UL 1340

STANDARD FOR SAFETY

Hoists

UL Standard for Safety for Hoists, UL 1340

Third Edition, Dated October 14, 2016

Summary of Topics

This revision of UL 1340 dated June 9, 2021 includes Rechargeable Battery Powered Hoist Requirements; Supplement SB.

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 requirements are substantially in accordance with Proposal(s) on this subject dated April 23, 2021.

No Text on This Page

OCTOBER 14, 2016
(Title Page Reprinted: June 9, 2021)

UL 1340

Standard for Hoists

First Edition – July, 2004
Second Edition – April, 2012

Third Edition

October 14, 2016

This UL Standard for Safety consists of the Third Edition including revisions through June 9, 2021.

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

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

ALL HOISTS

ELECTRICALLY POWERED HOISTS

PERFORMANCE

ALL HOISTS

ELECTRICALLY POWERED HOISTS

PNEUMATICALLY POWERED HOISTS

MANUFACTURING AND PRODUCTION TESTS

ELECTRICALLY POWERED HOISTS

MARKINGS

ALL HOISTS

INSTALLATION AND OPERATING INSTRUCTIONS

SUPPLEMENT SA – RESIDENTIAL HOISTS

GENERAL

CONSTRUCTION

PERFORMANCE

SUPPLEMENT SB – RECHARGEABLE BATTERY POWERED HOISTS

GENERAL

APPENDIX A

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements cover hoists of the overhead type intended for material lifting service using either chain, wire rope, or fibre kernmantle rope. They are intended to be suspended from a fixed member and may include trolleys for mobility.

1.2 This standard covers electrically powered hoists rated 1000 volts or less to be employed in nonhazardous environmental locations in accordance with the National Electrical Code, NFPA 70.

1.3 This standard covers pneumatically powered hoists.

1.4 These requirements do not cover:

a) Manual and power-operated type portable hoists intended for use with scaffolds suspended by wire ropes;

b) Hoists for transporting people;

c) Manual operated chain hoists;

d) The trolley as a stand-alone component; or

e) The fixed member that suspends the hoist.

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 used in the products covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

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

2.2.2 Unless 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 BONDED (BONDING) – The permanent joining of metallic parts to form an electrically conductive path that provides electrical continuity and the capacity to conduct any current likely to be imposed without a risk of electric shock, fire, or injury to persons.

3.3 BONDING JUMPER – A conductor, including a strap or similar part, that is used to provide the required electrical conductivity between metal parts required to be electrically connected.

3.4 CIRCUITS, ELECTRICAL –

a) High-Voltage – A circuit with a potential of not more than 1000 volts having circuit characteristics greater than those of a low-voltage power-limited circuit.

b) Low-Voltage – A circuit with a potential of not more than 30 volts AC rms, 42.4 volts DC or AC peak, and supplied by:

1) A primary battery;

2) An NEC Class 2 transformer; or

3) A combination of transformer and fixed impedance that, as a unit, complies with all of the performance requirements for a Class 2 transformer.

3.5 FIBRE KERNMANTLE ROPE – A rope design consisting of an interior core and an outer sheath.

3.6 GROUND – A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

3.7 GROUNDED – Connected to earth or to some conducting body that serves in place of earth.

3.8 GROUNDING CONDUCTOR – An equipment or circuit conductor that is intentionally connected between that electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

3.9 HOIST – A suspended machinery unit that is used for lifting or lowering a freely suspended (unguided) load. When a hoist is suspended from a trolley, the trolley shall be considered part of the hoist.

a) ELECTRICALLY POWERED – A hoist in which the prime mover is powered by electricity.

b) PNEUMATICALLY POWERED – A hoist in which the prime mover is powered by compressed gases.

3.10 RATED WORKING LOAD – The manufacturer's specified maximum load to be lifted by the hoist. The maximum load includes the weight of all materials, and all dead loads lifted by the hoist. Dead loads include the weight of:

a) The hoist;

b) Wire rope, chains, or fibre kernmantle rope;

c) Rigging equipment/device (s) attached to the hoist's bottom hook (e. g., slings, spreader bar/beams); and

d) Ancilliary equipment supported by the hoist, such as the electrical cords, air supply hoses, chain container, etc.

CONSTRUCTION

ALL HOISTS

4 General

4.1 A product shall be constructed so that it will have the strength and durability to withstand normal usage and to comply with the performance requirements.

4.2 An exposed metal surface shall be free from sharp edges, burrs, and other features that constitute a risk of injury to persons.

5 Materials and Assembly

5.1 All metal parts and fittings shall be made of aluminum or steel alloys, wrought iron, malleable iron, or other metal that is of equivalent strength for the intended purpose and shall be securely attached by means of rivets, bolts, screws, or other means determined to be the equivalent. Cast gray iron shall not be used for load-carrying parts.

5.2 Nuts shall be lock nuts or provided with lock washers.

5.3 For a hoist that is designed to operate using a fibre kernmantle rope, the rope shall be a static type in compliance with the requirements in Low Stretch and Static Kernmantle Life Safety Rope, CI 1801.

6 Protection Against Corrosion

6.1 All hardware and materials shall be resistant to normal atmospheric corrosion.

Exception: Aluminum, brass, copper, stainless steel, or other metal inherently resistant to corrosion may be used without additional protection.

6.2 Corrosion protection shall be by metallic or nonmetallic coatings, such as galvanizing, sherardizing, plating, or painting.

6.3 Different metals shall not be used in combination such as to cause galvanic action that will adversely affect the strength of the product.

7 Lubrication

7.1 Each separate enclosure of a hoist shall be provided with a means to maintain lubrication of all moving parts requiring lubrication at all times.

7.2 Self-sealed, self-lubricating, and dry bearings may be employed.

ELECTRICALLY POWERED HOISTS

8 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

8.1 To reduce the risk of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, or injury to a person from a moving part, an opening in an enclosure shall comply with either (a) or (b).

a) For an opening that has a minor dimension (see 8.5) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 8.1.

b) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in Table 8.1.

Exception No. 1: A motor need not comply with these requirements if it complies with the requirements in 8.2.

Exception No. 2: The inrunning wire rope need not comply with these requirements at any point where a static guide is provided. If roller guides or tension rollers are used, a fixed shield or static guard shall be provided to prevent access to the pinch area by the probe shown in Figure 8.2.

Exception No. 3: For a winding drum hoist, the inrunning wire rope at the drum need not be guarded when the drum is located in an area not readily accessible to a user in the normal work position. The pinch area shall be located off and below, or a minimum of 7 feet (2.13 m) above, the normal scaffold work area.

