



ANSI/CAN/UL 325:2023

JOINT CANADA-UNITED STATES
NATIONAL STANDARD

STANDARD FOR SAFETY

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

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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

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

First Edition – April, 1973
Second Edition – April, 1979
Third Edition – April, 1986
Fourth Edition – May, 1995
Fifth Edition – June, 2002
Sixth Edition – October, 2013

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.

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

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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.

STP 325 Membership

Name	Representing	Interest Category	Region
Beard, Jimmy	Self	General	USA
Blackburn, Bryan L.	Raynor Garage Doors	Producer	USA
Buhler, James	Wallace and Wallace Fences LTD	Producer	Canada
Claudiel, Christian	Manaras-Opera	Producer	Canada
Collins, John	Technronic Industries North America Inc	Producer	USA
Desilvia, Tom	The Chamberlain Group Inc	Producer	USA
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Name	Representing	Interest Category	Region
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Dormann, Susanne	TUV SUD	Testing and Standards	Germany
Doyle, Phillip W.	PHILLIPS Automated Gate Service	Commercial/Industrial User	USA
Dunham, Jeff E.	BEA Inc	Supply Chain	USA
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Shipkov, Alexey	Electrical Safety Authority	AHJ	Canada
Spehalski, Robert	Lutron Electronics CO INC	Producer	USA
Taufman, Curtis M.	Self	General	USA
Thornton, Anthony	American Fence Association	General	USA

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Name	Representing	Interest Category	Region
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Veness, Kenneth Evan	Advanced Entry Systems of Canada	Supply Chain	Canada
Vonnahme, Gary W	ASSA ABLOY	Supply Chain	USA
Walker, Amy	UL Standards & Engagement	Project Manager (Non-Voting)	USA
Watkins, Michael	RYTEC Corp	Producer	USA
Wright, Michael	California Technical Concepts	General	USA

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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.

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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 than 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.

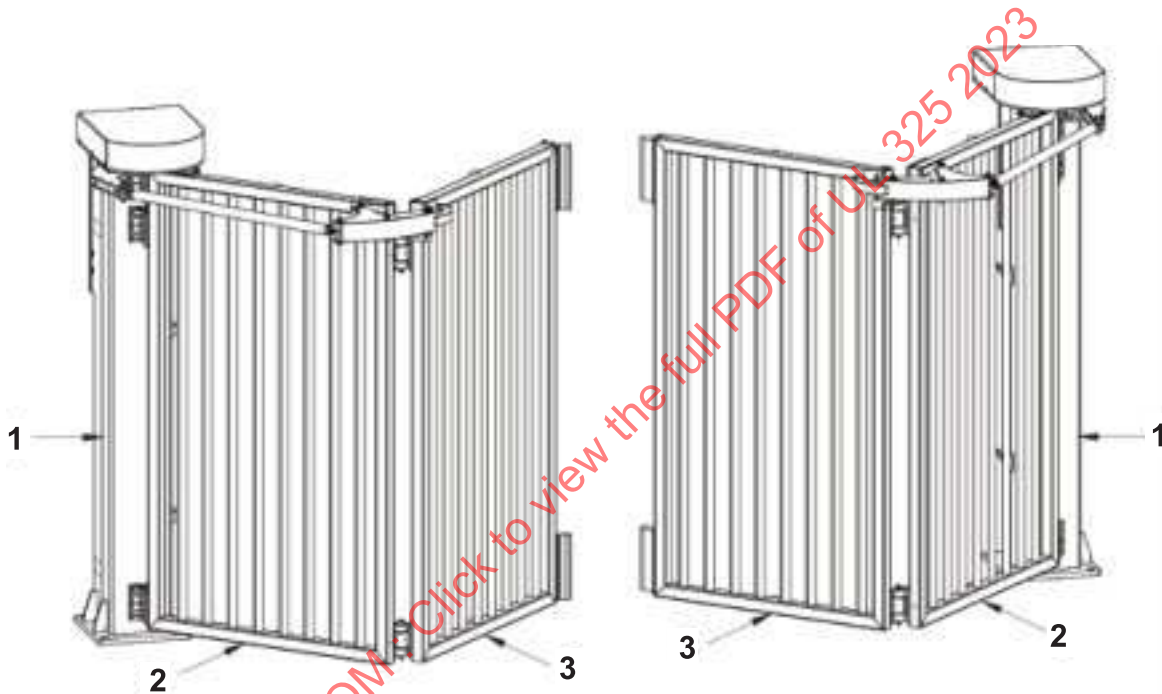
4.33 VEHICULAR VERTICAL PIVOT-GATE OPERATOR (OR SYSTEM) – A vehicular gate operator (or system) that controls a gate that moves in an arc in a vertical plane that is intended for use for vehicular entrances or exits to a drive, parking lot, or the like.

