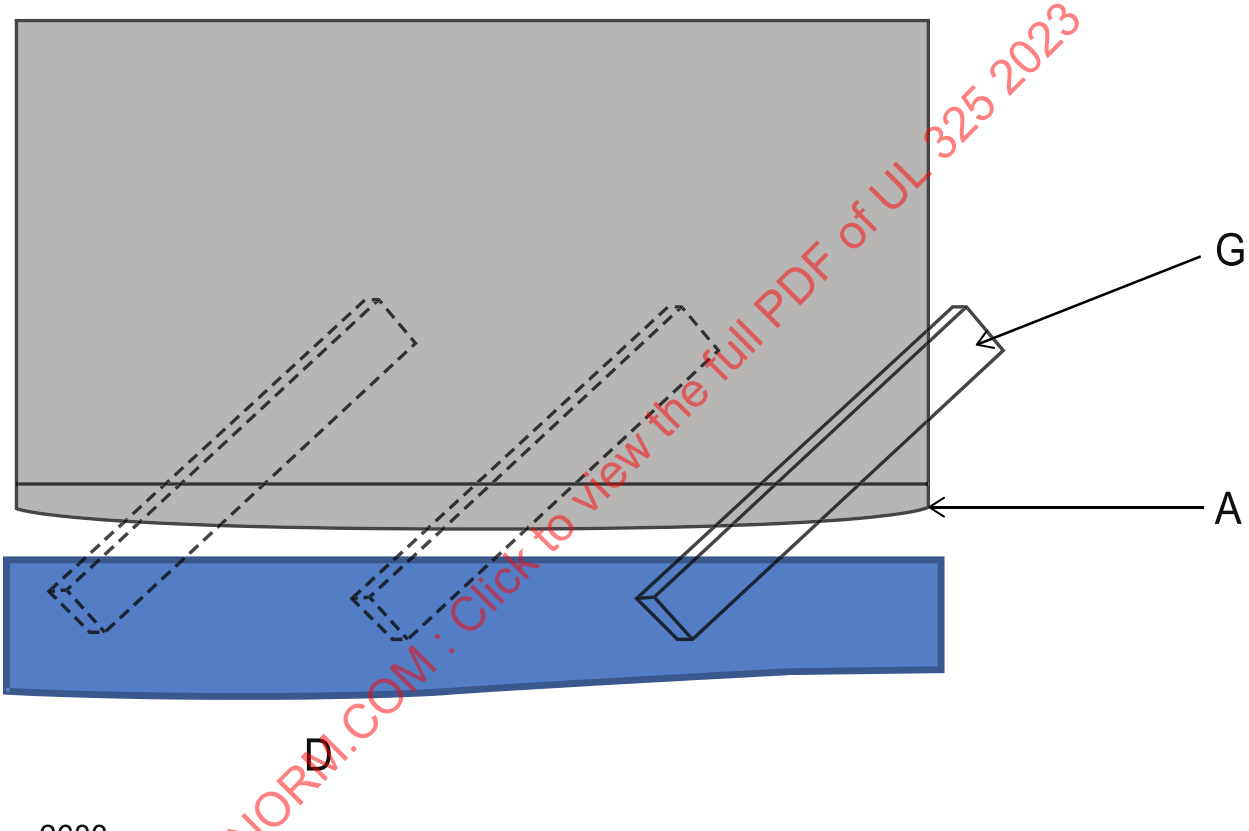
H – 152.4 mm (6 in) from floor to centerline of object

39.1.3 Vehicular gate operators

39.1.3.1 Vehicular gate operators intended to be used with a Type B2 device, with reference to 32.1.17(a), shall be tested per 32.2.2, 32.2.3, 32.2.4, or 32.2.5 as applicable. Also see Figure 39.9 for a vertical pivot, vertical lift gate, or barrier arm; Figure 39.10 for a horizontal slide gate; or Figure 39.11 for a swing gate. For a horizontal bifold gate operator system, the system shall be tested as per Figure 39.10 in the last 406 mm (16 in) of travel in the closing direction and Figure 39.11 elsewhere.

Figure 39.9

Front View – Vertically Moving Residential Garage Door, or Vertical Pivot or Vertical Lift Gate or Barrier Arm



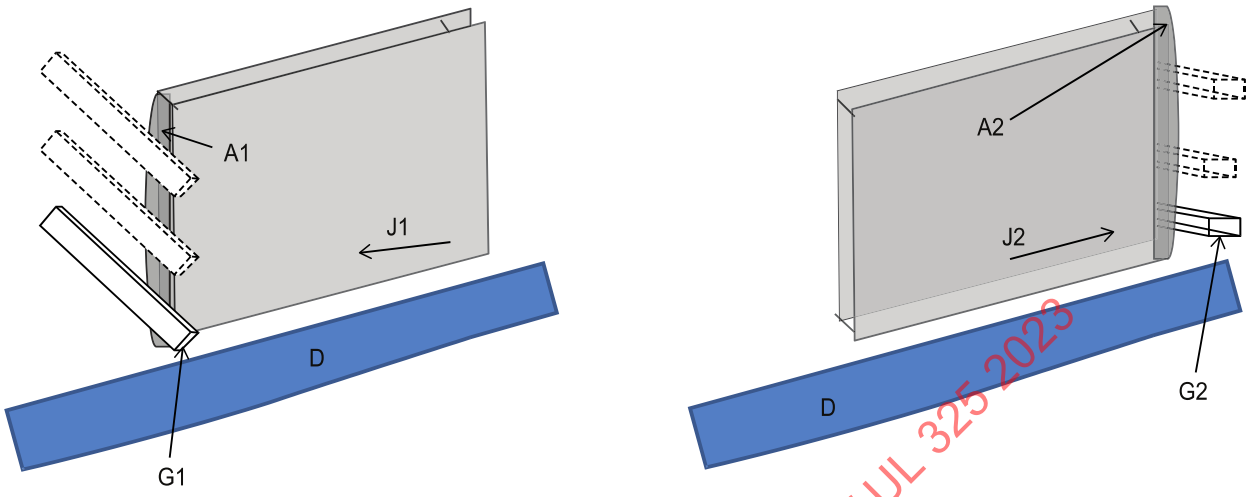
A – Edge Sensor

D – Ground/Floor

G – 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid object, min. 152.4 mm (6 in) long, placed at various locations along edge of door/gate

Figure 39.10

Side View – Slide Gate, Horizontal Bifold Gate, or Horizontally Moving Residential Garage Door



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A1 – Edge Sensor on Leading Edge

G1 – 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid object, min. 152.4 mm (6 in) long, placed at various locations along leading edge

J1 – Movement when closing

D – Ground/Floor

A2 – Edge Sensor on Trailing Edge

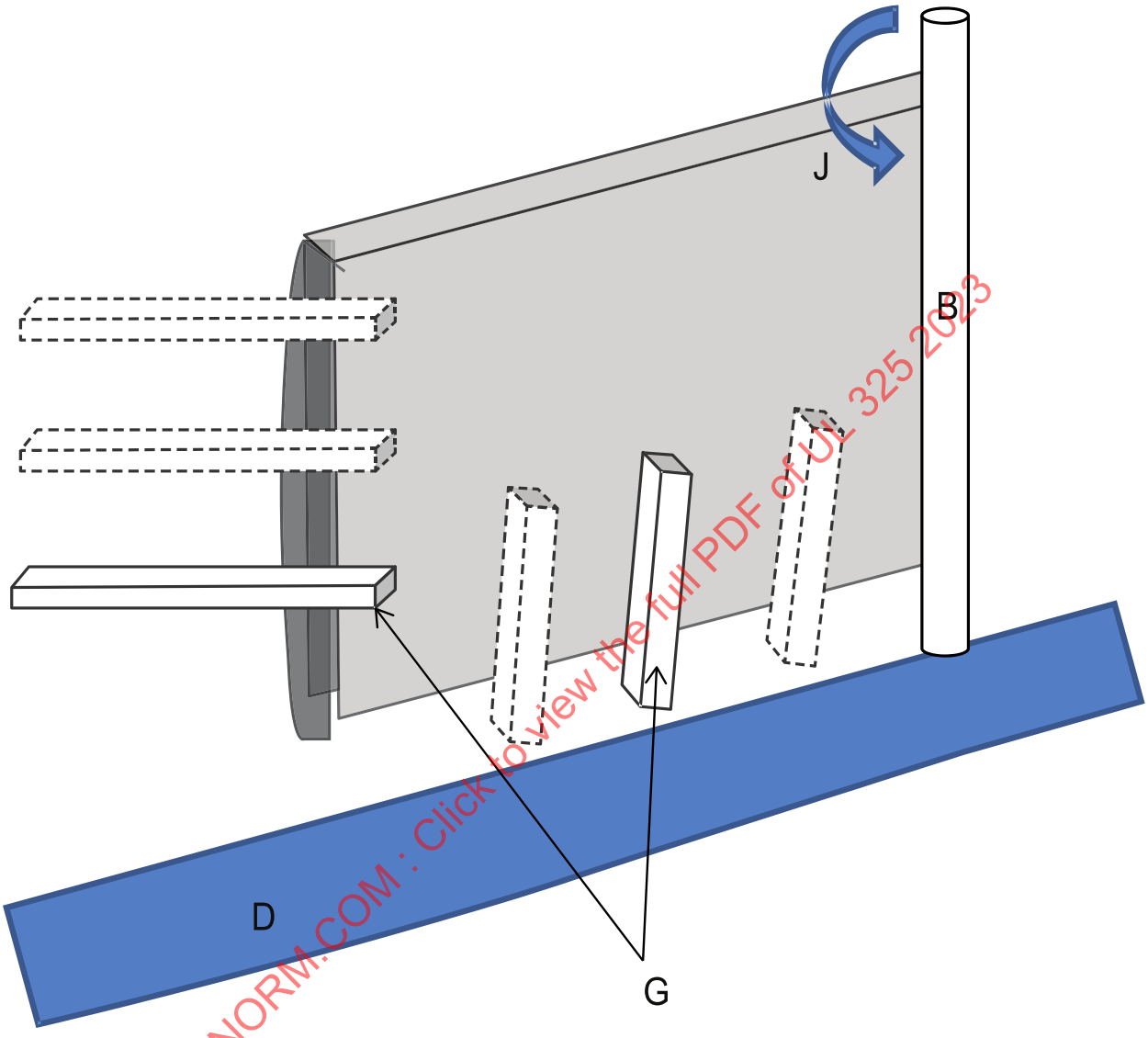
G2 – 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid object, min. 152.4 mm (6 in) long, placed at various locations along trailing edge

J2 – Movement when opening

D – Ground/Floor

Figure 39.11

Swing Gate or Horizontal Bifold Gate



su2685

B – Post

D – Ground/Floor

G – 41.3-mm by 88.9-mm (1-5/8-in by 3-1/2-in) solid object, min. 152.4 mm (6 in) long, placed at various locations along leading edge at a 30 degree angle and/or bottom edge

J – Movement when closing

39.1.4 Residential garage door operators

39.1.4.1 For vertically moving residential garage door operators intended to be used with an external edge sensor, with reference to 33.3.1(b), a 41.3 mm by 88.9 mm (1-5/8 in by 3-1/2 in) solid rectangular object not less than 152 mm (6 in) long is to be fixed in an immobile position at the fully closed position with the longitudinal axis perpendicular to the edge of the door. The 41.3 mm (1-5/8 in) side of the obstruction facing the leading edge is to contact the moving door at various points along the width of the door. See Figure 39.9.