Figure 8.1

Articulate probe with web stop

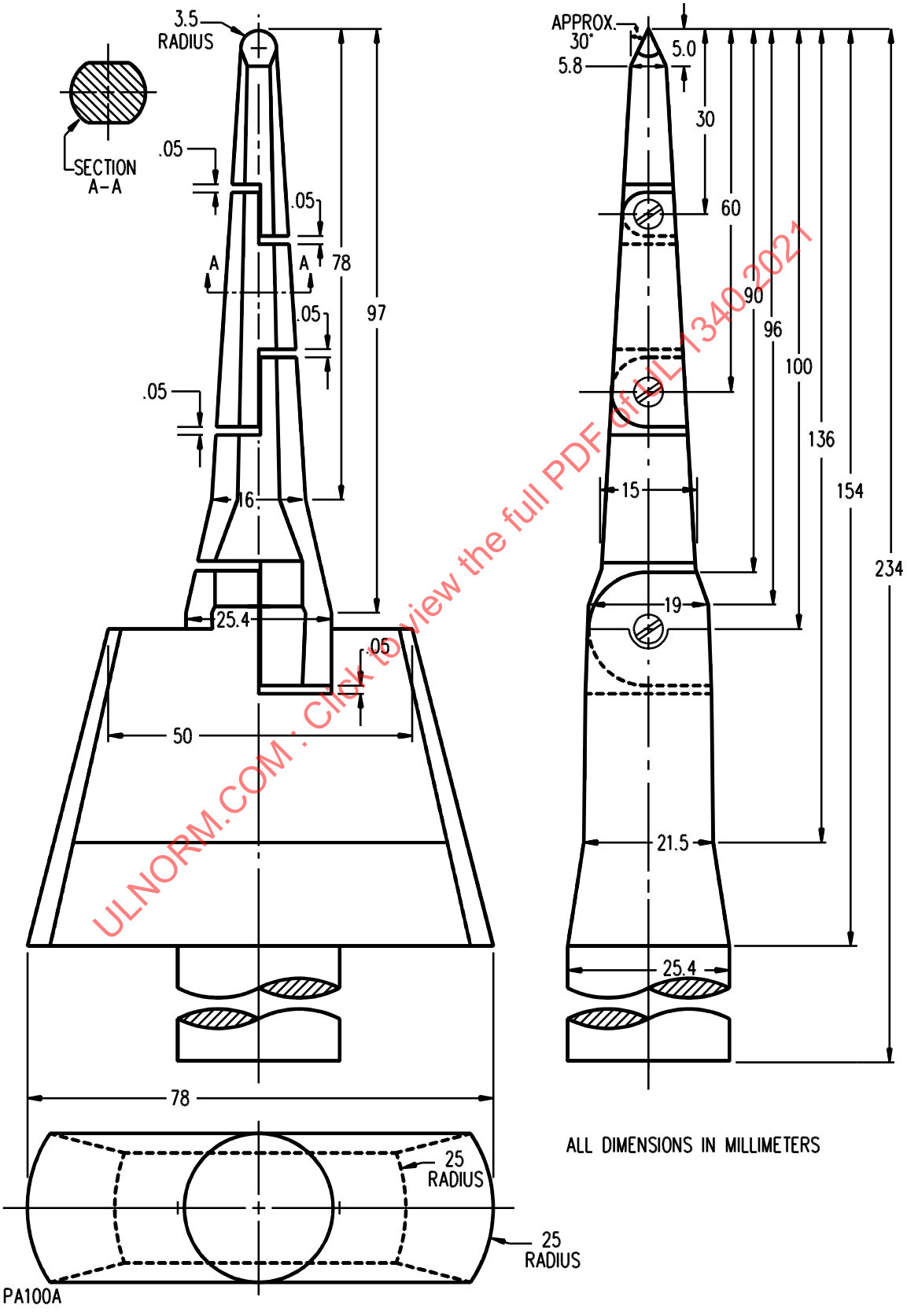
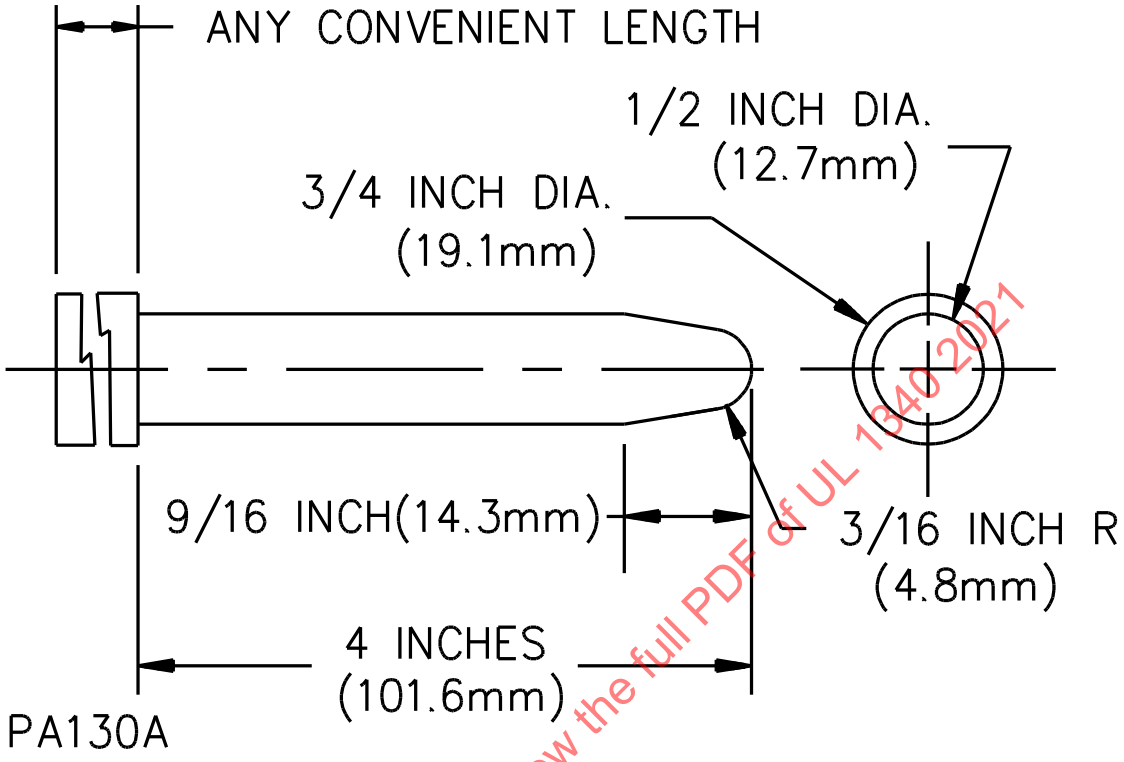


Figure 8.2

Probe for moving parts and uninsulated live parts



8.2 Regarding a part or wire in an integral enclosure of a motor mentioned in Exception No. 1 to 8.1:

a) An opening that has a minor dimension (see 8.5) less than 3/4 inch (19.1 mm) complies with these requirements if:

1) A moving part cannot be contacted by the probe illustrated in Figure 8.2;

2) Film-coated wire cannot be contacted by the probe illustrated in Figure 8.3;

3) In a directly accessible motor (see 8.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 8.4; and

4) In an indirectly accessible motor (see 8.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 8.2.

b) An opening that has a minor dimension of 3/4 inch or more may be used if a part or wire is spaced from the opening as specified in Table 8.1.