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.

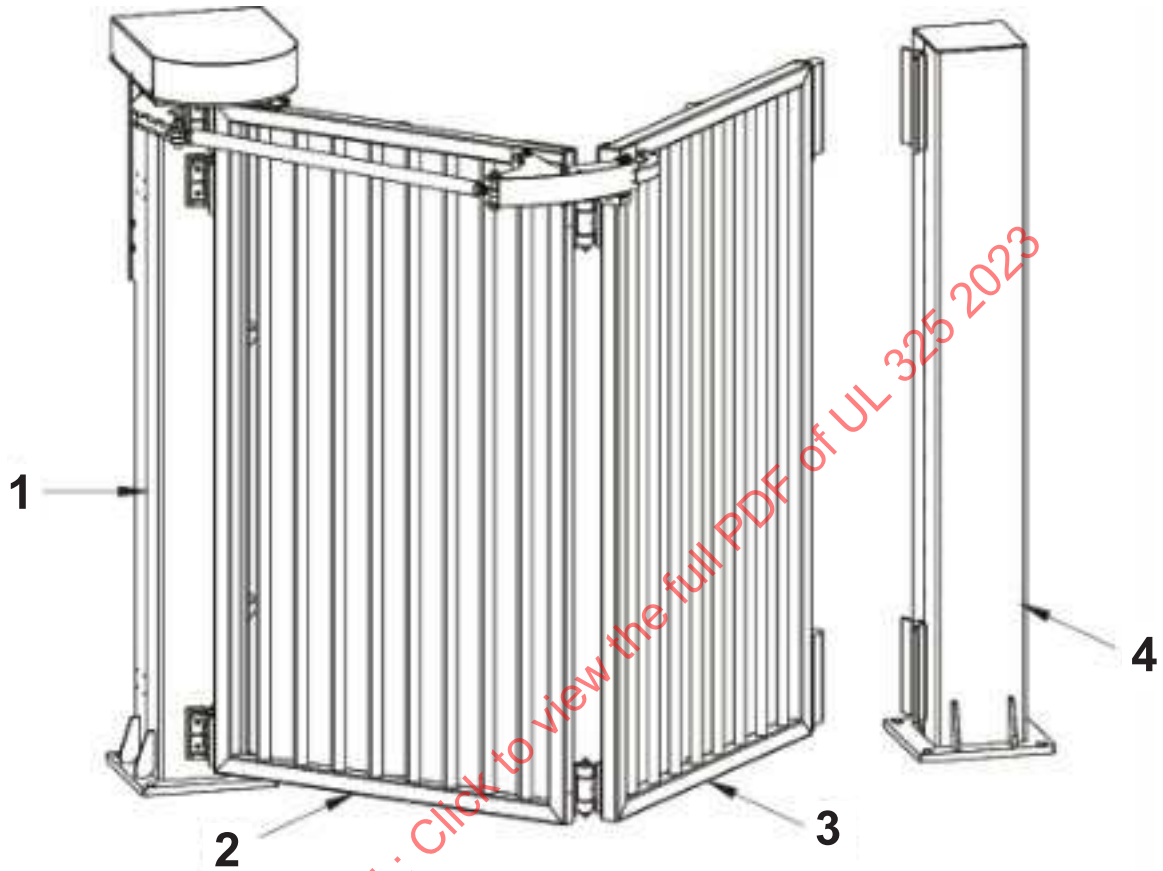
Figure 4.1
Pair Bifold Gate



su4620

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

Figure 4.2
Single Bifold Gate



su4621

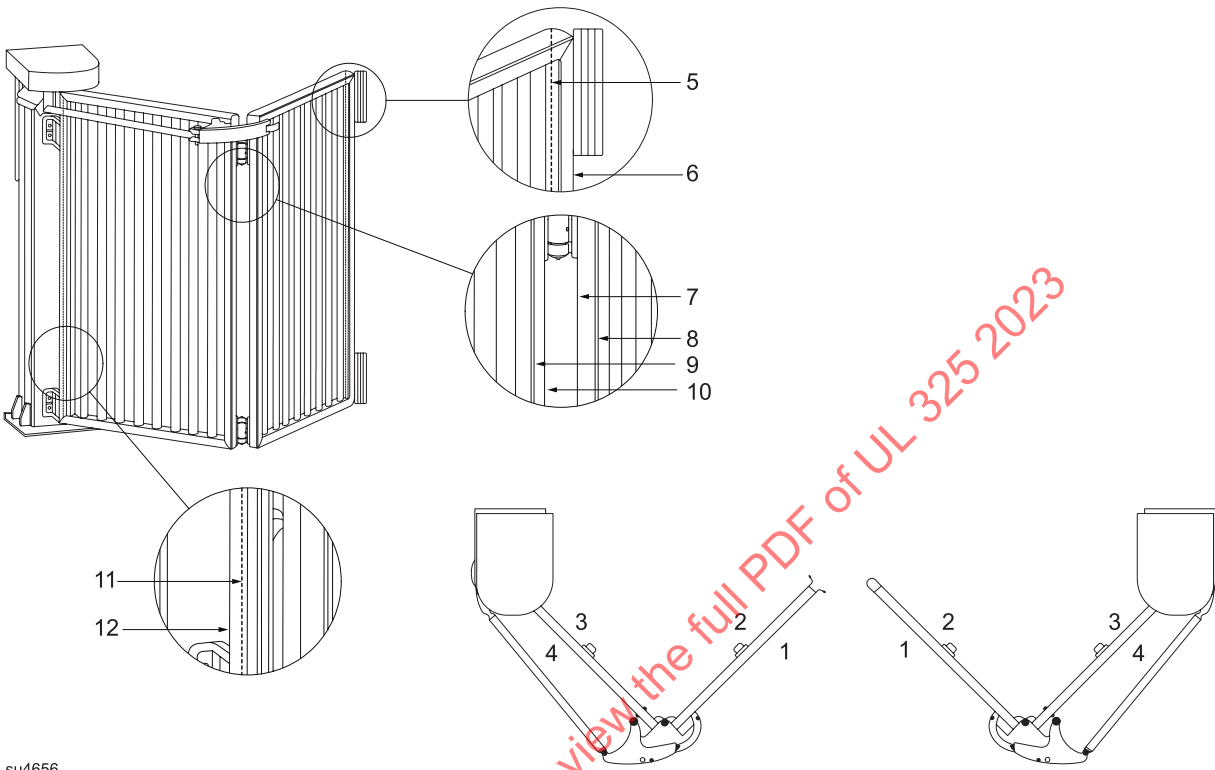
1. Hinging Structure (Post / Column / Pillar)
2. Panel A
3. Panel B