39.1.4.2 For horizontally moving residential garage door operators intended to be used with an external edge sensor, with reference to 33.3.2(b), a 41.3 mm by 88.9 mm (1-5/8 in by 3-1/2 in) solid rectangular object not less than 152 mm (6 in) long is to be fixed in an immobile position with the longitudinal axis perpendicular to the edge of the door. The 41.3 mm (1-5/8 in) side of the obstruction facing the leading edge is to contact the moving door at various points along the leading edge of the door. The same object is then to be arranged to contact the moving door at various points along the trailing edge of the door. See Figure 39.10.

39.2 Endurance test

39.2.1 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 as described in 39.1.1.1, except with a force of a 66.7 N (15 lbf) or greater, and at room temperature only. The force is to be applied to the same location for the entire test. All intended uses are to be tested. 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. After the 30,000 cycle test the normal operation test shall be repeated.

39.3 Elastomeric material conditioning test

39.3.1 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 51, and

Exception: Compliance to the Standard for Gaskets and Seals, referenced in Annex A, Ref. No. 29, fulfills this requirement.

b) Puncture Resistance Test, Section 55.

39.3.2 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 51.1 after being conditioned in accordance with the Ultraviolet Light Exposure Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, referenced in Annex A, Ref. No. 4.

40 Audio Alarms

40.1 Elastomeric material conditioning test

40.1.1 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 51.

Exception: Compliance to the Standard for Gaskets and Seals, referenced in Annex A, Ref. No. 29, fulfills this requirement.

40.1.2 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 51.1 after being conditioned in accordance with the Ultraviolet Light Exposure Test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, referenced in Annex A, Ref. No. 4.

40.2 Activation test

40.2.1 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 32.1.2, the gate operator shall be obstructed twice without being reset between obstructions. The first obstruction shall be as specified as in 32.2.2 – 32.2.4. 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 32.1.4.

41 Trial Installation

41.1 To determine whether the installation instructions in the instruction manual comply with the requirements in 60.1.3 – 60.1.5, 60.3.1, and 60.3.2, a trial installation is to be made using the instruction manual.

41A Lasers (In U.S.)

41A.1 A product employing a laser shall comply with the Code of Federal Regulations (CFR), Title 21, Part 1040.

41A.2 With reference to 41A.1, compliance of laser products with the Code of Federal Regulations (CFR), Title 21, Part 1040, shall be determined by:

a) Determining the Class of the laser product and the Class of the radiation emitted by the laser product (as defined in the CFR) from the manufacturer's Center for Devices and Radiological Health (CDRH) product report;

b) Verifying that the manufacturer's markings and labels having the information specified in the CFR are affixed on the laser product (as defined in the CFR);

c) Determining that the corresponding construction features, such as protective housing, interlocks, and similar features, are provided in accordance with the CFR;

d) Determining that the resulting construction complies with the construction requirements of this standard; and

e) Verifying that the manufacturer's safety instructions required by the CFR are provided with the laser product (as defined in the CFR).

41B Lasers (In Canada)

41B.1 A product employing a laser shall comply with the Consolidated Regulations of Canada (C.R.C), c. 1370 Radiation Emitting Devices Regulations.

41B.2 With reference to 41B.1, compliance of laser products with the Consolidated Regulations of Canada (C.R.C), c. 1370 Radiation Emitting Devices Regulations, shall be determined by:

a) Determining the Class of the laser product and the Class of the radiation emitted by the laser product (as defined in the C.R.C.) from the manufacturer's Health Canada product report;

b) Verifying that the manufacturer's markings and labels having the information specified in the C.R.C. are affixed on the laser product (as defined in the C.R.C.);

c) Determining that the corresponding construction features, such as protective housing, interlocks, and similar features, are provided in accordance with the C.R.C.;

d) Determining that the resulting construction complies with the construction requirements of this standard; and

e) Verifying that the manufacturer's safety instructions required by the C.R.C. are provided with the laser product (as defined in the C.R.C.).

PERFORMANCE

42 Leakage Current Test

42.1 General

42.1.1 The leakage current of a cord-connected appliance rated for a nominal 250-V or less supply when tested in accordance with 42.1.3 – 42.2.2 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.

Exception: A product that complies with the leakage current requirements in UL 101 is considered to comply with these requirements.

42.1.2 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.

42.1.3 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 10.1, 10.2 and 10.7. 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.

42.1.4 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 (4 by 8 in) in contact with the surface. If the surface is less than 10 by 20 cm (4 by 8 in), 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.

42.1.5 The measurement circuit for leakage current is to be as illustrated in Figure 42.1. 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 μF.

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-μF 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.

42.1.6 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.

42.2 Tests

42.2.1 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 42.1 – is to be as follows:

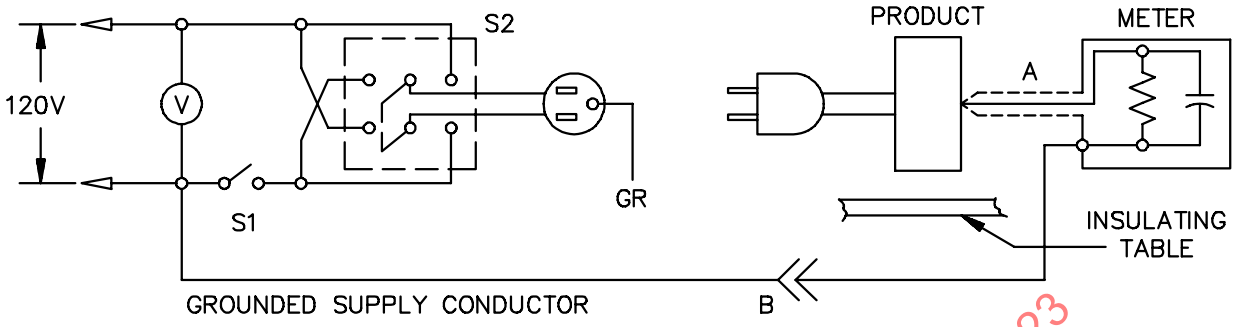
a) With switch S1 open, the appliance is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, and with the appliance switching devices in all their normal operating positions.

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.

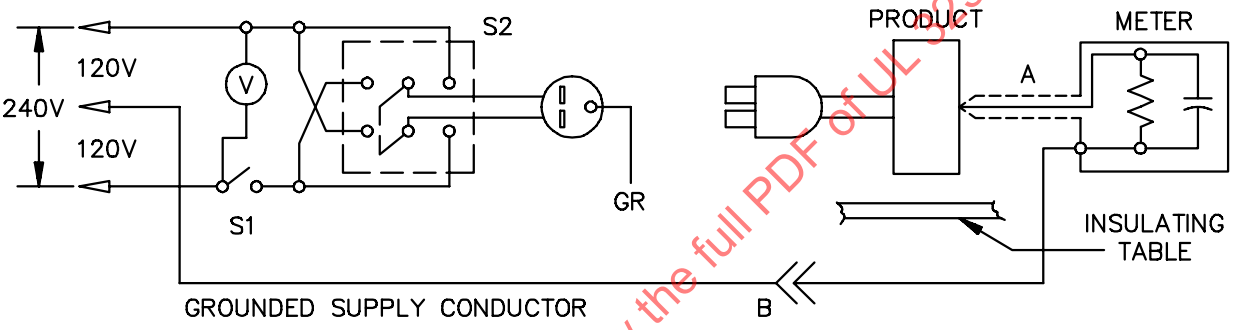
c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is considered to be obtained by operation as in the normal temperature test.

Figure 42.1

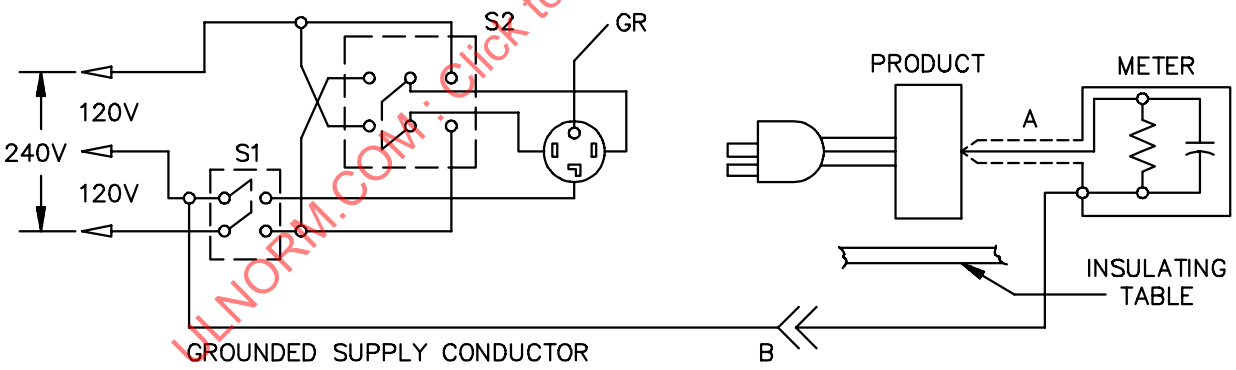
Leakage-current measurement circuit



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.