Figure 8.3

Probe for film-coated wire

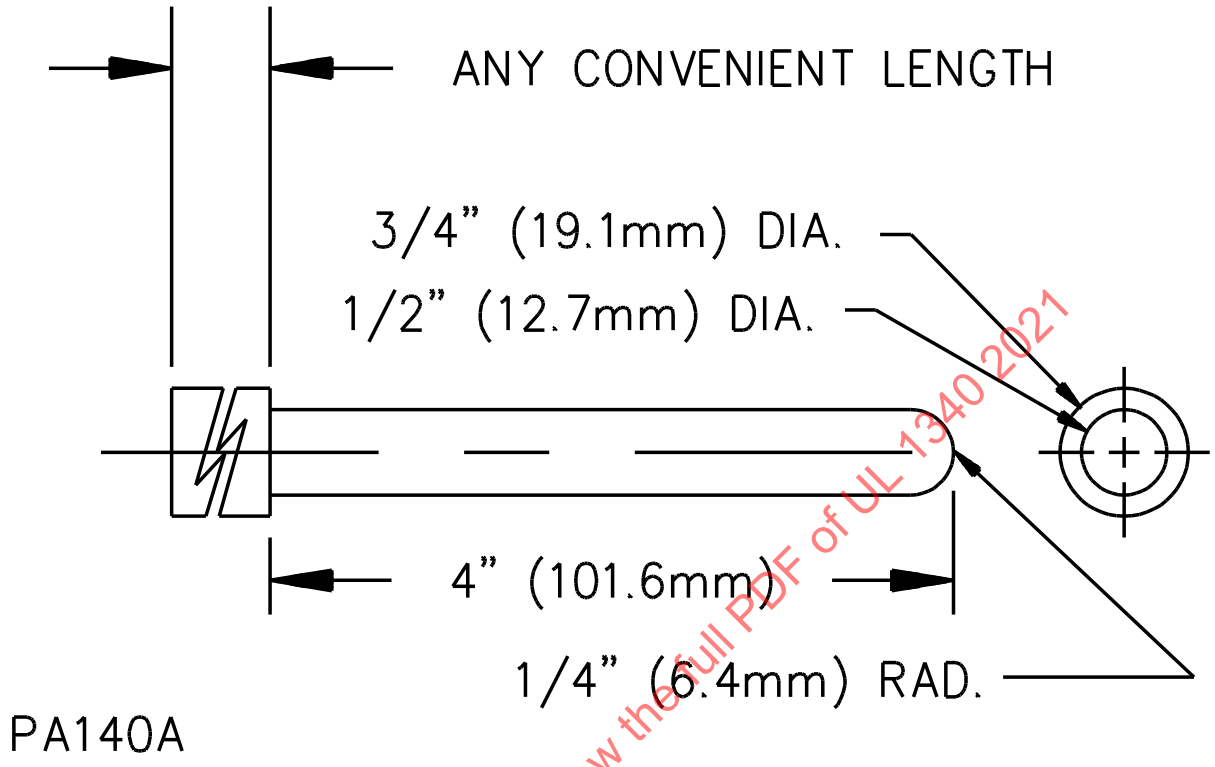


Figure 8.4

IEC articulate probe

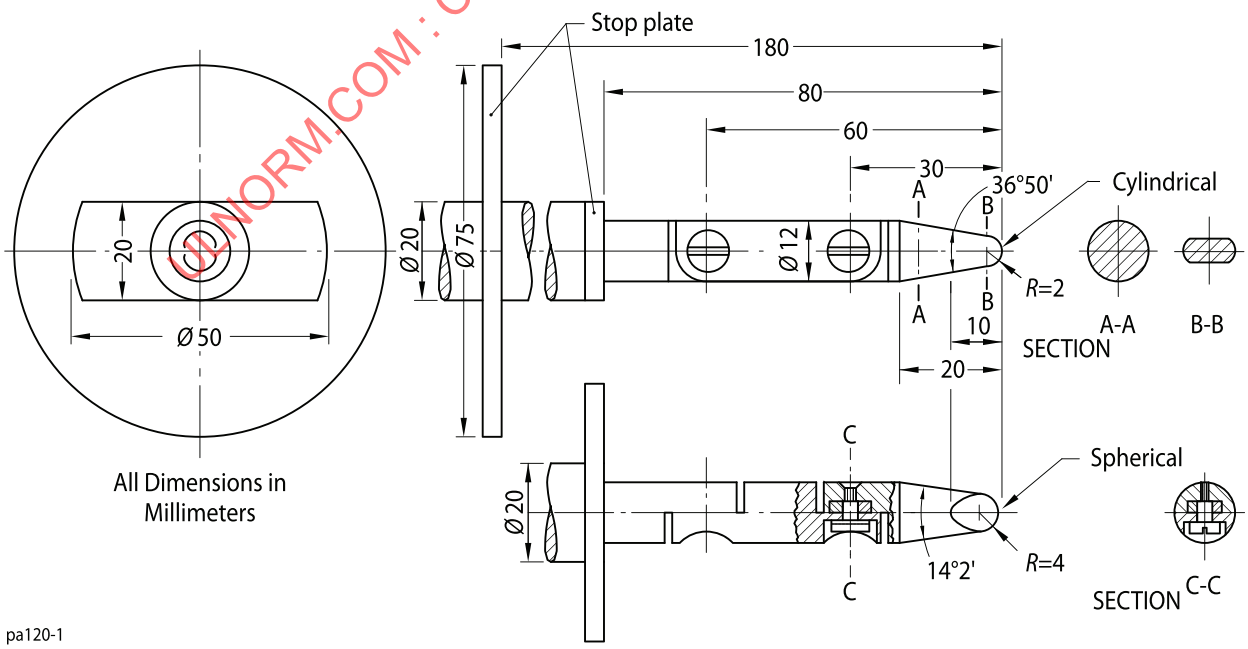


Table 8.1
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

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

[a] See 8.5.
[b] Between 3/4 and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.

8.3 The probes mentioned in 8.1 and 8.2 and illustrated in Figure 8.1 – Figure 8.4 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 8.1 and Figure 8.4 shall be applied in any possible configuration, and if necessary, the configuration shall be changed after insertion through the opening.

8.4 The probes mentioned in 8.3 and 8.5 shall be used as measuring instruments to evaluate the accessibility provided by an opening, and not as instruments to evaluate the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

8.5 With reference to the requirements in 8.1 and 8.2, 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.

8.6 With reference to the requirements in 8.2, an indirectly accessible motor is a motor that is:

a) Accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool or

b) Located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A directly accessible motor is a motor that can be contacted without opening or removing any part or that is located so as to be accessible to contact.

8.7 During the examination of a hoist to determine compliance with the requirements in 8.1 or 8.2, a part of the enclosure that may be opened or removed by the user without using a tool (for example, to attach an accessory or to make an operating adjustment) is to be opened or removed.

8.8 With reference to the requirements in 8.1 and 8.2, insulated brush caps are not required to be additionally enclosed.

9 Electrical Component Enclosures

9.1 General

9.1.1 An electrical enclosure or enclosure part shall have the necessary strength and rigidity to resist, under conditions of anticipated service, total or partial collapse which may result in:

a) The reduction of spacings, or the loosening or displacement of parts; and

b) Other defects that alone or in combination can result in a risk of fire or electric shock.

9.1.2 The construction of enclosures for individual electrical components, outer enclosures, and combinations of the two is to be considered in determining compliance with the requirement in 9.1.1.

9.1.3 If necessary, an enclosure shall be reinforced or formed to reduce the risk of damage during handling in shipment, installation, and use.

9.1.4 Access to the interior of electrical enclosures shall require the use of tools.

9.1.5 Electrical enclosures shall comply with the Rain Test, Section 33.

9.2 Nonmetallic enclosures

9.2.1 Among the factors that shall be taken into consideration when evaluating the acceptability of a nonmetallic enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility; and

e) Resistance to distortion at temperatures to which the material may be subjected.

Under conditions of normal or abnormal use, the material shall not display a loss of these properties beyond the minimum level of safety as a result of aging. A nonmetallic enclosure is also to be evaluated on the basis of the effect of exposure to water and ultraviolet light.

9.2.2 The mechanical strength of a nonmetallic enclosure or enclosure part shall be at least equivalent to that of a sheet-metal enclosure of the minimum thickness specified in Table 9.1.

Table 9.1
Thickness of sheet metal for enclosures – carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Uncoated,		Metal coated,	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch	(mm)	inch	(mm)
4.0	10.2	Not limited		6.25	15.9	Not limited		0.020[d]	0.51	0.023[d]	0.58
4.75	12.1	5.75	14.6	6.75	17.1	8.25	21.0				
6.0	15.2	Not limited		9.5	24.1	Not limited		0.026[d]	0.66	0.029[d]	0.74
7.0	17.8	8.75	22.2	10.0	25.4	12.5	31.8				
8.0	20.3	Not limited		12.0	30.5	Not limited		0.032	0.81	0.034	0.86
9.0	22.9	11.5	29.2	13.0	33.0	16.0	40.6				
12.5	31.8	Not limited		19.5	49.5	Not limited		0.042	1.07	0.045	1.14
14.0	35.6	18.0	45.7	21.0	53.3	25.0	63.5				
18.0	45.7	Not limited		27.0	68.6	Not limited		0.053	1.35	0.056	1.42
20.0	50.8	25.0	63.5	29.0	73.7	36.0	91.4				
22.0	55.9	Not limited		33.0	83.8	Not limited		0.060	1.52	0.063	1.60
25.0	63.5	31.0	78.7	35.0	88.9	43.0	109.2				
25.0	63.5	Not limited		39.0	99.1	Not limited		0.067	1.07	0.070	1.78
29.0	73.7	36.0	91.4	41.0	104.1	51.0	129.5				
33.0	83.8	Not limited		51.0	129.5	Not limited		0.080	2.03	0.084	2.13
38.0	96.5	47.0	119.4	54.0	137.2	66.0	167.6				
42.0	106.7	Not limited		64.0	162.6	Not limited		0.093	2.36	0.097	2.46
47.0	119.4	59.0	149.9	68.0	172.7	84.0	213.4				
52.0	132.1	Not limited		80.0	203.2	Not limited		0.108	2.74	0.111	2.82
60.0	152.4	74.0	188.0	84.0	213.4	103.0	261.6				
63.0	160.0	Not limited		97.0	246.4	Not limited		0.123	3.12	0.126	3.20
73.0	185.4	90.0	228.6	103.0	261.6	127.0	322.6				

[a] See 9.3.1.4.

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

[c] Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.

[d] Sheet steel for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.034 inch (0.86 mm) thick if zinc coated and not less than 0.032 inch (0.81 mm) thick if uncoated.

9.2.3 If the dimensional stability of a nonmetallic material is intended to maintain the continuity of the grounding system, an investigation shall be conducted to determine the effect of aging on the material. The result shall show that aging has a minimal effect on the material and poses no risk of fire, electric shock, or injury to persons.

9.2.4 An enclosure of polymeric material shall comply with the applicable requirements for products that are not categorized as household use only as contained in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

9.2.5 An enclosure of polymeric material shall be subjected to the Resistance to Impact Test described in UL 746C before and after cold conditioning at minus 35°C (minus 31°F) for 3 hours. For products marked in accordance with 46.6, the cold conditioning shall be at 0° C (32° F) for 3 hours. After each test, the enclosure shall comply with 9.1.1.

Exception: A product marked in accordance with 46.7 is not required to be subjected to the cold conditioning.

9.3 Metallic enclosures

9.3.1 General

9.3.1.1 These requirements do not cover the effects of corrosion that might be caused by exposure to the earth or other corrosive agents.

9.3.1.2 Cast metal of an enclosure shall be:

a) At least 1/8 inch (3.2 mm) thick at every point and

b) Greater than 1/8 inch thick at reinforcing ribs and door edges.

