

UL 1433

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Control Centers for Changing Message Type Electric Signs



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for
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NOVEMBER 22, 1996

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

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

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FOREWORD

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

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

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

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

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

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

INTRODUCTION

1 Scope

1.1 These requirements cover control centers for changing message type electric signs for use in accordance with the National Electrical Code, NFPA 70. These control centers may be either cord connected or permanently installed.

1.2 The control systems covered by these requirements are for indoor or outdoor use, and are either provided with an enclosure or are for installation within the enclosure of a sign. These requirements also cover interconnecting cables other than low voltage control cables. Such cables may be provided with the control unit or with the sign.

1.3 These requirements do not cover complete electric signs, lamp banks, data input equipment, or any other component or system covered in individual requirements.

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

2 General

2.1 Components

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

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard or
- b) Is superseded by a requirement in this standard.

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

2.1.4 Specific components are recognized as being 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 specific limits, and shall be used only under those specific conditions for which they have been recognized.

2.2 Units of measurement

2.2.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

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

2.3 Undated references

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

3 Glossary

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

3.2 **CONVENIENCE RECEPTACLE** – A receptacle that is installed on or within a permanently-installed control center, and supplied from a branch-circuit separate from other control center circuits and rated no more than 20 amperes, 125 volts.

3.3 **DEDICATED RECEPTACLE** – A receptacle that is installed on or within a control center, intended for the connection of a specific product, and marked for such use.

3.4 **ELECTRIC SHOCK** – The risk of injury to persons from electric shock is to be considered to exist at any exposed part of a unit or system if the available open-circuit potential is higher than 42.4 volts peak and the available current through a 1500-ohm resistance is more than 5 milliamperes.

3.5 **FIELD WIRING TERMINAL** – Any terminal to which a supply or other wire can be connected by an installer in the field, unless the wire is provided as part of the appliance and a pressure terminal connector, soldered loop, crimped eyelet, or other means for making the connection is factory assembled to the wire.

3.6 **PRIMARY CIRCUIT POWER** – Power derived from a branch circuit power line or from an AC or DC motor/generator set installed separately from or included as a part of a unit or system.

3.7 **PRINTED WIRING BOARD** – The finished combination of a pattern of conductive paths either on, in, or both on and in (multilayer) a sheet of insulating material.

3.8 **SECONDARY CIRCUIT** – A circuit supplied from the secondary winding of an isolating transformer.

3.9 **TRANSFER SWITCH** – A switch located in a circuit or interlocked so that it cannot be caused to make or break current under either normal or abnormal conditions.

3.10 **USER SERVICING** – Any form of servicing that might be performed by personnel other than those who are trained to maintain the message center controller. Some examples of such servicing are:

- a) The attachment of an accessory by means of an attachment plug cap and receptacle or by means of other separable connectors.
- b) The changing of a tape or ribbon that does not involve a complicated operation.
- c) The replacement of a recording tape, disk, program board, punched card, or paper form.
- d) Resetting or replacing a circuit breaker, fuse, or lamp that is accessible without the use of tools.

e) The making of a routine operating adjustment necessary to adapt the appliance for its different intended functions.

f) Routine cleaning.

CONSTRUCTION

ALL EQUIPMENT

4 General

4.1 A control center shall be made and finished with the degree of uniformity and grade of workmanship that are practicable in a well-equipped factory.

5 Frame and Enclosure

5.1 General

5.1.1 The frame and enclosure of control system equipment shall be constructed 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 total or partial collapse resulting in a risk of fire, electric shock, or injury to persons due to reduction of spacings, loosening or displacement of parts, or other serious defects.

Exception: In the case of a control unit constructed and intended for installation totally within the enclosure of the sign itself, a separate enclosure for the control unit shall not be necessary.

5.1.2 A part of the enclosure such as a door or cover shall be provided with a means for firmly securing it in place. Examples of such means are latches, locks, interlocks, screws, and the like.

5.1.3 An enclosure cover shall be hinged if it gives access to fuses or any other overload protective devices, the normal functioning of which require renewal, or if it is necessary to open the cover in connection with the normal operation of the unit.