4. Catch Structure (Post / Column / Pillar)

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).

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Figure 4.3
Bifold Gate Edges and Panels



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

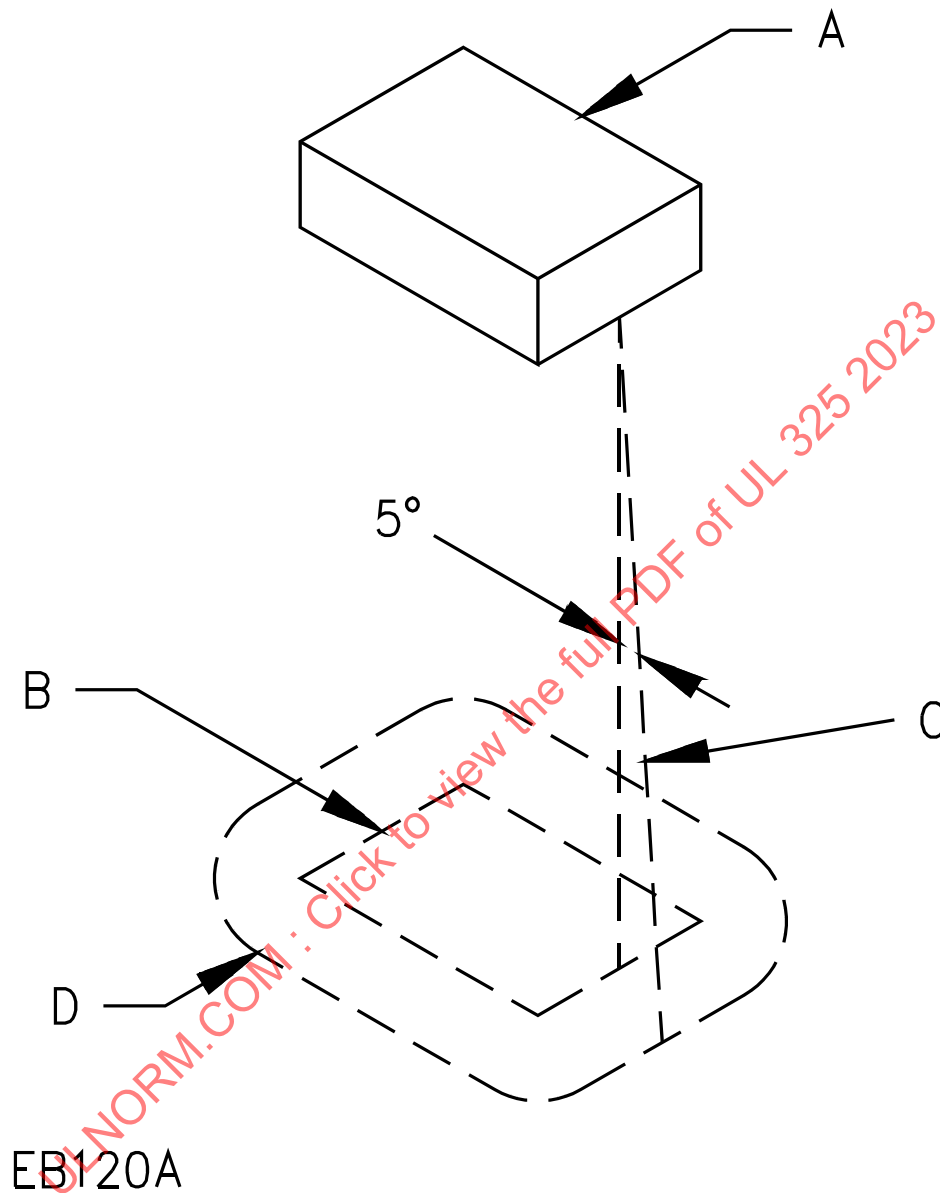
b) Under wiring, unless it is neoprene, cross-linked or thermoplastic-insulated.