42.2.2 Normally a sample will be carried through the complete leakage current test, as specified in 42.2.1, 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.

43 Leakage Current and Insulation Resistance Test Following Humidity Conditioning

43.1 An appliance shall comply with the requirements for leakage current in Section 42 following exposure for 48 h to air having a relative humidity of 88 ±2 percent and at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F).

43.2 To determine whether an appliance complies with the requirement in 43.1, a sample of the appliance at an initial temperature just above 34.0°C (93.2°F) is to be conditioned for 48 h in a humidity chamber maintained as specified in 43.1. Following the conditioning:

a) An appliance as mentioned in 42.1.1 is to be tested unenergized as described in 42.2.1(a). The sample is then to be energized and tested as described in 42.2.1 (b) and (c). The test is to be discontinued when the leakage current stabilizes or decreases. If UL 101 is used to assess the leakage current, the measurement conditions in UL 101 shall be followed instead of as described in 43.2(a).

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.

44 Starting Current Test

44.1 An appliance other than as described in 44.2 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.

44.2 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.

44.3 To determine whether an appliance complies with the requirement in 44.1, 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.

45 Input Current Test

45.1 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 46.2.1 – 46.11.1, and when connected to a supply circuit of maximum rated voltage and rated frequency.

45.2 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.

46 Normal Temperature Test

46.1 General

46.1.1 An appliance when tested under the conditions of maximum normal load as described in 46.2.1 – 46.11.1 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 46.1.

Table 46.1
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 178 mm (7 in), of a d-c motor, and of a universal motor[a,b]:			
	A.	In an open motor[c]		
		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 178 mm (7 in) or less excluding a universal motor and on vibrator coils[a,b]:			
	A.	In an open motor and on vibrator coils[c]		
		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[a]			
	A.	Transformers		
		Thermocouple method	85	(153)
		Resistance method	95	(171)
	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[d]		125	(225)
11.	Rubber- or thermoplastic-insulated wire and cord[d,e]		35	(63)
12.	Capacitor			

Table 46.1 Continued on Next Page

Table 46.1 Continued

Material and component parts	Degrees C	Degrees (F)
Electrolytic[f]	40	(72)
Other types[g]	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[a,c]		
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 178 mm (7 in) or more, excluding a universal motor[a,b]		
A. In an open motor[c]		
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 178 mm (7 in) or less, excluding a universal motor[a,b]		
A. In an open motor		
Thermocouple or resistance method[c]	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[c]	120	(216)
B. In a totally enclosed motor	125	(225)

[a] See 46.1.2.

[b] See note a in Table 24.2.

[c] 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:

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)

[d] 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.

Table 46.1 Continued on Next Page

Table 46.1 Continued

Material and component parts	Degrees	
	C	(F)
[e] 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 46.1.4.		
[f] 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).		
[g] 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.		

46.1.2 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 more than two layers – 0.8 mm (1/32 in) 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 178 mm (7 in) or less – items 8 and 16 in Table 46.1 – the thermocouple is to be mounted on the integrally applied insulation on the conductor.

46.1.3 All values for temperature rises in Table 46.1 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.

46.1.4 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.

46.1.5 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.

46.1.6 Thermocouples are to consist of wires not larger than 0.21 mm^2 (24 AWG) and not smaller than 0.05 mm^2 (30 AWG). When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of 0.05 mm^2 (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 Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

46.1.7 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.

46.1.8 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.

46.2 Maximum normal load

46.2.1 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 46.3.1 – 46.11.1 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.

46.3 Residential door operators

46.3.1 The input test is to be conducted with the operator exerting a 111.21-N (25-lbf) pull or its rated pull, if provided, 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.

46.4 Light duty (commercial/industrial) door operators

46.4.1 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 46.4.2. 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 60.7.1, 63.5.3, and 63.5.4.

46.4.2 With reference to 46.4.1, 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 3.66-m (12-ft) high and shall be such that it will require the rated pull of the operator to function.

46.5 Commercial or industrial door systems or operators

46.5.1 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 3.66-m (12-ft) 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.

46.6 Vehicular barrier (arm) operators

46.6.1 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.

46.7 Drapery operators

46.7.1 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 – 7.62 m (25 ft) 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 0.45 kg/0.30 m (1 lb/ft) of width.

46.7.2 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 46.1, the termination of the test by the overload- or overcurrent-protective device meets the intent of the requirement.

46.7.3 A commercial-type operator is to be tested as described in 46.7.2. 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.

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 46.1, the termination of the test by the overload- or overcurrent-protective device meets the intent of the requirement.

46.8 Louvers

46.8.1 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.

46.9 Pedestrian doors

46.9.1 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.

46.10 Pedestrian door operators

46.10.1 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.

46.11 Vehicular gate operators (or systems)

46.11.1 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 46.11.2.

46.11.2 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.

47 Dielectric Voltage-Withstand Test

47.1 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 373 W (1/2 horsepower) 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 373 W (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 15.4.2 – 15.4.5.

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

47.2 To determine whether an appliance complies with the requirements in 47.1, 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.

48 Insulation Resistance Test and Dielectric Voltage-Withstand Test (Repeated)

48.1 After exposure to a water spray as described in 48.2, 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.

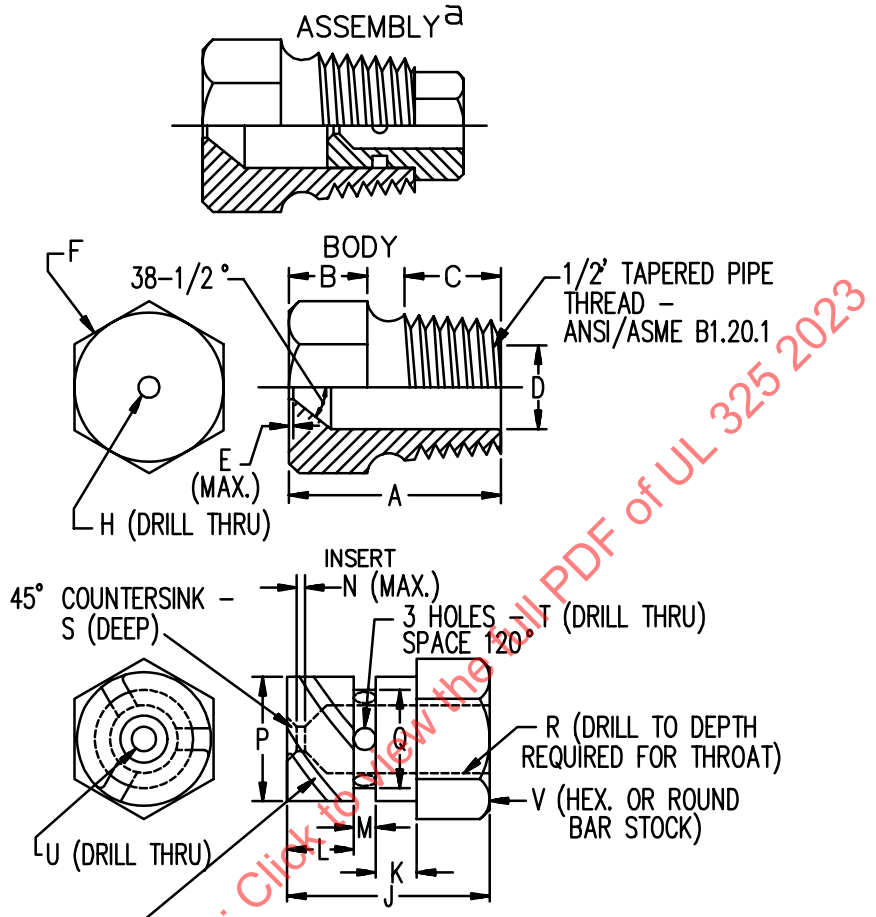
b) Shall comply with the requirement in 47.1 in a repeated dielectric voltage-withstand test, and

c) Shall have no water on uninsulated live parts.

48.2 An appliance is to be subjected to a water spray on its top and sides as described below. Covers which can be removed without use of a tool are to be removed for this test. The water spray apparatus is to consist of three spray heads constructed in accordance with the details in Figure 48.1, mounted in a water supply pipe rack as illustrated in Figure 48.2. The water pressure is to be maintained at 34 kPa (5 psig) at each spray head. The distance between the center nozzle and the unit is to be approximately 1.52 m (5 ft). 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 48.1

Spray head



Item	inch	mm	Item	inch	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)[b]	2.80
H	(No.9)[b]	5.0	U	(No. 40)[b]	2.50
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			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories

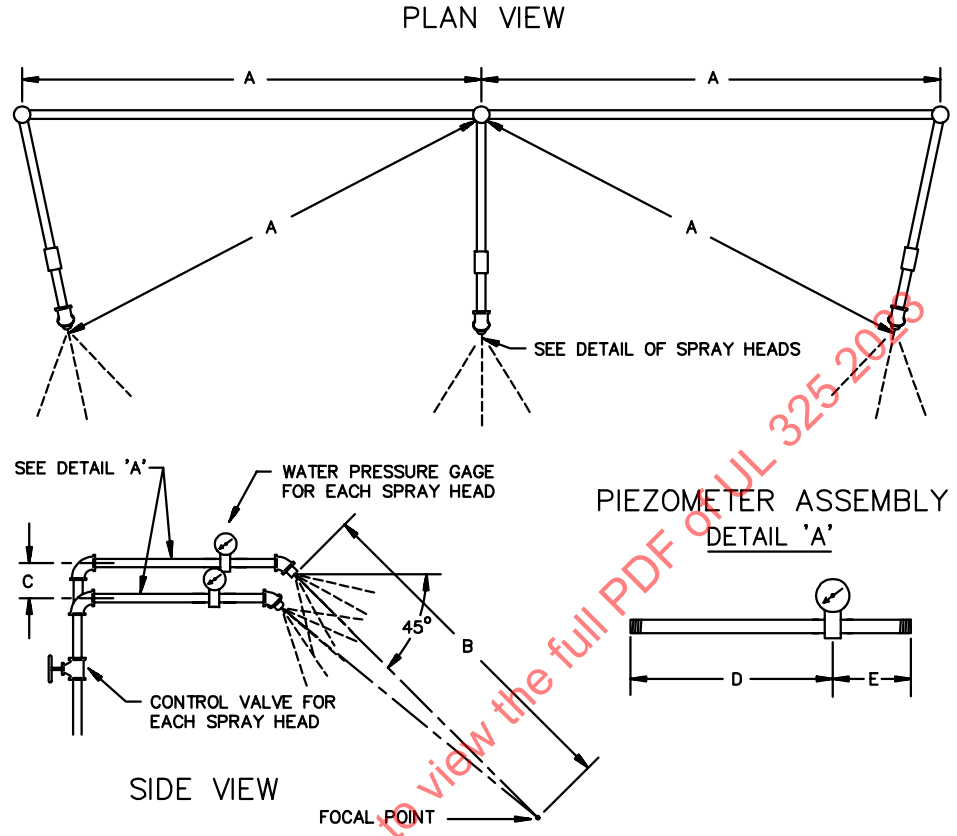
[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

RT100E

Figure 48.2

Spray head pipe rack



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

RT101E

49 Inherent Secondary Force Activated Door Sensors

49.1 General

49.1.1 A force activated door sensor of a door system installed according to the installation instructions shall actuate in accordance with 49.2 – 49.6 which are to be conducted in sequence on a single system sample, except for the separate test sequences of 49.1.2.