Exception: The thickness of die-cast metal may be:

a) Not less than 3/32 inch (2.4 mm) thick for an area greater than 24 square inches (154.8 cm^2) or having any dimensions greater than 6 inches (152 mm) and

b) Not less than 1/16 inch (1.6 mm) thick for an area of 24 square inches or less and having no dimensions greater than 6 inches.

The area limitation may be obtained by the provision of reinforcing ribs subdividing a larger area.

9.3.1.3 Sheet metal of an enclosure shall have a thickness not less than that specified in Table 9.1 and Table 9.2.

9.3.1.4 With reference to Table 9.1 and Table 9.2, a supporting frame is an angled structure or channel, or folded rigid section of sheet metal, that:

a) Is rigidly attached to the enclosure surface;

b) Has essentially the same outside dimensions as the enclosure surface; and

c) Has sufficient torsional rigidity to resist the bending moments that may be applied by the enclosure surface when it is deflected.

Table 9.2
Thickness of sheet metal for enclosures – aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,			
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch	(mm)
3.0	7.6	Not limited		7.0	17.8	Not limited		0.023[d]	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	63.4	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 9.3.1.4.

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

[c] Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.

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

9.3.1.5 It may be determined that equivalent reinforcing can be accomplished by constructions that will produce a structure as rigid as one that is built with a frame of angles or channels. Construction types without a supporting frame include:

a) A single sheet with single formed flanges or formed edges;

b) A single sheet that is corrugated or ribbed;

c) An enclosure surface loosely attached to a frame, for example, with spring clips; and

d) An enclosure surface having an unsupported edge.

9.3.2 Corrosion protection

9.3.2.1 An enclosure of cast iron or malleable iron shall be protected against corrosion by:

a) A 0.00015-inch (0.0038-mm) thick coating of zinc or cadmium (or other compound that has been determined to be equivalent) on the outside surface and a visible coating of such metal on the inside surface or

b) One coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface.

9.3.2.2 Corrosion tests are to be conducted on the paint noted in 9.3.2.1(b) unless an evaluation can determine the suitability of the paint's composition.

9.3.2.3 A sheet steel enclosure having a thickness less than 0.126 inch (3.20 mm) if zinc-coated or 0.123 inch (3.12 mm) thick if uncoated shall be protected against corrosion by one of the following means:

a) Hot-dipped mill galvanized sheet steel conforming with the coating Designation G90 in Table I of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single-spot-test requirement in this ASTM specification. The weight of zinc coating may be determined by any method deemed acceptable; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-93.

b) A zinc coating, other than that provided on hot-dipped mill galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.015 mm) on each surface with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of the coating shall be established by the Metallic-Coating-Thickness Test, Section 25. An annealed coating shall also comply with 9.3.2.8.

c) A zinc coating conforming with 9.3.2.4 (a) or (b) with open coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface applied after forming. See 9.3.2.2.

d) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of the coating shall be established in accordance with the Metallic-Coating-Thickness Test, Section 25.

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint conforming with 9.3.2.1(b) and 9.3.2.2 on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with the Metallic-Coating-Thickness Test, Section 25, and the paint shall be as specified in (c).

Exception: Other metallic or nonmetallic coatings that have been determined to provide equivalent protection as described in 9.3.2.6 may be used.

9.3.2.4 An enclosure of sheet steel 0.126 inch (3.20 mm) thick if zinc coated, or 0.123 inch (3.12 mm) thick if uncoated or heavier shall be protected against corrosion by one of the following means:

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

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.010 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the Metallic-Coating-Thickness Test, Section 25.

c) Two coats of an organic finish of the epoxy or alkyd resin or other outdoor paint on each surface. See 9.3.2.2.

d) Any one of the means specified in 9.3.2.3.

Exception: Other metallic or nonmetallic coatings that have been determined to provide equivalent protection as described in 9.3.2.6 may be used.

9.3.2.5 The requirements in 9.3.2.4 also apply to sheet steel that is 0.056 inch (1.42 mm) thick if zinc-coated or 0.053 inch (1.35 mm) if uncoated or heavier for use as an enclosure that is intended to be mounted within an enclosure of other equipment (such as an air conditioner) so that it will be protected from direct exposure to weather. Such an enclosure shall not be marked rainproof or raintight.

9.3.2.6 With reference to 9.3.2.3 – 9.3.2.5, other finishes, including paints, metallic finishes, and combinations of the two may be used if comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with 9.3.2.3(a) or 9.3.2.4(a), as applicable, indicate that they provide equivalent protection. Among the factors that are to be considered when evaluating 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.

9.3.2.7 Test specimens of a finish as described in 9.3.2.1, 9.3.2.3(c), 9.3.2.4(c) or 9.3.2.6 (if the paint is tested) 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, or the like.

9.3.2.8 A hot-dipped, mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing, and that is not otherwise required to be painted, shall be painted in the bent or formed area if the bending or forming process has damaged the zinc coating. However, such areas on the inside surface of an enclosure that are not exposed to water 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.

9.3.2.9 The requirements in 9.3.2.8 apply to extruded and rolled edges, but not to punched holes or simple sheared or cut edges unless the base material is over 0.125 inch (3.18 mm) thick.

10 Supply Connections

10.1 General

10.1.1 A hoist shall be provided with a power-supply cord that is not likely to be damaged or impaired by any cutting edges, blades, belts, or rotating parts of the hoist during intended operation.

Exception No. 1: A hoist may employ a connector base for connecting an extension cord.

Exception No. 2: A hoist may be provided without a power-supply cord if the instructions specified in 46.8 and 48.4 are included.

10.1.2 A hoist intended for use with an extension cord shall not be provided with terminal pins that will accommodate a standard flat iron or appliance plug.

10.1.3 A power-supply cord or extension cord shall be rated for a voltage not less than the rated voltage of the equipment and shall have a current rating not less than the current rating of the equipment. It shall be of Type SJ, SJT, SO, SOO, ST, STO, STOO or of a type at least equally serviceable for the particular application.

10.1.4 A hoist for outdoor use shall have a power-supply cord or extension cord that complies with the outdoor-use requirements specified in the Standard for Cord Sets and Power-Supply Cords, UL 817.

10.1.5 A power-supply cord shall be for use at a voltage not less than the rated voltage of the hoist and shall have an ampacity, as determined in accordance with the National Electrical Code, NFPA 70, of not less than the current rating of the hoist.

10.1.6 An attachment plug shall have a current rating not less than the rated current of the hoist, and a nominal voltage rating equal to the rated voltage of the hoist. If the hoist can be adapted for use on two or more different values of voltage by field alteration of internal connections, the attachment plug provided with the hoist shall be rated for the voltage for which the hoist is connected when shipped from the factory. See 44.3.

10.1.7 A three- to two-wire grounding adapter shall not be provided with a hoist.

10.1.8 An attachment plug may be of the locking type.

10.1.9 An attachment plug shall be provided with a weather sleeve to prevent the entrance of moisture during the Rain Test, Section 33.

10.2 Strain relief

10.2.1 The power-supply cord shall be provided with strain relief means so that a strain on the cord will not be transmitted to terminals, splices, or internal wiring. See the Strain-Relief Test, Section 32. If a metallic strain-relief means is provided, it shall not contact uninsulated live parts or reduce spacings within the enclosure if the cord is moved inward. The cord shall not be subject to damage by moving parts.

10.3 Bushings

10.3.1 A bushing shall be secured in place at the point where a flexible cord passes through an opening in a wall, barrier, or enclosing case. The bushing shall have:

a) A smooth, rounded surface against which the cord may bear and

b) Heat- and moisture-resistant properties that have been evaluated to be acceptable for the application.

Exception: A smoothly rounded hole in the wall or barrier may be used in lieu of a separate bushing.

10.3.2 The edges of the entry hole for the power-supply cord, including the cord entry hole in a bushing, shall be smooth and rounded, without burrs, fins, or sharp edges which might damage the cord insulation. The power-supply cord shall be routed so as to prevent damage to the cord insulation.

11 Internal Wiring

11.1 General

11.1.1 The internal wiring of a hoist shall consist of appropriately sized wires or appliance wiring material with insulation thicknesses, as specified in Table 11.1. The following are to be considered in determining the suitability of wiring:

a) The temperature and voltage to which the wiring may be subjected;

b) Exposure to oil or grease; and

c) Exposure to other conditions of anticipated service.