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.

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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).

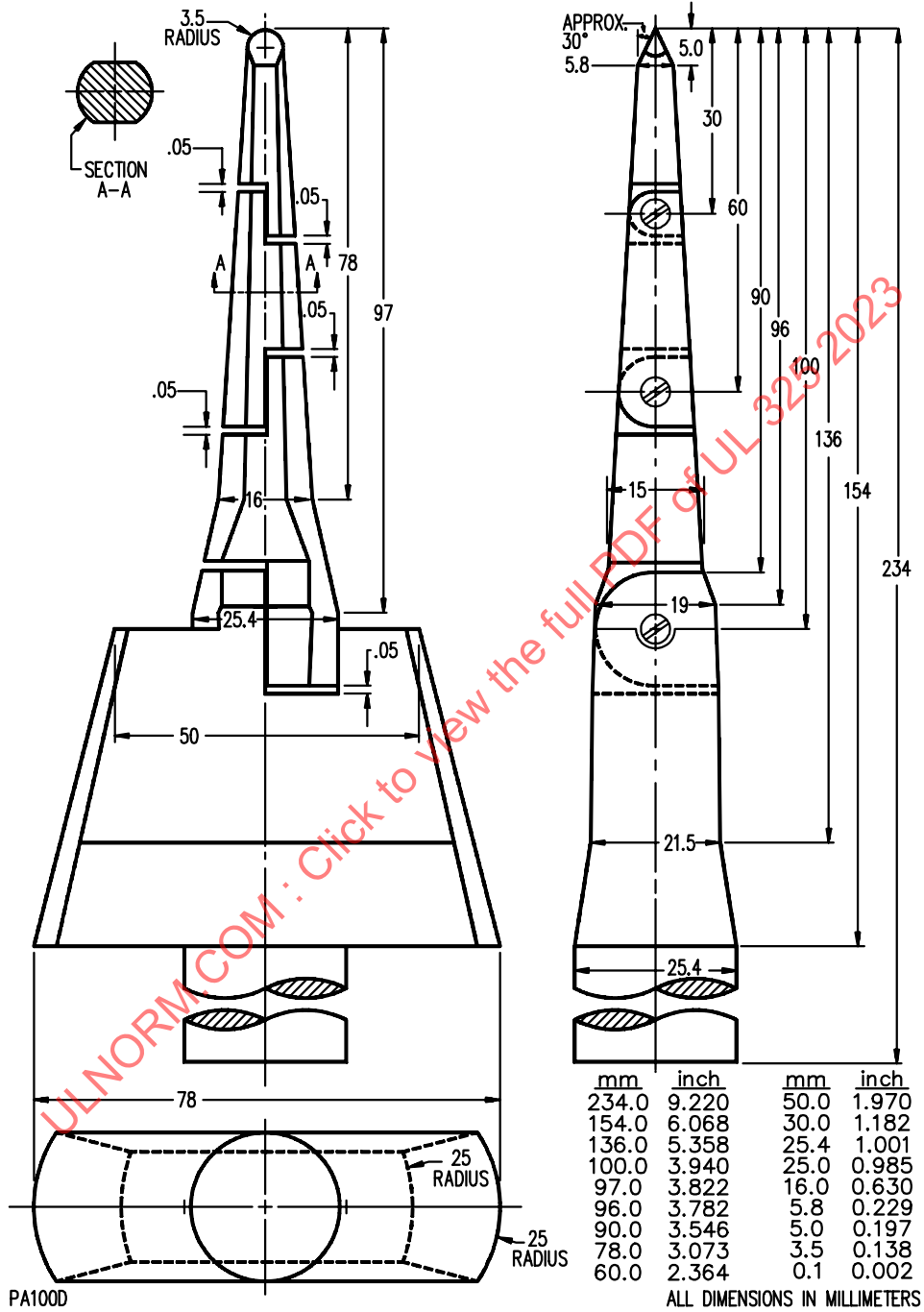
10.2 With respect to an integral enclosure of a motor as mentioned in the exception to [10.1](#):