49.1.2 The system shall actuate with the maximum and minimum specifications of the door, operator, and hardware.

49.1.3 Tests conducted per 49.2 – 49.6 shall be performed with the force exerted by a drive adjusted to its highest value if the force can be adjusted by the user during use or user maintenance.

49.1.4 The test cylinder of 49.2.7 shall be a 47.6 mm (1-7/8 in) diameter cylinder placed under the door so that the axis is perpendicular to the plane of the door. See Figure 39.1.

49.1.5 The measuring device of 49.2.1 shall:

a) Have an accuracy of ±1%;

b) Have a rise and fall time not exceeding 5 ms;

c) Have the equivalence of a spring constant of 500 N/mm, ±50 N/mm (2855 lb/in ±285 lb/in);

d) Be placed on a rigid, level surface; and

e) Have a rigid plate with a diameter of 80 mm (3.1 in).

Exception: See 49.1.6 for test equipment alternatives for force measurements at 305 mm (1 ft) or greater for 49.2 and 49.4.

49.1.6 With regards to the Exception for 49.1.5, the test device of 49.2.5 for force measurements at 305 mm (1 ft) or greater shall be:

a) A spring constant means such as 49.1.5,

b) A gravity based weight displacing means that suspends a weight off its supporting surface upon exceeding 67 N (15 lbf) such as the example shown in Figure 49.1 – Figure 49.3 if the equipment of 49.1.5 is applied before 49.3 and after 49.4 at the 305 mm (1 ft) height of 49.2.6, or

c) The equivalent of (a) or (b).

Figure 49.1

Example test apparatus for measurements at 305 mm (12 in) or greater

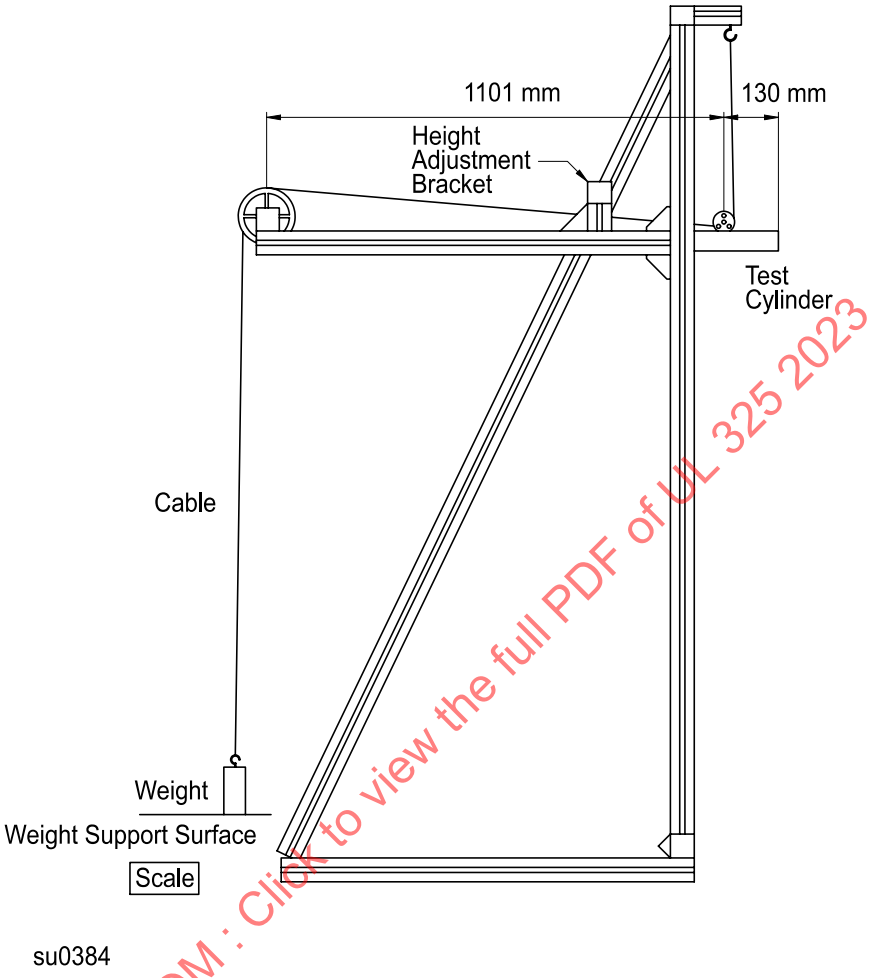


Figure 49.2

Example test apparatus for measurements at 305 mm (12 in) or greater

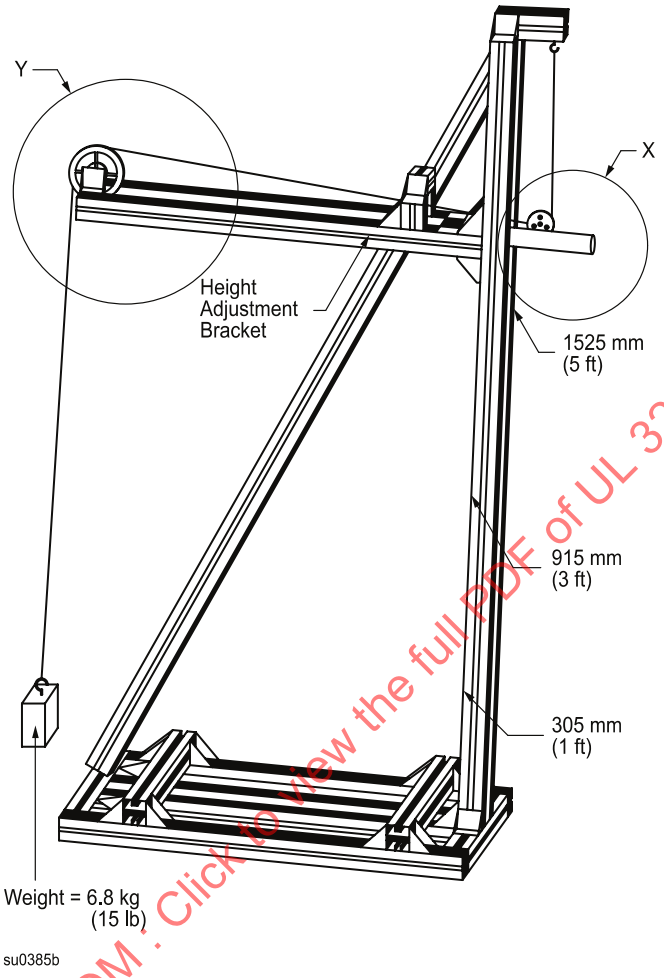
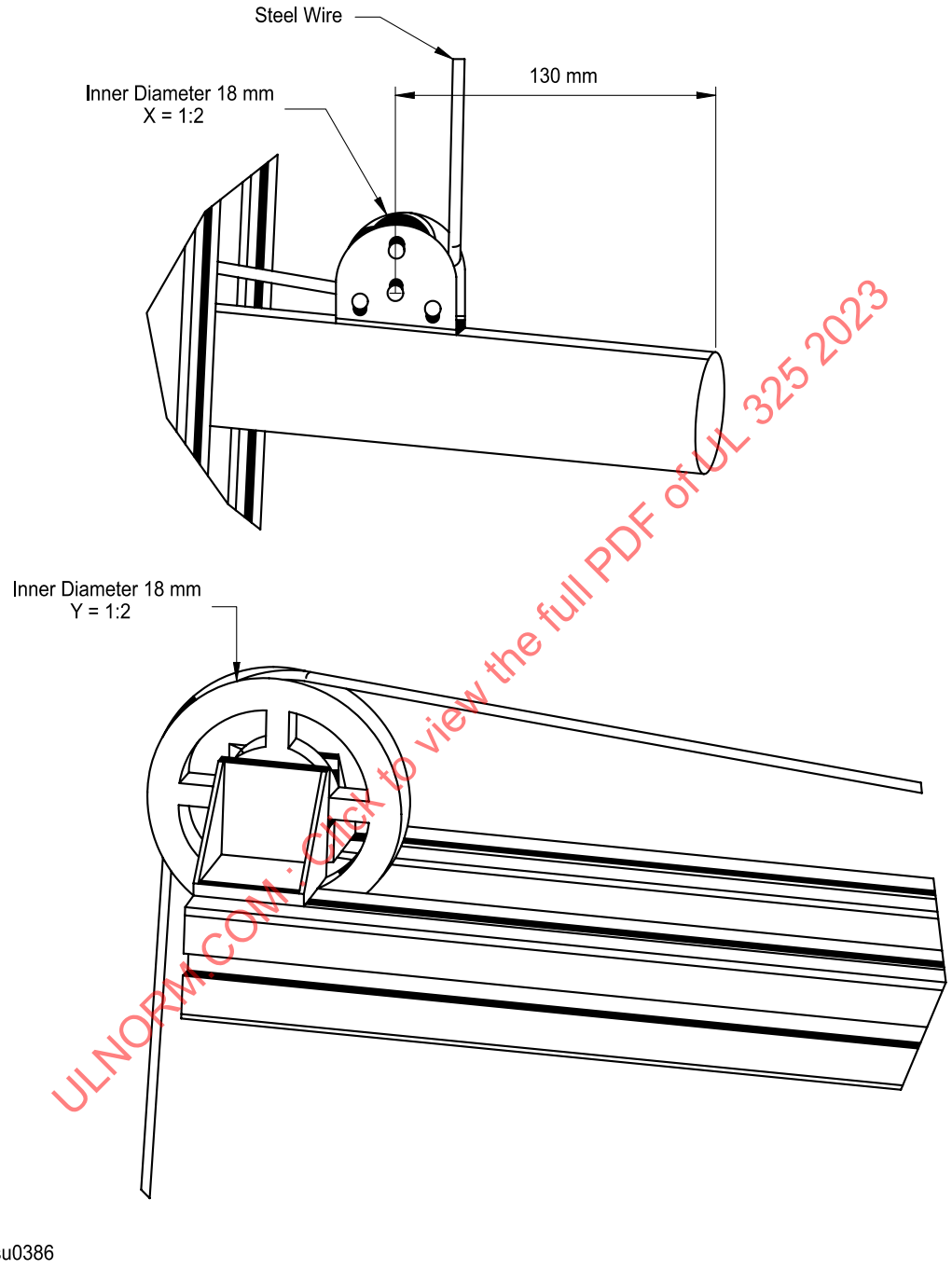