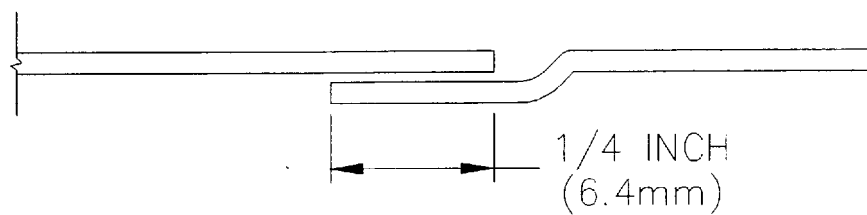
Exception: A hinged cover is not required for a unit in which the only fuses enclosed are control circuit fuses, if the fuses and control circuit loads (other than a fixed control circuit load such as a pilot lamp) are within the same enclosure.

5.1.4 A hinged cover provided in accordance with 5.1.3 shall not depend solely upon screws or other similar means requiring the use of a tool to hold it closed, but shall be provided with a spring latch or catch, or with a captive fastener that is intended to be closed by hand. Such a fastener shall be located or used in multiple so as to hold the cover closed over its entire length. A hinged cover more than 48 inches (1.22 m) long on the hinged side shall have at least a two point latch operated by a single knob or handle, or shall have two or more separate spring latches or hand operable captive fasteners.

5.2 Primary fuse or circuit breaker compartments

5.2.1 A door or cover giving access to a fuse or any portion of a circuit breaker other than the operating handle shall shut closely against a 1/4-inch (6.4-mm) rabbet as shown in Figure 5.1, or shall have flanges for the full length of the four edges. Flanges on a door or cover shall fit closely with the outside walls of the box, and shall be no less than 1/2 inch (12.7 mm) in depth. A combination of flange and rabbet is acceptable. Other types of construction are acceptable if they comply with 5.2.3 or 5.2.4.

Figure 5.1
Rabbet



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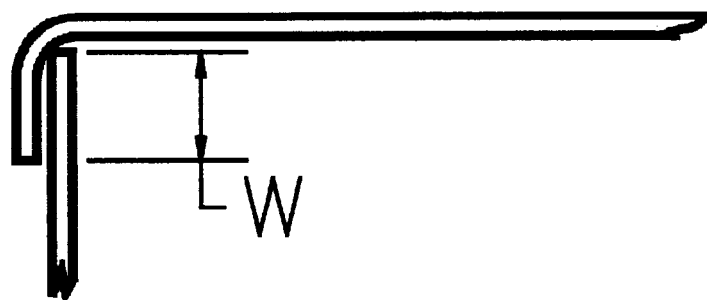
5.2.2 To determine compliance with the requirement in 5.2.1 regarding depth of flanges, the distance between the flat portion of the door or cover (clear of all forming radii, beads, draws, and the like) and a straight edge placed across any two flanges at any point is to be measured.

5.2.3 A construction involving a gasketed joint shall be investigated to determine whether it provides equivalent protection.

5.2.4 If the rabbet construction is not used, there shall be an overlap of no less than 7/16 inch (11.1 mm) at each edge at which a telescoping door or cover meets the cabinet or box of a surface-mounted enclosure.

5.2.5 To determine compliance with the requirement in 5.2.4, the enclosure is to be placed on its back on a bench, with the door or cover in its closed position, and a mark scribed on each wall of the box along the edge of the flange. The overlap is the measured distance W between the scribed marks and the edges of the box walls, as shown in Figure 5.2. In scribing the marks, the door or cover is to be held in a fixed position so that the cover will not be displaced by the scribing tool, but without bending or distorting any portion of the box, door, cover, or other part of the enclosure.

Figure 5.2
Measurement of overlap



SA0570A

5.2.6 A flat strip used to provide a rabbet, or an angle strip fastened to the edges of a door or cover giving access to a fuse or any portion of a circuit breaker other than the operating handle shall be no thinner than 60 percent of the required thickness of the metal of the box, and shall be no less than 0.042 inch (1.07 mm) thick if of uncoated steel, no less than 0.045 inch (1.14 mm) thick if of zinc coated steel, and no less than 0.058 inch (1.47 mm) thick if of nonferrous metal. Such a strip shall be secured at no fewer than two points. There shall be no more than 1-1/2 inches (38.1 mm) between an end of the strip and a point at which it is secured, and the distance between adjacent points at which the strip is secured shall not exceed 6 inches (152 mm).

5.3 Thickness of cast metal

5.3.1 Except for reinforcing ribs and door edges, an enclosure of cast metal shall be no less than 1/8 inch (3.2 mm) thick at any point, and no less than 1/4 inch (6.4 mm) thick at tapped holes for conduit.