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](#).

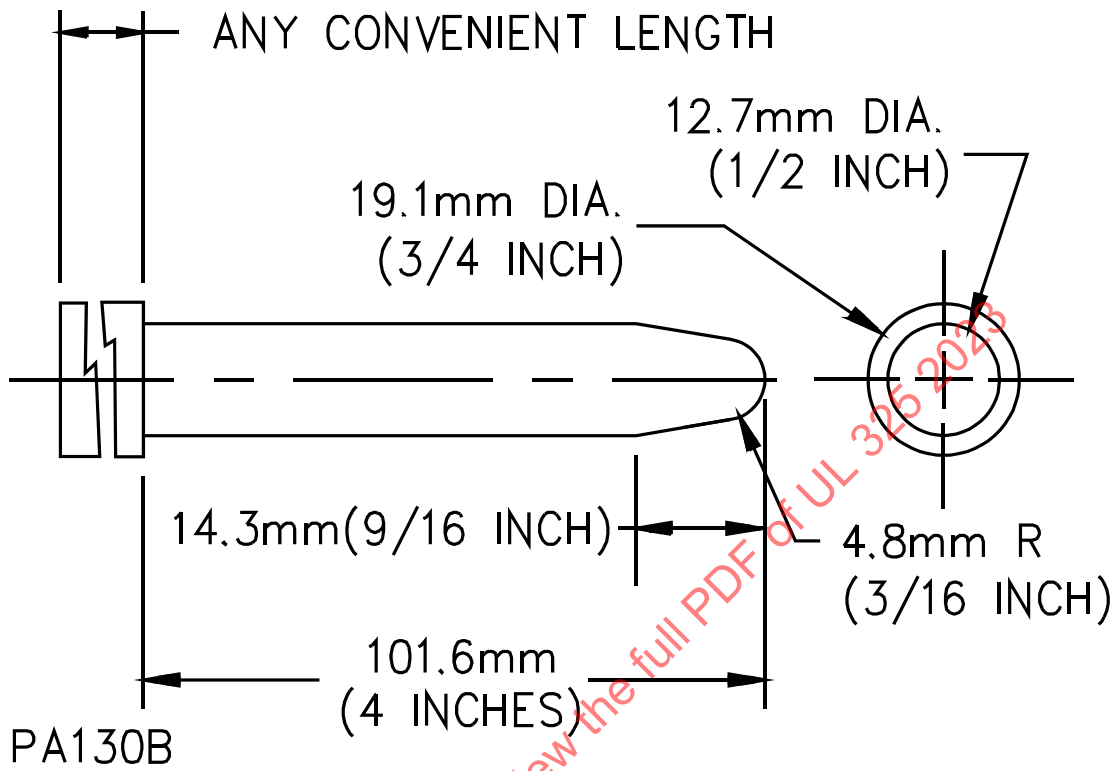
b) An opening that has a minor dimension of 19.1 mm (3/4 in) or more is acceptable if a part or wire is spaced from the opening as specified in [Table 10.1](#).

Figure 10.1
Articulate probe with web stop



PA100D

Figure 10.2
Probe for uninsulated live parts



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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 V_{peak}, 30 V_{rms}, or 60 V_{dc} 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.