Figure 49.3

Example test apparatus for measurements at 305 mm (12 in) or greater



49.1.7 The cycles of 49.4 are not required to be consecutive. Continuous operation of the motor without cooling is not required.

49.2 Closing force test

49.2.1 The door shall stop and reverse within 2 s after contacting the obstruction. The door shall apply the following forces at the locations noted in 49.2.2:

a) 400 N (90 lbf) or less average during the first 0.75 s after 67 N (15 lbf) is exceeded from initial impact, and

b) 67 N (15 lbf) or less from 0.75 s after 67 N (15 lbf) is exceeded from initial impact until the door reverses.

49.2.2 The test of 49.2.1 shall be conducted at the following test height and locations along the edge of the door:

a) The center point, at a height of 50.8 mm (2 in) from the floor;

b) Within 305 mm (1 ft) of the end of the door, at a height of 50.8 mm (2 in) from the floor; and

c) Within 305 mm (1 ft) of the other end of the door, at a height of 50.8 mm (2 in) from the floor.

49.2.3 The maximum force of 49.2.1 shall be tested by the door applying a force against the longitudinal edge of the test cylinder of 49.1.4.

49.2.4 The equipment used to measure force of 49.2.1 shall be in accordance with 49.1.5.

49.2.5 The door shall stop and reverse within 2 s after contacting the obstruction. The door shall apply a load of 67 N (15 lbf) or less in the closing direction along the path of door travel at the locations noted in 49.2.6.

49.2.6 The test of 49.2.5 shall be conducted at the following points along the edge of the door:

a) At the center at heights of 305 mm, 914 mm and 1.52 m (1 ft, 3 ft, and 5 ft) from the floor;

b) Within 305 mm (1 ft) of the end of the door, at heights of 305 mm, 914 mm and 1.52 m (1 ft, 3 ft, and 5 ft) from the floor; and

c) Within 305 mm (1 ft) of the other end of the door at heights of 305 mm, 914 mm and 1.52 m (1 ft, 3 ft, and 5 ft) from the floor.

49.2.7 The maximum force of 49.2.5 shall be tested by the door applying a force against the longitudinal edge of the test cylinder of 49.1.4.

49.2.8 The equipment used to measure forces of 49.2.1 shall be in accordance with 49.1.5 or 49.1.6.

49.3 Opening force test

49.3.1 The door shall stop within 2 s after a weight of 20 kg (44 lb) is applied to the door.

49.3.2 The test of 49.3.1 shall be conducted with the door starting from the fully closed position and at heights of approximately 305 mm, 914 mm and 1.52 m (1 ft, 3 ft, and 5 ft) from the floor.

49.3.3 Test weight(s) shall be applied to sections of the door that are vertical in the initial stopped position for each test height prior to operator activation.

49.4 Fifty cycle test

49.4.1 With the door(s) at the test point(s) determined by the tests of 49.2 and 49.3 to be most severe with respect to both reversal time and force, the door system shall function as intended after 50 cycles of operation. After the last cycle, the system shall complete one additional cycle of opening the door to its fully open condition and closing the door to its fully closed position.

49.4.2 The tests of 49.2 and 49.3 shall be repeated upon completion of cycling.

49.5 Adjustment of door weight test

49.5.1 At the point determined by the test in 49.2.5 to be the most severe, weight is to be added to the door in 2.3 kg (5.0 lb) increments and the tests of 49.2 and 49.3 repeated until a total of 6.8 kg (15.0 lb) 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 6.8 kg (15.0 lb), the tests of 49.2 and 49.3 are to be repeated by subtracting weight in 2.3 kg (5.0 lb) increments until a total of 6.8 kg (15.0 lb) has been subtracted from the door.

49.6 Obstruction test

49.6.1 For a door traveling in the downward direction, when an inherent secondary entrapment protection device senses an obstruction and initiates a reversal, any control activation shall not move the door downward until the operator reverses the door a minimum of 50.8 mm (2 in). The test is to be performed as described in Exception No. 2 of 33.2.2.3. The system may be initially manually re-profiled for the purpose of this test.

50 Metallic-Coating-Thickness Test

50.1 The method of determining the thickness of zinc and cadmium coatings by the metallic-coating-thickness test is described in 50.2 – 50.9.

50.2 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 (CrO_3) and 50 g/L of reagent grade concentrated sulfuric acid (H_2SO_4). The latter is equivalent to 27 mL/L of reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

50.3 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 0.63 mm (0.025 in) and a length of 140 mm (5.5 in). 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 (0.0017 oz) 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 ±5 drops per min. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

50.4 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°F (21.1 – 32.0°C).

50.5 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.

50.6 The sample to be tested is to be supported from 17.7 to 25.4 mm (0.7 to 1.0 in) 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.

50.7 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.

50.8 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.

50.9 To calculate the thickness of the coating being tested, select from Table 50.1 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 50.7.

Table 50.1
Coating thickness factors

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

51 Accelerated Aging Test of Gaskets

51.1 Rubber compounds forming gaskets that are depended upon for protection from rain shall have physical properties as specified in Table 51.1, before and after conditioning for 168 h in an air-circulating oven at 70°C (158°F).

Table 51.1
Physical properties of gasket-accelerated aging test

	Before accelerated aging	After accelerated aging
Recovery– Maximum set when 50.8-mm (2-in) gauge marks are stretched to 127 mm (5 in), held for 2 min, and measured 2 min after release	12.7 mm (1/2 in)	–
Elongation – Minimum increase in distance between 50.8-mm (2-in) gauge marks at break	250 percent [50.8 – 178 mm (2 to 7 in)]	65 percent of original
Tensile Strength – Minimum force at breaking point	5.9 MPa (850 psi)	75 percent of original

52 Tests on Switches and Controls

52.1 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: This test does not apply to a switch that has been investigated and found to be acceptable for the application.

Exception No. 2: This test does not apply to a switch so interlocked that it will never have to break the locked-rotor motor current.

52.2 In a test to determine whether or not the switch or other control device performs acceptably in the overload test mentioned in 52.1, the appliance is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage – 46.1.5 – 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.

52.3 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 52.4. 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: This requirement does not apply to a switch or other device that has been investigated and found to be acceptable for the application.

52.4 In a test to determine if a switch or other control device complies with the requirement in 52.3, 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.

52.5 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.

52.6 In addition to complying with 52.5, in the event malfunction of a switch or a relay (open or short) described in 52.5 results in loss of any entrapment protection required by 32.1.1, 33.2.2.1, 33.2.2.7, 33.2.2.8, or 33.3.1, 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, 305 mm (1 ft) of the uppermost position.

52.7 An electromechanical interlock employed as described in 34.1 (d) and 34.1 (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.

53 Strain-Relief Test

53.1 When tested in accordance with 53.2, the strain-relief means provided on the flexible cord shall withstand for 1 min, without displacement a direct pull of 155.69 N (35 lbf) 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.

53.2 A 15.9 kg (35 lb) 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.

54 Interconnection Cable Overload Heating Test

54.1 In accordance with the Exception of 15.1.3, the interconnection cable shall be subjected to the overload heating tests described in 54.2 – 54.7 and shall not ignite the cheesecloth of 54.3.

54.2 The maximum output current, including short circuit, of each output of the operator shall be measured at the point of supply to the interconnection cable. A variable resistor may be used for this determination. For multiple circuits contained within an interconnection cable, the test shall be repeated with all circuits interconnected. The loading conditions of 54.5 – 54.7 shall be conducted on the individual circuits or all circuits interconnected, whichever produces the highest maximum current

54.3 With insulation removed, the bare conductors shall be draped with cheesecloth consisting of bleached cotton cloth, running 26 – 28 m^2/kg (14 – 15 yd^2/lb) having a trade as a count of 32 by 28.

54.4 One sample of the maximum intended length of interconnection cable shall be operated under the conditions of Table 54.1 as described in 54.5 – 54.7. The sample shall be connected to a source of supply equal to the maximum output voltage of the operator as measured at one minute. The sample shall be loaded using a resistive load. Combination power and data cables shall load all conductors to maximum current for this test.

Table 54.1
Loading Conditions

Condition	Interconnection Cable Load
A	Maximum current of the operator output, including short circuit
(For conditions B – H) rated current plus indicated percent of difference between condition A and rated current:	
B	75
C	50
D	25
E	20
F	15
G	10
H	5

54.5 For the loading conditions, a variable resistor is to be connected across the load side of the interconnection cable.