Exception: Other than at plain or threaded conduit holes, die cast metal shall be:

a) *No less than 3/32 inch (2.4 mm) thick for an area greater than 24 square inches (154.8 cm²) or less and having no dimension greater than 6 inches (152 mm) and*

b) *No less than 1/16 inch (1.6 mm) thick for an area of 24 square inches or less and having no dimension greater than 6 inches. The area limitation may be obtained by the provision of reinforcing ribs subdividing a larger area.*

5.4 Thickness of sheet metal

5.4.1 The thickness of a sheet metal enclosure shall be no less than indicated in Tables 5.1 and 5.2.

Exception: At points where a wiring system will be connected, uncoated steel shall be no less than 0.032 inch (0.81 mm) thick, zinc coated steel shall be no less than 0.034 inch (0.86 mm) thick, and nonferrous metal shall be no less than 0.045 inch (1.14 mm) thick.

5.4.2 Tables 5.1 and 5.2 are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

5.4.3 With regard to Tables 5.1 and 5.2, a supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is attached to and has essentially the same outside dimensions as the enclosure surface and that has the torsional rigidity necessary to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure as rigid as one built with a frame of angles or channels. Constructions considered to be without supporting frames include a single sheet with single formed flanges (formed edges), a single sheet that is corrugated or ribbed, and an enclosure surface loosely attached to a frame (for example, with spring clips).

5.5 Ventilation openings

5.5.1 A ventilation opening in an enclosure, including a perforated hole, a louver, or an opening protected by means of wire screening, expanded metal, or a perforated cover, shall be judged in accordance with 6.1.3.

5.5.2 The diameter of the wires of a screen shall be no less than 0.051 inch (1.30 mm) if the screen openings are 1/2 square inch (323 mm²) or less in area, and shall be no less than 0.081 inch (2.06 mm) for larger screen openings.

Table 5.1
Minimum thickness of sheet metal for electrical enclosures
carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness	
Maximum width ^b , inches (cm)	Maximum length ^c , inches (cm)	Maximum width ^b , inches (cm)	Maximum length, inches (cm)	Uncoated, inch (mm)	Metal coated, inch (mm)
4.0 10.2	Not limited	6.25 15.9	Not limited		
4.75 12.1	5.75 14.6	6.75 17.1	8.25 21.0	0.020 ^d 0.51	0.023 ^d 0.58
6.0 15.2	Not limited	9.5 24.1	Not limited		
7.0 17.8	8.75 22.2	10.0 25.4	12.5 31.8	0.026 ^d 0.66	0.029 ^d 0.74
8.0 20.3	Not limited	12.0 30.5	Not limited		
9.0 22.9	11.5 29.2	13.0 33.0	16.0 40.6	0.032 0.81	0.034 0.86
12.5 31.8	Not limited	19.5 49.5	Not limited		
14.0 35.6	18.0 45.7	21.0 53.3	25.0 63.5	0.042 1.07	0.045 1.14
18.0 45.7	Not limited	27.0 68.6	Not limited		
20.0 50.8	25.0 63.5	29.0 73.7	36.0 91.4	0.053 1.35	0.056 1.42
22.0 55.9	Not limited	33.0 83.8	Not limited		
25.0 63.5	31.0 78.7	35.0 88.9	43.0 109.2	0.060 1.52	0.063 1.60
25.0 63.5	Not limited	39.0 99.1	Not limited		
29.0 73.7	36.0 91.4	41.0 104.1	51.0 129.5	0.067 1.70	0.070 1.78
33.0 83.8	Not limited	51.0 129.5	Not limited		
35.0 88.9	47.0 119.4	54.0 137.2	66.0 167.6	0.080 2.03	0.084 2.13
42.0 106.7	Not limited	64.0 162.6	Not limited		
47.0 119.4	59.0 149.9	68.0 172.7	84.0 213.4	0.093 2.36	0.097 2.46
52.0 132.1	Not limited	80.0 203.2	Not limited		
60.0 152.4	74.0 188.0	84.0 213.4	103.0 261.6	0.108 2.74	0.111 2.82
63.0 160.0	Not limited	97.0 246.4	Not limited		
73.0 185.4	90.0 228.6	103.0 261.6	127.0 322.6	0.123 3.12	0.126 3.20

^a See 5.4.3.