Table 11.1
Appliance-wiring material

Type of insulation	Minimum thickness of insulation		
	inch	(mm)	250-volt applications
Thermoplastic	0.028	0.71	
	0.013	0.33[a]	
Rubber	0.013	0.33	Plus an impregnated-braid cover
	0.028	0.71	Without a braid cover
Neoprene	0.013	0.33	Plus an impregnated-braid cover
	0.028	0.71	Without a braid cover
Silicone Rubber	0.013	0.33	Plus an impregnated-braid cover
	0.028	0.71	Without a braid cover[b]

[a] Only for short, moving pigtails or coil leads, provided such leads make no more than casual contact with parts of opposite polarity and with grounded parts.

[b] Only if routed away from live parts of opposite polarity and protected from mechanical damage both during installation of field wiring and while in operation, unless material has been determined to provide resistance to mechanical damage.

11.1.2 Appliance wiring material insulation with thickness less than that specified in Table 11.1 may be used for an application, if the insulation when evaluated with respect to temperature, voltage, and condition of service is determined to be equivalent to the specified insulation.

11.1.3 A flexible cord used for external interconnection shall be provided with bushings and strain relief in accordance with 10.2.1 – 10.3.2.

Exception: Bushings and strain relief are not required when the construction is such that the cord will be protected from stress and motion.

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

11.1.5 Wiring inside an enclosure that may otherwise be subjected to mechanical damage shall be in metal-clad cable, conduit, or electrical metallic tubing, or shall be otherwise protected.

11.1.6 Insulating tubing employed in lieu of wire insulation shall be of a type that has been evaluated and determined acceptable for the application and shall have a minimum wall thickness of 1/32 inch (0.8 mm).

11.2 Wiring methods

11.2.1 Wiring shall:

a) Be protected against damage;

b) Be supported and routed to reduce the risk of damage due to contact with sharp edges such as fins on moving parts, or with hot parts that may attain a temperature in excess of that for which the wire insulation is rated; and

c) Not be immersed in water unless it is for use in wet locations.

11.2.2 Means shall be provided to prevent a flexible cord from being pushed into the enclosure through the cord's entry hole if such displacement is likely to:

a) Subject the cord to mechanical damage; or

b) Expose the cord to a temperature higher than that for which it is rated; or

c) Reduce spacings, such as to a metal strain-relief clamp, below the required values.

d) Interfere with other hoist components or equipment such as relays, brakes, or other similar parts.

11.2.3 All splices and connections shall be mechanically secure and bonded electrically. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in a risk of electric shock.

11.2.4 A splicing device of the thread-on or setscrew type shall be secured by wrapping the wires and the connector with friction tape or by other means determined to be equivalent.

11.2.5 Insulation on a splice shall be at least 1/32 inch (0.8 mm) thick.

Exception: If spacing between the splice and other metal parts cannot be maintained, insulation of the splice shall be as thick as the required insulation of the wires involved.

11.2.6 A splice shall be located, enclosed, and supported so that it is not subject to damage, flexing, motion, or vibration.

11.2.7 A splicing device, such as a fixture-type splicing connector, pressure wire connector, or the like, may be employed if it provides mechanical security and employs insulation rated for the voltage to which it is intended to be subjected. In determining if splice insulation consisting of coated fabric, thermoplastic, or other type of tubing may be used, consideration is to be given to such factors as its electrical, mechanical, and flammability properties. Thermoplastic tape wrapped over a sharp edge shall not be used.

11.2.8 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will not contact other live or dead metal parts. This may be accomplished by use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering of all strands of the wire, or other means that have been determined to be equivalent.

11.2.9 The internal wiring shall be constructed and assembled to reduce the risk of electric shock due to weather exposure.

11.2.10 Moisture-resistant wiring materials, such as Type RW, RHW, TW, THW, XHHW, MTW, THW-MTW, or THWN, may be used between electrical component enclosures if enclosed in rigid flexible-steel conduit or electrical metallic tubing.

11.2.11 Other wiring materials may be installed in either rigid conduit or electrical metallic tubing with raintight fittings, or in liquid-tight flexible metal conduit with fittings.

11.2.12 The wiring assembly shall be constructed and located so as to exclude water from electrical enclosures in accordance with 33.1.

12 Grounding

12.1 The power-supply cord of a hoist shall include an equipment grounding conductor.

12.2 An equipment grounding conductor of a power-supply cord shall be connected to the grounding member of an attachment plug of the grounding type.

12.3 The surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished green with or without one or more yellow stripes. No other lead visible to the installer other than grounding conductors shall be so identified.

12.4 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 terminal connector intended for connection of such a conductor shall be identified by:

a) Use of a wire binding screw with a green-colored head that is hexagonal, slotted, cross-slotted, or both;

b) Use of a threaded stud with a green colored hexagonal nut;

c) Use of a green colored pressure terminal connector;

d) Being marked "G", "GR", "'GND", "Ground", "Grounding", or the like;

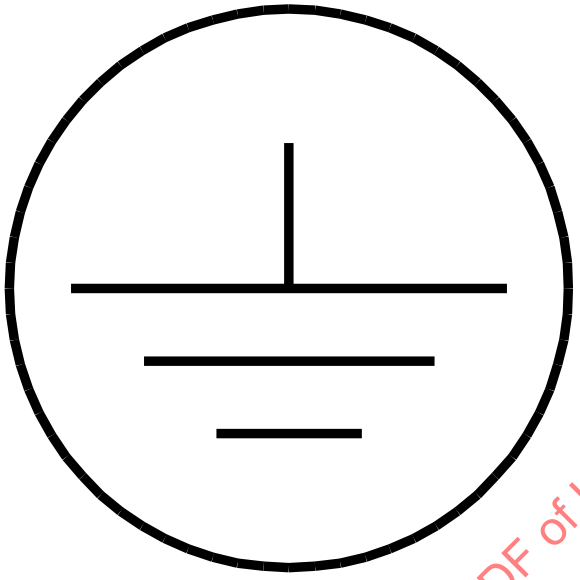
e) A marking on a wiring diagram provided on the product; or

f) The grounding symbol illustrated in Figure 12.1 on or adjacent to the terminal, or on a wiring diagram provided on the product.

The wire-binding screw or pressure wire connector shall be located so that it is not removed during normal servicing of the machine.

Figure 12.1

Grounding symbol



IEC417, Symbol 5019

12.5 The wire-binding screw or pressure terminal connector shall be located so that it is unlikely to be removed during anticipated servicing of the equipment. At a wire-binding screw, upturned lugs or the equivalent shall be provided to retain the conductor. If a pressure connector is used adjacent to the connectors intended for the supply conductors and if it could be mistaken for the neutral of a grounded supply, a marking shall be additionally provided indicating "EQUIPMENT GROUND" or identifying the connector by a green color.

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

12.7 A soldering lug, a push-in (screwless) connector, or a quick-connect or similar friction-fit connector shall not be used for the grounding terminal.

13 Bonding for Grounding

13.1 General

13.1.1 An exposed dead metal part of a hoist that is likely to become energized through electric fault shall be bonded to the point of connection of the field-equipment grounding means.

13.1.2 To determine whether a part is likely to become energized, such factors as the construction, and the proximity of wiring are to be considered. If necessary, an investigation is also to be conducted to determine compliance with:

a) A dielectric voltage-withstand test after the overload and endurance tests and

b) When subjected to the Limited Short-Circuit Test, Section 39, in the as-received condition only.

13.1.3 Except as indicated in 13.1.6 – 13.1.8 and 13.1.10, uninsulated metal parts of cabinets, electrical enclosures and covers, motor frames and mounting brackets, controller mounting frames and brackets, capacitors, and other electrical components shall be electrically bonded if they can be contacted by the user or service person.

13.1.4 For the purposes of bonding, an uninsulated metal part is considered to be exposed if a 4-inch (101-mm) rod having a 3/8-inch (9.5-mm) diameter and a hemispherical end can be inserted through an opening following removal of all guards, baffles, and covers that can be detached without the use of tools.

13.1.5 Operations or adjustments that are considered to expose live parts to users are those made at the time of installation or during intended use. These operations include the:

a) Replacement of fuses;

b) Resetting of overload devices; or

c) Oiling of motors.

13.1.6 The following are considered not exposed to a user:

a) A part on the back side of a component mounting panel or

b) A part in a location that requires tools for major disassembly.

Additionally, such parts are considered not exposed to a service person unless it is likely that servicing will be done while the main unit is energized after disassembly.

13.1.7 Metal parts, such as adhesive-attached metal-foil marking, screws, handles, and the like, need not comply with the requirements in 13.1.1 if:

a) Located on the outside of enclosures and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized or

b) Separated from wiring and spaced from uninsulated live parts as if they are grounded parts.

13.1.8 The requirements in 13.1.1 do not apply to:

a) Small internal assembly screws or other small fasteners such as rivets,

b) Handles for pull-out disconnect switches, and

c) Relay and contactor magnets and armatures.