54.6 The test shall be conducted continuously for a minimum 7 hours or ultimate results. The operator shall be restarted after each cycle to achieve continuous operation.

54.7 If Condition A results in permanent shutdown of the operator or opening of a conductor prior to 7 hours of continuous operation, the test is repeated on using the loading of Condition B – H in sequence until 7 hours of continuous operation is achieved.

55 Puncture Resistance Test

55.1 After being subjected to the test described in 55.2 or 55.3 as applicable, 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

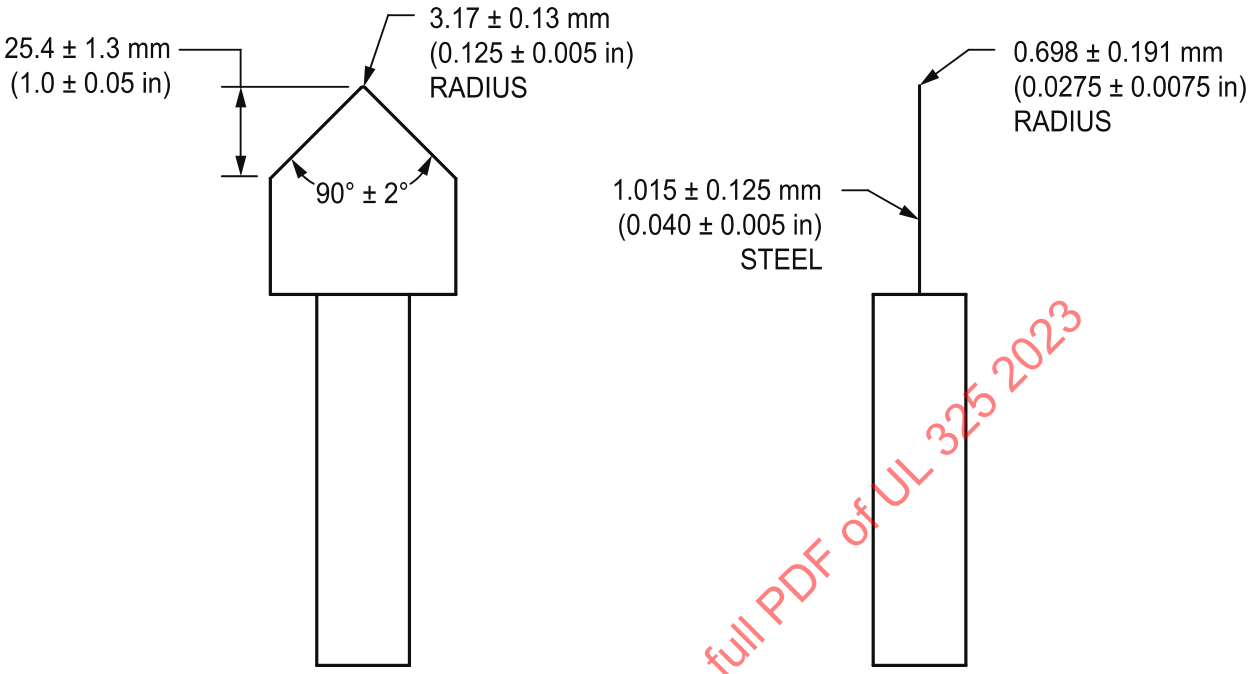
b) Maintain enclosure integrity if it serves to reduce the likelihood of contamination of electrical contacts.

55.2 For a vertically moving door or gate, a sample of the edge sensor is to be installed in the intended manner on a representative door or gate edge. The probe described in Figure 55.1 is to be applied with a 89 N (20 lbf) to any point on the sensor that is 76 mm (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 Figure 39.1 or Figure 39.3 as applicable. The test is to be repeated on three locations on each surface of the sensor being tested.

55.3 For horizontally sliding doors or gates, and horizontal swing gates and swing doors, sample of the edge sensor is to be installed in the intended manner on a representative door or gate edge. The probe described in Figure 55.1 is to be applied with a 89 N (20 lbf) to any point on the sensor when the door is within 76 mm (3 in) of its fully open position and within 76 mm (3 in) of any stationary wall. For each type of door, the force is to be applied in the direction specified in Figure 39.2 or Figure 39.4 as applicable. The test is to be repeated on three locations on each surface of the sensor being tested.

Figure 55.1

Puncture probe



55.4 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 55.1 and 55.2 or 55.3 as applicable.

56 Permanence of Marking Tests

56.1 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.

56.2 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, referenced in Annex A, Ref. No. 32. 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.

57 Dead Load Test

57.1 A horizontal track assembly as described in 34.1(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 60.9.1.

MANUFACTURING AND PRODUCTION TESTS

58 Dielectric Voltage-Withstand Test

58.1 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.

58.2 The production-line test shall be in accordance with either Condition A or Condition B of Table 58.1.

Table 58.1
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 373 W (1/2 horsepower) or less	1000	60	1200	1
More than 250 V with a motor rated more than 373 W (1/2 horsepower)	1000+2V[a]	60	1200+2.4V[a]	1

[a] Rated voltage.

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

58.4 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.

58.5 For an appliance employing a solid-state component that can be damaged by the dielectric potential, the test required by 58.1 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 58.1, 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.

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

58.7 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.

58.8 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.

58.9 Test equipment other than that described in 58.6 – 58.8 may be used if found to accomplish the intended factory control.

58.10 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.

59 Grounding Continuity Test

59.1 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.

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

59.3 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 59.1.

INSTRUCTION MANUAL

60 Details

60.1 General

60.1.1 In Canada, there are two official languages. Therefore, it is necessary to have CAUTION, WARNING, and DANGER instructions and markings in both English and French. Annex B lists acceptable French translations of the CAUTION, WARNING, and DANGER instructions and markings specified in this Standard. When a product is not intended for use in Canada, instructions and markings may be provided in English only.

60.1.2 In the United States, it is acceptable to have instruction and marking measurements in English units only.

60.1.3 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.

60.1.4 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.

60.1.5 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 13.4.1(c), this requirement does not apply.

60.1.6 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."

60.1.7 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."

60.1.8 Information shall be supplied with a gate operator for:

a) The required installation and adjustment of all devices and systems to effect the protection against entrapment (where included with the operator) as specified in Table 32.1, and

b) The intended connections for all devices and systems to effect the protection against entrapment as specified in Table 32.1. The information shall be supplied in the instruction manual, wiring diagrams, separate instructions, or the equivalent.

c) The recommended placement location of external entrapment protection devices for each entrapment zone, if using Type B1 or B2 devices.

60.1.9 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.

60.1.10 For an exterior shutter and awning operator the following instruction or the equivalent must be provided: "To reduce the risk of electric shock the operator power is to be provided from a weatherproof outlet in the case of attachment plug connection or weatherproof junction box in the case of permanent wiring per 314.15 of the National Electrical Code, NFPA 70 and the Canadian Electrical Code, Part I."

60.1.11 For an operator or system provided with an external entrapment protection device requiring a non-rechargeable battery, instructions shall be provided with the operator and/or the device for:

a) The rating, size, number, and type of battery(s) to be used, and

b) The proper insertion, polarity, orientation, and replacement of the battery(s).

60.1.12 For an operator or system provided with an external entrapment protection device or system utilizing wireless control, instructions shall be provided with the operator and/or the device for:

a) The proper method of configuring and initializing the wireless communication link between device and operator,

b) The proper orientation, antenna positioning, and mounting location with regard to maintaining communication link between device and operator,

c) The maximum range at which the wireless device will operate, and

d) The proper location of the device where the transmission of the signals are not obstructed or impeded by building structures, natural landscaping or similar obstruction.

60.1.13 When provided with a detachable supply cord per 13.1.5, the operator instructions shall contain complete details concerning proper selection of the power supply cord replacement that complies with 13.3, 13.4, 13.5, or 13.7 as applicable.

60.1.14 The installation, operation, and maintenance instructions may be provided in electronic read-only media format only, such as CD-ROM, USB flash drive, or company website, if the following instructions are additionally provided with the operator in an instruction sheet, manual, booklet, or similar printed material:

a) All operators, instructions of 60.1.4 – 60.1.13, as applicable;

b) Pedestrian doors and door operators, instructions of 60.2;

c) Residential garage doors and door operators, adjustment instructions of 60.3.1, and instructions of 60.3.2 – 60.3.7, and 60.4 – 60.5;

d) Commercial/industrial door operators (or systems), instructions of 60.6;

e) Light duty (commercial/industrial) door operators, instructions of 60.6 – 60.7; or

f) Vehicular gate operators (or systems), instructions of 60.8.

60.1.15 The printed instruction material referenced in 60.1.14 shall contain detailed instructions of how to obtain a printed copy of the material contained in electronic format.

60.1.16 All printed instruction material referenced in 60.1.14 shall be also be provided in the electronic read-only media format.

60.1.17 For an operator, system, or external device requiring field installed wiring between a Class 2 output of an operator and an external device, unless the wiring is provided as part of the operator or external device, the instructions shall specify the type of wiring to be used in accordance with 15.4.8.

60.2 Pedestrian doors and door operators

60.2.1 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 30.4.1 and 30.4.3.

60.2.2 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.

60.2.3 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 30.5.1.

60.2.4 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.

60.2.5 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.

60.3 Residential garage doors and door operators

60.3.1 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.

60.3.2 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.

60.3.3 The instruction manual shall include the important instructions specified in 60.4.1 and 60.5.1. All required text shall be legible and contrast with the background. Upper case letters of required text shall be no less than 2.0-mm (5/64-in) high and Lower case letters shall be no less than 1.6-mm (1/16-in) 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 4.8-mm (3/16-in) high.

60.3.4 The instructions listed in 60.4.1 and 60.5.1 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 60.5.1 shall be first and last respectively. Other important and precautionary items considered appropriate by the manufacturer may be inserted.

60.3.5 The instructions listed in 60.4.1 shall be located immediately prior to the installation instructions. The instructions listed in 60.5.1 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).

60.3.6 Instructions of a combination sectional overhead garage door operator system described in 4.3 shall specify:

a) The operator by manufacturer and model,

b) The door(s) by manufacturer(s), model(s), and maximum and minimum door width and height required for compliance to 33.1.1 and 33.1.3, and

c) Hardware required for compliance to 33.1.1 and 33.1.3.