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

^c For panels that are not supported along one side (for example, side panels of boxes) the length of the unsupported side shall be limited to the dimensions specified.

^d Sheet steel for an enclosure intended for outdoor use (rainproof) is required to be no less than 0.034 inch (0.86 mm) thick if zinc coated and no less than 0.032 inch (0.81 mm) thick if uncoated.

Table 5.2
Minimum thickness of sheet metal for electrical enclosures
aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, inches (mm)
Maximum width ^b , inches (cm)	Maximum length ^c , inches (cm)	Maximum width ^b , inches (cm)	Maximum length, inches (cm)	
3.0 7.6	Not limited	7.0 17.8	Not limited	0.023 ^d 0.58
3.5 8.9	4.0 10.2	8.5 21.6	9.5 24.1	
4.0 10.2	Not limited	10.0 25.4	Not limited	0.029 0.74
5.0 12.7	6.0 15.2	10.5 26.7	13.5 34.3	
6.0 15.2	Not limited	14.0 35.6	Not limited	0.036 0.91
6.5 16.5	8.0 20.3	15.0 38.1	18.0 45.7	
8.0 20.3	Not limited	19.0 48.3	Not limited	0.045 1.14
9.5 24.1	11.5 29.2	21.0 53.3	25.0 63.5	
12.0 30.5	Not limited	28.0 71.1	Not limited	0.058 1.47
14.0 35.6	16.0 40.6	30.0 76.2	37.0 94.0	
18.0 45.7	Not limited	42.0 106.7	Not limited	0.075 1.91
20.0 50.8	25.0 63.5	45.0 114.3	55.0 139.7	
25.0 63.5	Not limited	60.0 152.4	Not limited	0.095 2.41
29.0 73.7	36.0 91.4	64.0 162.6	78.0 198.1	
37.0 94.0	Not limited	87.0 221.0	Not limited	0.122 3.10
42.0 106.7	53.0 134.6	93.0 236.2	114.0 289.6	
52.0 132.1	Not limited	123.0 312.4	Not limited	0.153 3.89
60.0 152.4	74.0 188.0	130.0 330.2	160.0 406.4	

^a See 5.4.3.

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

^c For panels that are not supported along one side (for example, side panels of boxes) the length of the unsupported side shall be limited to the dimensions specified.

^d Sheet copper, brass, or aluminum for an enclosure intended for outdoor use (rainproof) shall be no less than 0.029 inch (0.74 mm) thick.

5.5.3 Perforated sheet steel and sheet steel used for expanded metal mesh shall be no less than 0.042 inch (1.07 mm) thick if uncoated and no less than 0.046 inch (1.17 mm) thick if zinc coated for mesh openings or perforations 1/2 square inch (323 mm²) or less in area, and shall be no less than 0.080 inch (2.03 mm) thick if uncoated and no less than 0.084 inch (2.13 mm) thick if zinc coated for larger openings.

Exception: In a small unit where the indentation of a guard or enclosure will not alter the clearance between uninsulated, movable live parts and grounded metal so as to adversely affect performance or reduce spacings below the minimum values, expanded metal mesh of uncoated steel not less than

0.020 inch (0.51 mm) thick may be used if the exposed mesh on any one side or surface of the device so protected has an area no greater than 1/2 square foot (0.046 m²) and has no dimension greater than 12 inches (305 mm), or if the width of an opening so protected is no greater than 3-1/2 inches (88.9 mm).

5.6 Nonmetallic enclosures

5.6.1 An enclosure of insulating or other nonmetallic material shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

5.7 Tapped holes and knockouts

5.7.1 A tapped hole for the attachment of threaded rigid conduit shall be provided with:

- a) An end stop (or located so that a standard bushing may be attached to the end of the conduit);
- b) In equipment for outdoor use, a tapered thread, if not provided with an end stop; and
- c) At least three full threads when tapped all the way through the wall of an enclosure, or with at least 3-1/2 full threads and a smooth, well-rounded inlet hole having a diameter approximately the same as the internal diameter of a standard bushing to provide protection for the conductors equivalent to that provided by such a bushing.

5.7.2 A knockout shall be provided with a flat surrounding surface for proper seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than the minimum requirements in this standard.