13.1.9 Uninsulated live parts and wiring shall be separated from moving parts (such as relay and contactor magnets and armatures) by clamping, routing, or the equivalent that will maintain separation.

13.1.10 A metal panel or cover employed as described in (a) – (c) need not comply with the requirement in 13.1.1 if:

a) The panel or cover is insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant material not less than 1/32 inch (0.8 mm) thick that is secured in place;

b) The panel or cover does not enclose uninsulated live parts, and wiring is separated from the panel or cover so that it is not likely to become energized; or

c) The panel or cover is separated from live parts and wiring, and the like, by grounded or bonded interposing metal such that the interposing metal would be subject to the electrical fault before the isolated metal part in question.

13.1.11 If a component after installation in the hoist is likely to be separated from its intended bonding during testing or adjustment while energized, it shall be provided with a bonding terminal or bonding conductor that does not require removal from the component for such service.

13.2 Construction and connections

13.2.1 Bonding conductors

13.2.1.1 The requirements in 13.2.1.2 – 13.2.1.7 apply only to materials depended upon for bonding and that have been evaluated for use as electrical conductors.

13.2.1.2 Bonding shall be accomplished by metal-to-metal contact of the parts or by a separate bonding jumper.

13.2.1.3 A splice shall not be employed in a wire used for bonding purposes.

13.2.1.4 If more than one size of branch-circuit overcurrent device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a motor is individually protected by a branch-circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding conductor for that motor shall be sized on the basis of the overcurrent device intended for ground-fault protection of the motor.

13.2.1.5 A bonding conductor or strap for a separate component shall be of copper, copper alloy, or equivalent metal. A ferrous-metal part in the grounding path shall be protected against corrosion by enameling, galvanizing, plating, or similar means that has been evaluated. A separate bonding conductor or strap shall be:

a) Protected from mechanical damage or be located within the outer enclosure or frame and

b) Secured by a removable fastener used only for the purpose of bonding, unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

The ends of the bonding conductor shall be in metal-to-metal contact with the parts to be bonded.

13.2.1.6 A bonding conductor for a separate component shall not be smaller than the smaller of the following:

a) The AWG size specified in Table 13.1 or

b) The AWG size of the conductor supplying the motor or component.

Exception: A smaller bonding conductor may be used if it complies with the requirement in 37.1.

Table 13.1
Bonding-wire conductor size

Maximum current rating or setting of automatic overcurrent device in circuit ahead of equipment, conduit, and the like	Size of Bonding Conductor[a]							
	Copper wire,		Aluminum wire,		Rigid conduit or pipe nominal,		Electrical metallic tubing nominal,	
	AWG	(mm^2)	AWG	(mm^2)	inch[b]	(mm OD)	inch[c]	(mm OD)
20[d]	12	3.3	10	5.3	1/2	21.3	1/2	21.3
30	10	5.3	8	8.3	1/2	21.3	1/2	21.3
40	10	5.3	8	8.3	1/2	21.3	1/2	21.3
60	10	5.3	8	8.3	1/2	21.3	1/2	21.3
100	8	8.4	6	13.3	1/2	21.3	1/2	21.3
200	6	13.3	4	21.2	1/2	21.3	1/2	21.3

[a] Or equivalent cross-sectional area.

[b] Trade size in accordance with the Specification for Rigid-Steel Conduit – Zinc-Coated, ANSI C80.1.

[c] Trade size in accordance with the Specification for Electrical Metallic Tubing – Zinc-Coated, ANSI C80.3.

[d] For a cord-connected product, the grounding wire in the cord may be the same size as the current-carrying conductors.

13.2.1.7 The impedance of the path between the two parts connected by the bonding conductor shall not exceed the requirements specified in the Impedance Test – Bonding Conductors, Section 38.

14 Mounting of Components

14.1 A switch, fuseholder, attachment plug receptacle, connector base, or similar electrical component shall be secured in its mounting position and shall be prevented from turning.

Exception: A switch may turn if all the following conditions are met:

a) The switch is a plunger or other type that does not tend to rotate when operated. A toggle switch is considered subject to forces that tend to turn the switch during its intended operation.

b) The means for mounting the switch makes it unlikely that operation of the switch will loosen it.

c) The spacings are not reduced below the minimum required values if the switch rotates.

d) The intended operation of the switch is by mechanical means rather than by direct contact by persons.

e) If the rotation will not cause any wiring to be overstressed resulting in a possible hazard or impair its intended operation.

14.2 The means for preventing turning is to rely on more than friction between surfaces.

Exception: A toothed lock washer that provides both spring take-up and an interference lock can be used as the means for preventing a small stem-mounted switch or other small device having a single-hole mounting means from turning.

14.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the required values.

14.4 Friction between surfaces cannot be used as a means to prevent shifting or turning of live parts. However, a lock washer applied as intended may be used.

15 Capacitors

15.1 Motor starting and running capacitors shall be housed within an enclosure.

Exception: A separate enclosure for the capacitor is not required if:

a) The capacitor is protected against damage by the outer enclosure of the hoist or

b) The thickness of the metal shell of a capacitor is in accordance with Table 9.1 and Table 9.2, and the terminals are securely enclosed.

15.2 If the container of an electrolytic capacitor is constructed of metal, the container shall be either:

a) Insulated from dead metal parts by moisture-resistant insulation not less than 1/32 inch (0.8 mm) thick, or a means that has been evaluated and determined to be the equivalent or

b) Separated from dead metal parts by spacings as specified under the "General" heading in Table 21.1.

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

16 Insulating Material

16.1 Material for the mounting of current-carrying parts shall be porcelain, phenolic composition, cold-molded composition, or other material determined acceptable for the application.

16.2 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for live parts of other than low-voltage circuits. Plastic materials may be used for the sole support of live parts if an investigation shows them to have the necessary:

a) Mechanical strength;

b) Rigidity;

c) Resistance to heat;

d) Flame propagation;

e) Arcing resistance;

f) Creeping resistance;

g) Moisture characteristics;

h) Dielectric withstand characteristics; and

i) Other properties that may be required for the application.

These properties shall not breakdown below their required minimum levels of safety as a result of aging.

16.3 A molded part shall have the mechanical strength and rigidity necessary to withstand the stresses of anticipated service. A brush cap shall be protected from mechanical damage by recessing or other means unless the part has the mechanical strength necessary to withstand the abuses to which it is likely to be subjected.

17 Motors

17.1 A motor shall be capable of handling its rated working load.

17.2 A motor winding shall resist the absorption of moisture. Film-coated wire is not required to be additionally treated to prevent absorption of moisture. However, fiber slot liners, cloth coil wrap, and similar moisture absorptive materials shall be impregnated or otherwise treated to prevent moisture absorption.

17.3 A motor-protective device shall not open the circuit during intended operation of the hoist. See the Temperature Test, Section 31.

17.4 If a motor is provided with an inherent thermal protector, it shall comply with the Standard for Thermally Protected Motors, UL 1004-3.

Exception: A hoist having a voltage rating outside the ranges specified in Table 30.1 shall be tested at 100 – 105 percent of the rated voltage, but not less than 100 percent

17.5 The insulation system of a motor shall be of a temperature rating not less than that at which the motor windings are intended to operate.

17.6 A motor shall employ insulation at least equivalent to Class A insulation consisting of a combination of magnet wire and materials such as vulcanized fiber, polyethylene terephthalate, cambric, treated cloth, treated paper, or materials for use in insulation systems higher than Class A. Wood may be used for wedges.

Exception: Nylons, polycarbonates, integral ground insulation systems, and other insulation systems may be employed in a Class A insulation system if, after being subjected to an investigation consisting of thermal conditioning and overload tests, the insulation is determined to be acceptable for their application.

18 Switches and Controllers

18.1 If a hoist is supplied with its own separate movement control, it shall be guarded against unintentional actuation.

Exception: A hoist may be provided without a supplied movement control if the instructions specified in 46.9 and 48.5 are included.

18.2 A switch or other control device shall have a current and voltage rating not less than that of the circuit (load) that it controls.

18.3 A switching device that controls a motor, another load, or both shall have a current interrupting capacity not less than the locked rotor load of the motor plus the other load. See the overcurrent tests in the Tests on Switches and Controllers, Section 36.

18.4 The current rating of a switch that controls an inductive load other than a motor, such as a transformer, shall not be less than twice the rated full load current of the inductive load unless the switch has been evaluated for use with the application.

18.5 A switch shall be located or protected so that it will not be subjected to mechanical damage or unintentional tripping.

18.6 A switch employed for the hoisting function shall be of either:

a) The momentary contact type or

b) The fixed position type.