60.3.7 Installation and maintenance instructions of a combination sectional overhead garage door operator system described in 4.3 shall indicate how to properly counter-balance the door.

60.4 Installation instructions for residential garage door operators and systems

60.4.1 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 operating and 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 pull ropes and remove, or make inoperative, all locks connected to the garage door before installing the operator.

4. Where possible, install the door operator 2.14 m (7 ft) or more above the floor. For products having an emergency release, mount the emergency release within reach, but at least 1.83 m (6 ft) above the floor and avoiding contact with vehicles to avoid accidental release.

5. Do not connect the door operator to source of power until instructed to do so.

6. Locate the control button: (a) within sight of the door, (b) at a minimum height of 1.53 m (5 ft) above floors, landings, steps or any other adjacent walking surface 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 38-mm (1-1/2-inch) high object (or a 2 by 4 board laid flat) on the floor.

9. For products having a manual release, instruct the end user on the operation of the manual release.

Exception: For horizontally sliding doors, Item 2 shall be replaced with "Have a qualified service person make repairs and hardware adjustments before installing the opener".

60.4.2 In accordance with the Exception of 33.5.1.1, the installation instructions of 60.4.1 of a residential garage door operator intended for use with both sectional and one-piece door that has an unattended operation close feature shall comply with 60.4.1 and include:

10. "WARNING: To reduce the risk of injury to persons – Only enable [+] feature when installed with a sectional door.", where + is the unattended operation function.

Exception: For operators that automatically sense one piece door operation, this warning is not required.

60.4.3 For residential garage door operators constructed in accordance with 13.4.2 which do not have provision for permanent supply connection, the installation instructions shall include the following or

equivalent text: "This operator not equipped for permanent wiring. Contact licensed electrician to install a suitable receptacle if one is not available."

60.5 User instructions for residential garage door operators and systems

60.5.1 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. NEVER GO UNDER A STOPPED, PARTIALLY OPEN DOOR.

5. Test door opener monthly. The garage door MUST reverse on contact with a 38-mm (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.

6. 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.

7. KEEP GARAGE DOORS PROPERLY BALANCED. See user'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.

8. For operator systems equipped with an unattended operation feature, the following statement shall be included: "This operator system is equipped with an unattended operation feature. The door could move unexpectedly. NO ONE SHOULD CROSS THE PATH OF THE MOVING DOOR."

9. SAVE THESE INSTRUCTIONS.

Exception No. 1: For horizontally moving doors, Item 4 shall be replaced with "NEVER GO THROUGH A STOPPED, PARTIALLY OPEN DOOR".

Exception No. 2: For horizontally moving doors, Item 6 is not required.

Exception No. 3: For horizontally moving doors, Item 7 shall be replaced with "Have a qualified service person make repairs and hardware adjustments before installing the opener".

60.6 Commercial/industrial door operators (or systems)

60.6.1 An operator shall be provided with specific instructions describing any necessary adjustment of the control mechanism required for satisfactory operation of the operator. The instructions shall also indicate the need for periodic checking of any control mechanism.

60.6.2 The installation instructions for commercial/industrial door operators shall include information on the types and sizes of doors for which the operator is intended including the type of entrapment protection suitable for each size and type of door for which the operator is intended.

60.6.3 An operator shall be provided with instructions in the instruction manual specifying the methods of installation, adjustment, and wiring of external controls or devices serving as required protection against entrapment. The following instructions or the equivalent shall also be supplied where applicable:

a) Install the operator only when all openings of a horizontal slide door are guarded or screened from the bottom of the door to a minimum of 1.22 m (4 ft) above the ground to prevent a 57.2 mm (2-1/4 in) diameter sphere from passing through the openings anywhere in the door.

b) All warning signs and placards must be installed where visible in the area of the door.

c) For operators utilizing a non-contact sensor in accordance with 31.2.1:

1) Instructions on the placement of non-contact sensors for each type of application shall be provided.

d) For operators utilizing a contact sensor in accordance with 31.2.1:

1) One or more contact sensors shall be located where the risk of entrapment or obstruction exists, such as at the leading edge or trailing edge of a horizontal slide door.

2) One or more contact sensors shall be located at the bottom edge of a vertically moving door.

60.6.4 The instruction manual for a commercial/industrial door operator shall include the important instructions specified in 60.6.7 – 60.6.8. All required text shall be legible and contrast with the background. Uppercase letters of required text shall be no less than 2.0 mm (5/64 in) high and lowercase letters shall be no less than 1.6 mm (1/16 in) high. Headings such as "IMPORTANT INSTALLATION INSTRUCTIONS", "IMPORTANT SAFETY INSTRUCTIONS", "SAVE THESE INSTRUCTIONS," etc. and the words "WARNING – To reduce the risk of severe injury or death to persons:" shall be in letters no less than 4.8 mm (3/16 in) high.

60.6.5 The instructions listed in 60.6.7 and 60.6.8 shall be in the exact words specified or shall be in equally definitive terminology to those specified. The items may be numbered. The first and last items specified in 60.6.8 shall be first and last respectively. Other important and precautionary items considered appropriate by the manufacturer may be inserted.

Exception: The instruction required in 60.6.7 item (8), when applicable, shall not be in exact words specified, and instead shall be replaced by wording describing this operation.

60.6.6 The instructions listed in 60.6.7 shall be located immediately prior to the installation instructions. The instructions listed in 60.6.8 shall be located immediately prior to the 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).

60.6.7 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 operating and balanced door. A door that is operating improperly could cause severe injury. Have qualified service personnel make repairs to cables, spring assemblies, and other hardware before installing the operator.

3) Remove all pull ropes and remove, or make inoperative, all locks (unless mechanically and/or electrically interlocked to the power unit) connected to the door before installing the operator.

4) A commercial/industrial door operator that has exposed moving parts capable of causing injury to persons or employs a motor deemed indirectly accessible by 10.6 by virtue of its location above the floor shall include:

a) Install the door operator at least 2.44 m (8 ft) or more above the floor; or

b) If the operator must be installed less than 2.44 m (8 ft) above the floor, then exposed moving parts must be protected by covers or guarding, provided by the operator manufacturer; or

c) Both (a) and (b).

5) Do not connect the door operator to the source of power until instructed to do so.

6) Locate the control station: (a) within sight of the door, and (b) at a minimum height of 1.53 m (5 ft) above floors, landings, steps, or any other adjacent walking surface and (c) away from all moving parts of the door.

7) Install the Entrapment Warning Placard next to the control station in a prominent location.

8) For products having a manual release, instruct the end user on the operation of the manual release.

60.6.8 The User Instructions shall include the following instructions or their equivalent, as applicable:

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 (where provided) away from children.

3) Personnel should keep away from a door in motion and keep the moving door in sight until it is completely closed or opened. NO ONE SHOULD CROSS THE PATH OF A MOVING DOOR.

4) Test the door's safety features at least once a month. After adjusting either the force or the limit of travel, retest the door operator's safety features. Failure to adjust the operator properly may cause severe injury or death.

5) For products having a manual release, if possible, use the manual release only when the door is closed. Use caution when using this release when the door is open. Weak or broken springs may cause the door to fall rapidly, causing severe injury or death.

6) KEEP DOORS PROPERLY OPERATING AND BALANCED. See Door Manufacturer’s User's Manual. An improperly operating or balanced door could cause severe injury or death. Have trained door systems technician make repairs to cables, spring assemblies, and other hardware.

7) SAVE THESE INSTRUCTIONS.

60.7 Light duty (commercial/industrial) door operators

60.7.1 In addition to complying with the requirements in Commercial/Industrial Door Operators (or Systems), Section 60.6, a light-duty commercial 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 46, 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 46.4.1.

60.8 Vehicular gate operators (or systems)

60.8.1 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 4. The installation instructions for vehicular gate operators shall include information on the Types of gate for which the gate operator is intended.

60.8.2 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.

60.8.3 Instructions for the installation and connection 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. When shipped separately from the operator, external entrapment protection devices shall be provided with instructions for installation, adjustment, and wiring.

60.8.4 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 1.83 m (6 ft) above the ground to prevent a 57.2 mm (2-1/4 inch) 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 areas of the moving vertical pivot gate panel from the bottom of the gate to the top of the gate or a minimum of 1.83 m (72 in) above grade, whichever is less, that pass by a fixed stationary object, and in the area of the adjacent fence that the gate covers during the travel of the gate, shall be designed, guarded or screened to prevent a 57 mm (2-1/4 in) diameter sphere from passing through such areas.

4) All exposed pinch points are eliminated or guarded, and

5) Guarding is supplied for exposed rollers.

6) The operator instructions shall list the maximum number of open and close entrapment protection devices capable of being connected to the operator.

b) The operator is intended for installation only on gates used for vehicles. Pedestrians must be supplied with a separate access opening. The pedestrian access opening shall be designed to promote pedestrian usage. Locate the gate such that persons will not come in contact with the vehicular gate during the entire path of travel of the vehicular gate.

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 an improperly installed, improperly functioning, or damaged gate.

e) For a gate operator utilizing Type D entrapment protection in accordance with 32.1.1:

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 62.1.6 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) Permanently mounted controls intended for user activation must be located at least 1.83 m (6 ft) away from any moving part of the gate and where the user is prevented from reaching over, under, around or through the gate to operate the controls.

Exception: Emergency access controls only accessible by authorized personnel (e.g. fire, police, EMS) may be placed at any location in the line-of-sight of the gate.

g) The Stop and/or Reset button must be located in the line-of-sight of the gate. Activation of the reset control shall not cause the operator to start.

h) A minimum of two (2) WARNING SIGNS shall 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. Also see 62.1.1.

i) For a gate operator utilizing Type B1, non-contact entrapment protection in accordance with 32.1.1:

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.

j) For a gate operator utilizing Type B2, contact entrapment protection in accordance with 32.1.1:

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 post mounted 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 device 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 device 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 101.6 mm (4 in) but less than 406 mm (16 in) above the ground at any point in its arc of travel, one or more contact sensors shall be located on the bottom edge.

7) For a vertical barrier (arm) operator utilizing Type B2 contact entrapment protection in accordance with 32.1.1, one or more contact sensors shall be located at the bottom edge of a vertical barrier (arm).