5.7.3 For an enclosure not provided with conduit openings or knockouts, spacings no less than the minimum required shall be provided between uninsulated live parts and a conduit bushing installed at any location likely to be used during installation. Permanent marking on the enclosure, a template, or a full scale drawing furnished with the unit may be used to limit such a location.

5.7.4 In measuring a spacing between an uninsulated live part and a bushing installed in the knockout referred to in 5.7.2 and 5.7.3, it is to be assumed that a bushing having the dimensions indicated in Table 5.3 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

5.8 Remote or automatic units – enclosures

5.8.1 The enclosure of a remotely- or automatically-controlled unit; a unit intended for operation unattended; or a unit whose operation or failure to operate would not be evident to the operator shall reduce the risk of molten metal, burning insulation, flaming particles, or the like falling outside the enclosure or onto the surface upon which the unit rests or is supported through ventilation or other openings.

Table 5.3
Dimensions of bushings

Trade size of conduit, inches	Overall diameter,		Height,	
	inches	(mm)	inches	(mm)
1/2	1	25.4	3/8	9.5
3/4	1-15/64	31.4	27/64	10.7
1	1-19/32	40.5	33/64	13.1
1-1/4	1-15/16	49.2	9/16	14.3
1-1/2	2-13/64	56.0	19/32	15.1
2	2-45/64	68.7	5/8	15.9
2-1/2	3-7/32	81.8	3/4	19.1
3	3-7/8	98.4	13/16	20.6
3-1/2	4-7/16	113	15/16	23.8
4	4-31/32	126	1	25.4
4-1/2	5-35/64	141	1-1/16	27.0
5	6-7/32	158	1-3/16	30.2
6	7-7/32	183	1-1/4	31.8

5.8.2 The requirement in 5.8.1 necessitates the use of a barrier or pan of material resistant to combustion:

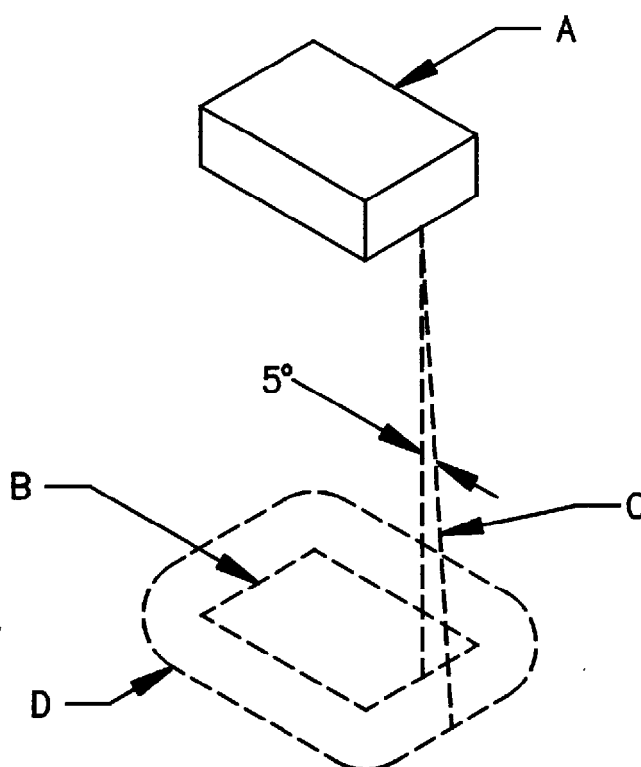
a) Under a motor unless one of the following four items applies:

- 1) The structural parts of the motor or of the unit provide the equivalent of such a barrier;
- 2) The overload (overcurrent) protection provided with the motor is such that no burning insulation, molten metal, or the like falls to the surface that supports the unit when the motor is energized under each of the following fault conditions:
 - i) Main winding opened,
 - ii) Starting winding opened,
 - iii) Starting switch short circuited, and
 - iv) For a permanent split capacitor motor, the capacitor 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 motor protector (a protective device that is sensitive to both temperature and current) so that the temperature of the motor windings will not exceed 125°C (257°F) under the maximum load that the motor will run without causing the protector to cycle, and will not exceed 150°C (302°F) with the rotor of the motor locked; or

- 4) The motor complies with the requirements for impedance protected motors.
- b) Under wire unless it is of the flame retardant type (such as thermoplastic and neoprene insulated wires).
- c) Under a switch, relay, solenoid, transformer, or the like unless it can be shown that failure of the component will not result in a risk of fire.