If of the fixed position type, the switch either shall have provision for automatic locking when in the off position or shall be guarded against unintentional actuation.

18.7 A hoist shall not employ a through-cord switch.

18.8 A single pole switch in a hoist employing a polarized attachment plug shall be connected to the conductor not intended to be grounded.

19 Interlock Switches

19.1 Internal spacings of an interlock switch shall be as specified under the "Safety Controls" heading in Table 21.1.

19.2 An optional interlock switch that prevents operation of the hoist when, for example, a manual crank is in use, shall also comply with the requirements specified in Switches and Controllers, Section 18.

20 Uninsulated Live Parts

20.1 Uninsulated live parts of a hoist shall be completely enclosed so as to prevent the entrance of water onto the live parts. See the Rain Test, Section 33.

21 Spacings

21.1 The spacing between uninsulated live parts of opposite polarity, between uninsulated live parts and a 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 21.1. If an uninsulated live part is not fixed in position by means other than friction between surfaces, or if a movable dead metal part is close to an uninsulated live part, the minimum required spacing shall be maintained in all possible positions of the movable part.

Exception: The spacing requirements in Table 21.1 do not apply to the inherent spacings inside motors, except at wiring terminals, or to the inherent spacings of a component provided as part of the hoist. Such spacings are to be investigated on the basis of the requirements for the component.

Table 21.1
Spacings at parts other than motor components and field-wiring terminals

Location	Distance	Minimum spacings									
		General						1 horsepower (746 watt output) or less,		Safety controls,[a]	
		51 – 150 volts,		151 – 250 volts,		251 – 600					
		inch	(mm)	inch	(mm)	(inch)	(mm)	inch	(mm)	inch	(mm)
Between any uninsulated live part and an uninsulated live part of opposite polarity, an uninsulated grounded dead-metal part other than an enclosure, or an exposed dead metal part that is isolated (insulated).	Through air or oil	1/8	3.2	1/4	6.4[a]	3/8	9.5	1/16	1.6[a]	1/8	3.2[b]
	Over surface	1/4	6.4	3/8	9.5[a]	1/2	12.7	1/8	3.2[a]	1/4	6.4
Between any uninsulated live part and the walls of a metal enclosure including fittings for conduit or metal-clad cable.[c]	Shortest distance	1/2	12.7	1/2	12.7	1/2	12.7	1/4	6.4	1/4	6.4

[a] In a safety control, the spacing between same polarity live parts on opposite sides of a switching mechanism, except at contact point, shall not be less than 1/32 inch (0.8 mm) through air and 1/16 inch (1.6 mm) over surface.

[b] In a safety control and equivalent, the spacing between wiring terminals regardless of polarity and the spacing between a wiring terminal and a grounded dead metal part (including the enclosure) shall not be less than 1/4 inch (6.4 mm).

[c] For the purpose of this requirement, a metal piece attached to the enclosure is considered to be a part of the enclosure if deformation of the enclosure is likely to reduce the spacing between the metal piece and uninsulated live parts.

21.2 The electrical clearance resulting from the assembly of a component into the complete product, including clearances to dead metal or enclosures, shall be as specified in Table 21.1.

21.3 In a wiring device, such as a snap switch, that is a part of a safety control circuit or equivalent, spacings shall also be as specified under the "Safety Controls" heading in Table 21.1.

21.4 If an isolated dead metal part is interposed between:

a) Live parts of opposite polarity;

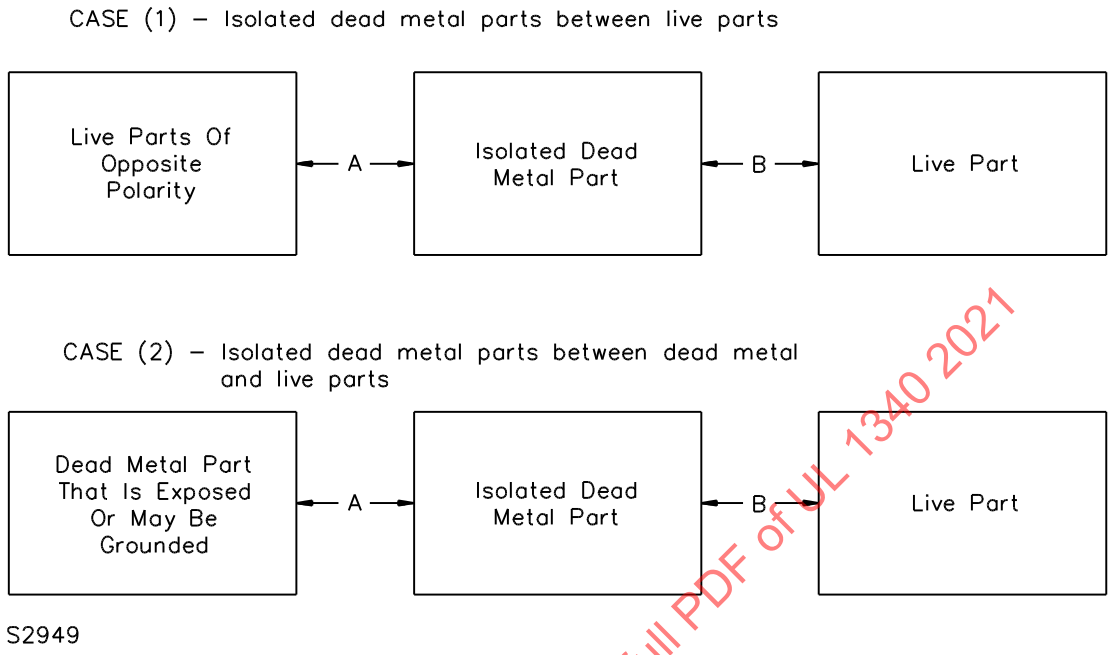
b) A live part and an exposed dead metal part; or

c) A live part and a dead metal part that may be grounded,

the spacing may be minimum 3/64 inch (1.2 mm) between the isolated dead metal part and any of the parts in (a) – (c) if the sum of the spacings between the isolated dead metal part and each of the other two parts is not less than that specified in Table 21.1. Also, see Figure 21.1.

Figure 21.1

Spacings for isolated dead metal parts



NOTE – Spacing A and spacing B shall be at least 3/64 inch (1.2 mm), and spacing A plus spacing B shall not be less than specified in Table 21.1.

21.5 An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material employed to provide spacings shall not be less than 0.028 inch (0.71 mm) thick.

Exception No. 1: A liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through-air spacing required. The liner shall be located so that it will not be affected adversely by arcing.

Exception No. 2: Insulating material of lesser thickness may be used if, upon investigation, it is determined to be acceptable for the application.

21.6 Internal spacings in a motor shall comply with the spacing requirements in the Standard for Rotating Electrical Machines - General Requirements, UL 1004-1, the Standard for Impedance Protected Motors, UL 1004-2, or the Standard for Thermally Protected Motors, UL 1004-3.

22 Printed-Wiring Boards

22.1 A circuit board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796.

PERFORMANCE

ALL HOISTS

23 Normal-Operation Test

23.1 A hoist is to operate for one complete revolution in each direction while the hoist is carrying 125 percent of its rated working load. The load is to be applied to the cable, chain, or fibre kernmantle rope. After the test, the hoist shall operate as intended.

24 Strength Test

24.1 A hoist, while suspended, is to be loaded for 5 minutes to 2.5 times its rated working load. The load is to be applied as intended for normal working conditions for which the hoist was designed so that the test load will be transmitted throughout the hoist, except that elements specifically provided to give visible warning of severe overload by structural deformation shall be excluded from this test. In excluding such elements from the test, the configuration of the hoist for the test shall be as close as possible to the design condition, excepting the exclusion of such elements. During the test, no load-bearing component of a hoist shall give way, permanently deform, or weaken. After the test load is released, the hoist components shall operate as intended.

24.2 The hoist is to be prepared for test by securing the shaft of the hoist to prevent it from rotating.

ELECTRICALLY POWERED HOISTS

25 Metallic-Coating-Thickness Test

25.1 The method of determining the thickness of a zinc or cadmium coating is described in 25.2 – 25.9.

25.2 The solution used for this test is to be made from distilled water and is to contain 200 grams per liter of American Chemical Society (ACS) reagent grade chromic acid (CrO_3) and 50 grams per liter of ACS reagent grade concentrated sulfuric acid (H_2SO_4). The latter is equivalent to 27 milliliters per liter of ACS reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

25.3 The test solution is to be contained in a glass vessel, such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube having an inside bore of 0.025 inch (0.64 mm) and a length of 5.5 inches (139.7 mm). The lower end of the capillary tube is to be tapered to form a tip, the drops from which are to be about 0.025 milliliters 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 minute. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

25.4 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 – 90°F (21 – 32°C).