8) One or more contact sensors shall be located where the risk of entrapment or obstruction exists on a bifold gate, such as:

i) At the inner and outer leading edge,

ii) Between the outer column panel and the inner bifold panel of an opening bifold gate,

iii) Between the outer/column panel and any obstruction within 406mm (16 in) of the gate panel when it is in the fully open position,

iv) At hinge points depending on the construction of the gate,

v) On the bottom edge(s),if the bottom edge(s) of a bifold gate is/are greater than 152 mm (4 in) but less than 406 mm (16 in) above the ground at any point in its arc of travel.

60.8.5 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 severe 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 severe injury or death.

5. Use the manual release only when the gate is not moving.

6. KEEP GATES PROPERLY MAINTAINED. Read the user'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.

60.8.6 The installation manual provided with the operator shall identify any external entrapment protection devices required by 32.1.1 and Table 32.1. See also 63.3.5.

60.8.7 Instructions provided with an operator shall specify each external entrapment protection device or external entrapment protection device accessory that is suitable for use with the operator. The external device(s) shall be specified by type of device (e.g.: photo sensor, edge sensor), device manufacturer, and device model number or model family. The device(s) specified in the instructions shall only be those that have been tested and found to be acceptable with the operator during evaluation to this standard.

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

60.9.1 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.

60.10 Drapery Operators

60.10.1 A cord-connected drapery operator shall include: "Do not use an extension cord. If the power supply cord is too short, have a qualified electrician install an outlet near the drapery operator.", or equivalent.

61 Field Installed Labels

61.1 A residential garage door operator shall be provided with labels for field installation and constructed as specified in 61.3 – 61.10. The labels shall be acceptable for permanent installation. The instruction manual shall specify where the labels are to be located.

61.2 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.

61.3 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.

61.4 The label required in accordance with 61.3 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 127-mm (5-in) wide by 159-mm (6-1/4-in) long overall.

61.5 The signal word panel as specified in 61.4 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 11.1-mm (7/16-in) high on an orange background.

61.6 The pictorial panel as specified in 61.4 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 47.6 mm (1-7/8 in) minimum.

61.7 The message panel specified in 61.4 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."

5) For products equipped with an unattended operation feature, the instructions shall include the following: "This operator system is equipped with an unattended operation feature. The door could move unexpectedly."

c) INSTRUCTIONS:

1) "Test Door Operator Monthly: Use a 38-mm (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.

61.8 In accordance with the Exception of 33.5.1.1, the instructions of a residential garage door operator intended for use with both sectional doors and either one-piece or swinging doors and are provided with an unattended operation feature shall comply with 61.7 and include the following under the avoidance statements of 61.7(b):

5) “Only enable [+] feature when installed with a sectional door.”, or equivalent, where + is the unattended operation closing function.

Exception: For operators that automatically sense one piece door operation, this warning is not required.

61.9 The lettering of the message panel described in 61.7 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 3.2-mm (1/8-in) 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.

61.10 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 33.4.1, a cautionary marking is not required.

61.11 Both the operator and the door that comprise a combination sectional overhead garage door operator system described in 4.3 shall be provided with permanent labels. The labels shall contain the following statement or the equivalent: “WARNING: THIS OPERATOR AND DOOR FUNCTION AS A SYSTEM. IF EITHER THE DOOR OR THE HARDWARE MUST BE REPLACED, THE REPLACEMENT DOOR OR HARDWARE MUST BE IDENTICAL TO THE ORIGINAL EQUIPMENT WITH RESPECT TO MANUFACTURER AND MODEL TO MAINTAIN THE SAFETY OF THE SYSTEM. SEE INSTRUCTION MANUAL.” The marking shall be visible to the user after installation without the need to remove any covers.

61.12 A label of 61.13 when intended to be affixed during installation shall:

a) Be provided with the operator or door assembly, and

b) Have installation instructions of how and where to install the label so that it is visible to the user after installation.

61.13 The operator of a combination sectional overhead garage door operator system described in 4.3 shall be provided with a permanent marking that contains the following statement or the equivalent: "NO USER SERVICEABLE PARTS INSIDE."

62 Field Installed Placards

62.1 Vehicular gate operators (systems)

62.1.1 A gate operator shall be supplied with a minimum of two placards as described in 62.1.2 – 62.1.5 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 56, for applicable requirements for placards for outdoor use.

62.1.2 A placard required by 62.1.1 shall comply with the standard practices for safety information as prescribed in the Standard for Product Safety Signs and Labels, ANSI Z535.4. 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 216-mm (8-1/2-in) wide by 280-mm (11-in) long overall.

62.1.3 The signal word panel specified in 62.1.2 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 25.4-mm (1-in) high on an orange background.

62.1.4 The pictorial panel specified in 62.1.2 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 102 mm (4 in).

62.1.5 The message panel specified in 62.1.2 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 12.7-mm (1/2-in) 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 6.4-mm (1/4-in) 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.

62.1.6 A gate operator having provision for a Type D entrapment protection device as described in 32.1.22 and 32.1.23 shall additionally be provided with a placard that is marked in letters at least 6.4-mm (1/4-in) 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."

62.2 Commercial/Industrial door operator (or system)

62.2.1 A door or door operator as described in 31.1.1 shall be provided with a placard as shown in Figure 62.1 (vertically moving door), Figure 62.2 (horizontally moving door), or Figure 62.3 (vertically and horizontally moving door), as applicable for the door type(s) for which the operator is intended. The word "WARNING" shall be marked in letters at least 6.4 mm (1/4 in) high. 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.

Figure 62.1

Field installed placard for a vertically moving commercial/industrial door operator (or system)

S5460

Figure 62.2

Field installed placard for a horizontally moving commercial/industrial door operator (or system)

s5460a

Figure 62.3

Field installed placard for a vertically and horizontally moving commercial/industrial door operator (or system)

s5460b

MARKING

63 Details

63.1 General

63.1.1 In Canada, there are two official languages. Therefore, it is necessary to have CAUTION, WARNING, and DANGER instructions and markings in both English and French. Annex B lists acceptable French translations of the CAUTION, WARNING, and DANGER instructions and markings specified in this Standard. When a product is not intended for use in Canada, instructions and markings may be provided in English only.

63.1.2 In the United States, it is acceptable to have instruction and marking measurements in English units only.

63.1.3 Unless specifically indicated otherwise, markings required in 63.1.4 – 63.4.8 and elsewhere in this standard shall be permanent in accordance with Permanence of Marking Tests, Section 56.

63.1.4 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, VA, or watts. The ampere or VA 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; and

d) The date or other dating period of manufacture not exceeding any three consecutive months. 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.

Exception No. 3: The input in amperes or watts may be shown as part of the motor nameplate, if the appliance employs a single motor, the nameplate is readily visible after the appliance has been installed, and the appliance complies with 45.1.

Exception No. 4: For tubular drives for use with drapery, shutters, awnings, blinds, and window coverings, the markings may be located on the tubular drive which may not be visible after installation, when in accordance with 63.3.12.

63.1.5 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.

63.1.6 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.

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

63.1.8 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."

63.1.9 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.

63.1.10 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 93.2 W (1/8 hp) or less or a nonmotor load 1 A or less, unless either constitutes the principal load.

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

63.1.12 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.

63.1.13 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.

63.1.14 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.

63.1.15 The input in amperes or watts may be shown as part of the motor nameplate, if the appliance employs a single motor, this nameplate is readily visible after the appliance has been installed, and the appliance complies with 45.1.

63.1.16 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 63.1.15, 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.

63.1.17 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.

63.1.18 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.

63.2 Components

63.2.1 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.

63.2.2 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.

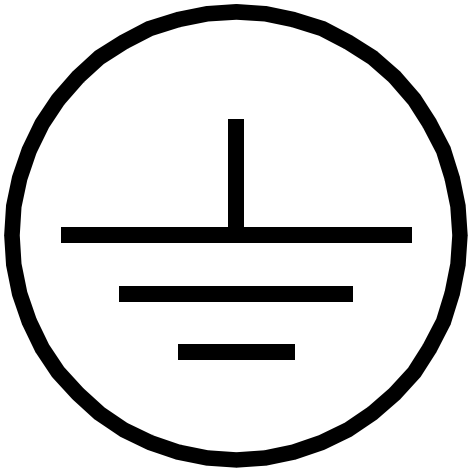
63.2.3 A power receptacle intended for use by the serviceman shall be marked with a voltage and current rating.

63.2.4 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.

63.2.5 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 63.1, a similar marking; or by a marking on the wiring diagram supplied on the appliance.

Figure 63.1

Grounding symbol



63.2.6 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 63.1. 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 63.1
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)

63.2.7 With reference to 13.6.2.21, 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.

63.2.8 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 15.4.5, 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."

63.3 Specific appliances

63.3.1 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)."

63.3.2 In accordance with the exception of 33.5.1.1, a residential garage door operator intended for use with both sectional and one-piece or swinging door that has an unattended operation close feature indicating the function in the carton markings shall include the following carton marking:

> "WARNING: To reduce the risk of injury to persons – Only enable [+] feature when installed with sectional door.", where + is the unattended operation closing function.

Exception: For operators that automatically sense one piece door operation, this warning is not required.

63.3.3 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 38-mm (1-1/2-inch) high obstruction (or a 2 by 4 board laid flat) on the floor." This marking shall be located where visible to the user when making the adjustments.

63.3.4 For residential garage door operators constructed in accordance with 13.4.2 which do not have provision for permanent supply connection, the operator shall be marked with the following or equivalent text: "This operator not equipped for permanent wiring. Contact licensed electrician to install a suitable receptacle if one is not available." This marking is to be placed adjacent to the power cord entry.

63.3.5 For a separately supplied accessory, including an external entrapment protection device, the instructions, packaging, or marking on the product shall indicate:

a) The accessory manufacturer's name and model number; and

b) The type of appliance or appliances (such as a residential garage door operator) with which it is intended to be used.

63.3.6 An appliance provided with terminals or connectors for connection of a separately supplied accessory, such as an external entrapment protection device or system, 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.

63.3.7 With reference to 63.3.5, 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.

63.3.8 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."

63.3.9 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.