5.8.3 The barrier mentioned in 5.8.2 shall be horizontal or constructed to provide equivalent protection and shall be located and no smaller in area than as indicated in Figure 5.3. One or more openings for drainage, ventilation, and the like may be used in the barrier if they are protected by a baffle, screen, or the like so that molten metal, burning insulation, and the like cannot fall outside the enclosure.

Figure 5.3
Location and extent of barrier



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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. When moving, the line is always tangent to the component, 5 degrees from the vertical, and 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.

6 Accessibility of Live Parts

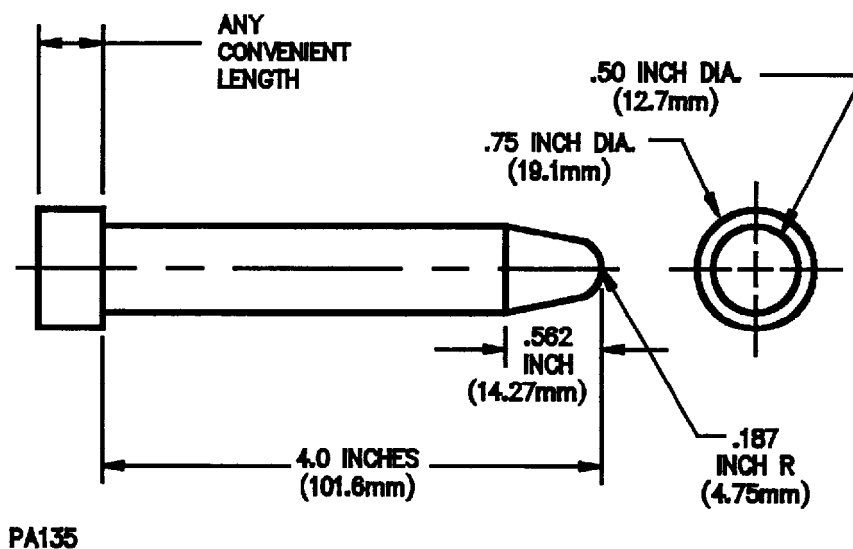
6.1 General

6.1.1 An electrical part shall be located or enclosed so that persons are protected against inadvertent contact with uninsulated live parts.

Exception: Live parts may be accessible if the available open circuit potential is 42.4 volts peak or less, or if the available current measured through a 1500-ohm resistor is 5 milliamperes or less. The method for evaluating openings in the enclosure is specified in 6.1.2 and 6.1.3.

6.1.2 An opening anywhere in the enclosure of a hand-supported unit or part, or in any portion of a unit hand-held in normal use, is acceptable if a probe (Figure 6.1) inserted point-first as far as possible into the opening does not enter the opening for a distance of more than 1/8 inch (3.2 mm) and does not touch any uninsulated live part or film-coated wire.

Figure 6.1
Accessibility probe



6.1.3 In the enclosure of equipment other than as described in 6.1.2:

- a) An opening that does not admit a 3/4-inch (19.1-mm) diameter rod is acceptable if:
 - 1) The probe in Figure 6.1 cannot be made to touch any uninsulated live part when inserted through the opening, and
 - 2) The probe in Figure 6.2 cannot be made to touch film-coated wire when inserted through the opening.
- b) An opening that admits a 3/4-inch diameter rod is acceptable under the conditions described in Figure 6.3.

Figure 6.2
Accessibility probe

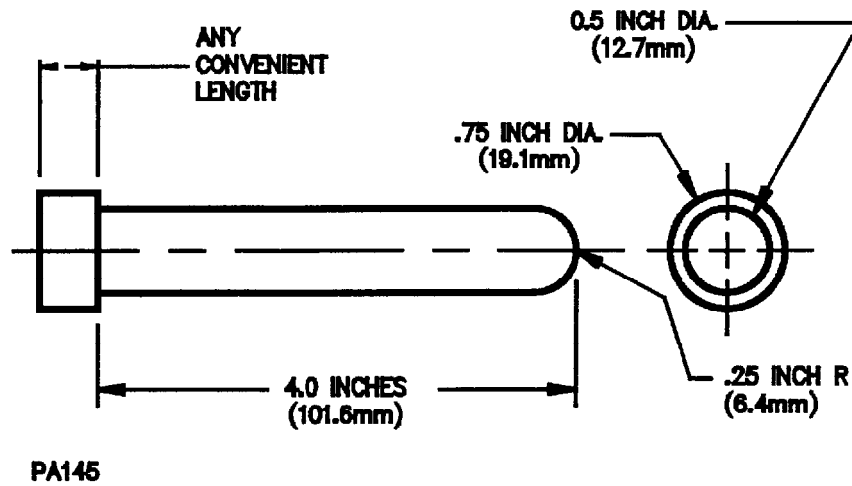
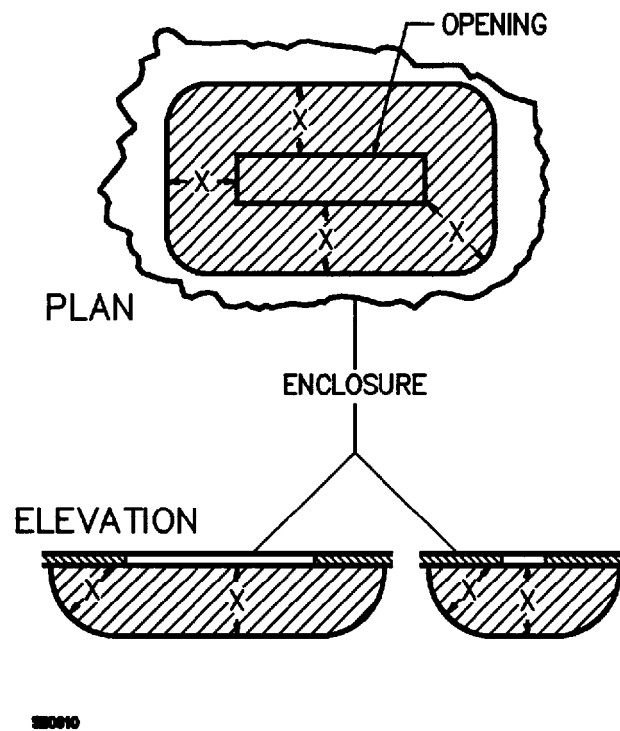


Figure 6.3
Openings in enclosure



The opening is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire less than X inches from the perimeter of the opening, and within the volume generated by projecting the perimeter X inches normal to its plane. X equals five times the diameter of the largest-diameter rod that can be inserted through the opening, but no less than 4 inches (102 mm).

6.1.4 If any part of the enclosure either must be opened or removed for user servicing with or without the use of tools, or can be opened or removed without the use of tools, the probes specified in 6.1.2 and 6.1.3 are to be inserted without such a part in place.

6.1.5 It is to be assumed that the user of a control center or equipment of similar complexity enters the enclosure only for user servicing. Thumbscrews, finger latches, and the like that are used for the closing of doors or securing of panels are considered acceptable for securing doors or panels that are not opened or removed during user servicing. Doors or panels that are not opened or removed during such servicing are to be closed or in place during application of the probes described in 6.1.2 and 6.1.3.

6.2 Interlocks

6.2.1 An interlock provided for the purpose of protecting persons against contact with a live part shall open all ungrounded conductors.

Exception: An interlock switch that opens all conductors in the area in which the interlock is intended to provide protection is acceptable even though conductors outside the protected area remain energized.

6.3 Lampholders, fuseholders, and circuit breakers

6.3.1 Unless a unit is marked in accordance with 49.2, a lampholder, fuseholder, or circuit breaker shall be constructed and installed so that a person servicing the lamp, fuse, or breaker will not be exposed to contact with a live part other than the screw shell of a lampholder or the fuseholder clips.

7 Mechanical Assembly

7.1 A unit shall be assembled so that it will not be affected adversely by the vibration of normal operation.

7.2 A switch, fuseholder, lampholder, receptacle, motor attachment cap, or other component that is handled by the user shall be mounted securely and prevented from turning.

Exception: The requirement that a switch be prevented from turning may be waived if all four of the following conditions are present:

- a) The switch is of a plunger, slide, 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;*
- b) The means of mounting the switch make it unlikely that operation of the switch will loosen it;*
- c) Spacings cannot be reduced below the minimum acceptable values if the switch does rotate; and*
- d) Normal operation of the switch is by mechanical means rather than manually.*

7.3 The means by which the turning specified in 7.2 is prevented is to include more than just friction between surfaces – for example, a lock washer, properly applied, is acceptable as the means for prevention of turning of a device having a single hole mounting means.