25.5 Each sample is to be cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed 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 one's hands or any foreign material.

25.6 The sample to be tested is to be supported from 0.7 to 1.0 inch (17.8 to 25.4 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested should be inclined about 45 degrees from horizontal.

25.7 The stopcock is to be opened, and the time the dropping solution takes to dissolve the protective metal coating exposing the base metal is to be measured in seconds. The timing end point is the first appearance of the base metal recognizable by a change in color at that point.

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

25.9 To calculate the thickness of the coating being tested, select from Table 25.1 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 described in 25.7.

Table 25.1
Thickness of coatings

Temperature,		Thickness factors, 0.00001 inches (0.00025 mm) per second	
°F	(°C)	Cadmium plating	Zinc plating
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

26 Leakage Current Test

26.1 The leakage current of a cord-connected hoist rated for a nominal 250-volt or less supply when tested in accordance with 26.3 – 26.7 shall not be more than:

a) 0.5 milliampere for an ungrounded 2-wire portable or stationary hoist;

b) 0.5 milliampere for a grounded 3-wire portable hoist; and

c) 0.75 milliampere for a grounded 3-wire stationary hoist using a standard attachment plug rated 20 amperes or less.

26.2 Leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces of a hoist and ground or other exposed surfaces of the hoist.

26.3 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 has been evaluated for protection against the risk of electric shock as defined in Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section 8. 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. If all accessible surfaces are bonded together and connected to the grounding conductor of the power-supply cord, the leakage current can be measured between the grounding conductor and the grounded supply conductor. If exposed dead metal parts of the hoist are connected to the neutral supply conductor, this connection is to be open during the test.

26.4 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 centimeters in contact with the surface. If the surface is less than 10 by 20 centimeters, 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 hoist.

26.5 The measurement circuit for leakage current is to be as illustrated in Figure 26.1. 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.

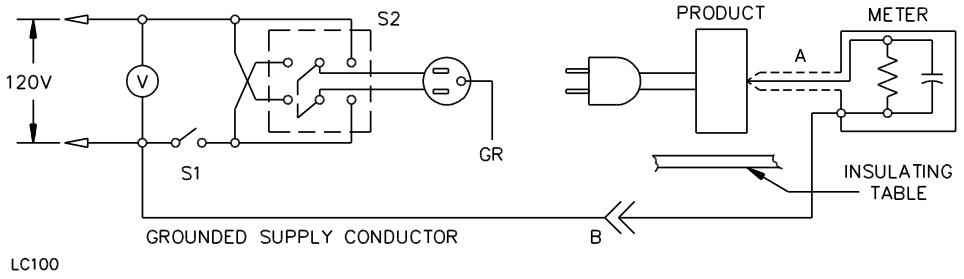
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

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 kilohertz, 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-microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

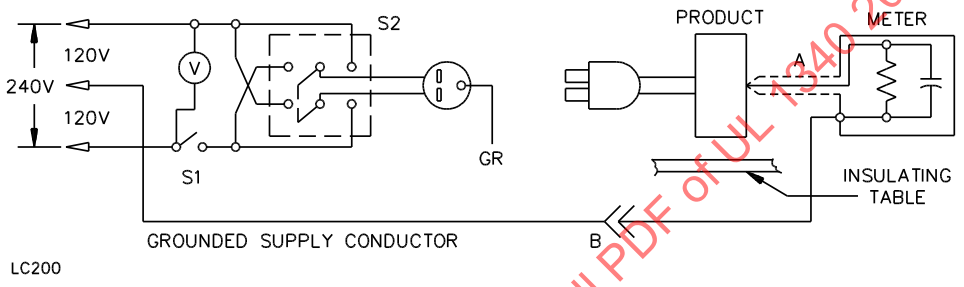
Figure 26.1

Leakage-current measurement circuits



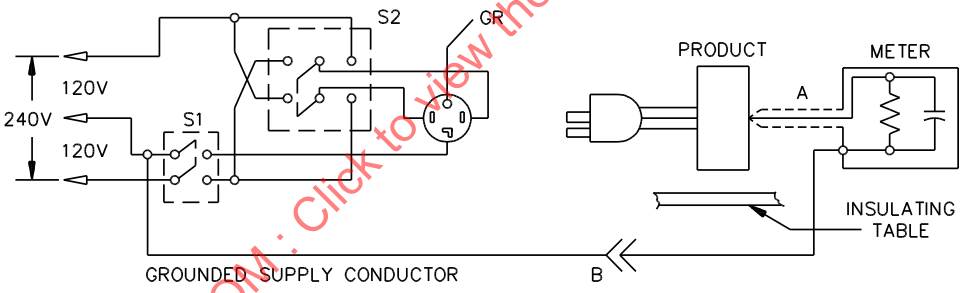
LC100

Product intended for connection to a 120-volt power supply.



LC200

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



LC300

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

A – Probe with a shielded lead.

B – Separated and used as a clip when measuring currents from one part of a product to another.

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

26.7 A sample of the hoist is to be tested for leakage current starting with the as-received condition – 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 the voltage specified in Table 30.1. The test sequence, with reference to the measurement circuit in Figure 26.1 is to be as follows:

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

b) Switch S1 is then to be closed energizing the hoist, and within 5 seconds, the leakage current is to be measured using both positions of switch S2 with the hoist switching devices in all their normal operating positions.

c) The leakage current is to be monitored under 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.

27 Humidity Test

27.1 A cord-connected hoist shall comply with the requirements for leakage current in Section 26, following exposure for 48 hours to air having a relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (90 ±4°F).

27.2 To determine whether a product complies with the requirement in 27.1, a sample of the product is to be heated to a temperature just above 34°C (93°F) to reduce the likelihood of condensation of moisture during conditioning. The heated sample is to be placed in the humidity chamber and is to remain for 48 hours under the conditions specified in 27.1.

27.3 Following the conditioning, the sample is to be tested, without load current flowing, as described in 26.7, either in the humidity chamber or immediately after removal of the conditioned sample from the humidity chamber. Note that moisture in the air condensing on the conditioned sample surfaces after removal from the chamber can invalidate the test results. After the test without load current flowing, the sample is then to be energized and tested as described in 26.7. For each test, the maximum leakage current is to be recorded and the test is to be discontinued when the leakage current stabilizes or decreases.

28 Continuity of Grounding Test

28.1 Electrical continuity shall be provided between all exposed dead-metal parts and all dead-metal parts within the enclosure that are exposed to contact during any user-servicing operation and that can become energized and:

a) The equipment grounding terminal or lead, and to the metal surrounding the knockout, hole, bushing, or metallic fitting (at the end of flexible armored cable for attachment to a field-provided metallic outlet box) provided for field power-supply connection for a hoist intended for permanent electrical connection; or

b) b) The point of connection of the grounding conductor of the power-supply cord of a hoist equipped with a power-supply cord of the grounding type. See 28.2.

28.2 A power-supply cord of a hoist intended for use on a circuit operating at a potential of more than 150 volts to ground shall include an equipment-grounding conductor.

28.3 The resistance shall be not more than 0.1 ohm between any point required to be grounded, as specified in 28.1, and:

a) For a hoist intended for permanent electrical connection, the point on the enclosure at which the power-supply system is connected.

b) For a cord-connected hoist employing a grounding conductor in the cord, the point to which the grounding conductor of the power-supply cord is connected.

28.4 The resistance shall be determined by any convenient method. When unacceptable results are obtained, either a direct or alternating current equal to the current rating of the maximum-current-rated branch-circuit overcurrent-protective device that is employed with the hoist is to be passed from the equipment grounding terminal or the point of attachment of the wiring system to the dead metal part, and the resulting drop in potential is to be measured between these two points. The resistance in ohms is determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

29 Starting Current Test

29.1 When operated as described in 29.3, a hoist shall start and operate normally without:

a) Tripping an overload protector provided as part of the hoist; or

b) Opening the fuse, when connected to a circuit protected by a fuse as described in 29.2.

29.2 The fuse mentioned in 29.1(b) is to be other than a time-delay type. The current rating of the fuse is to be equal to the current rating of the supply circuit of the lowest rating to which the appliance is intended to be connected.

29.3 To determine whether a hoist complies with the requirements in 29.1, the hoist is to be connected to a power-supply circuit protected by a fuse as specified in 29.2. The hoist is to be at room temperature at the beginning of the test. The hoist is to be started three times without tripping an overload protector provided as part of the hoist, or opening the fuse protecting the supply circuit. Each start of the hoist is to be made under conditions representing the beginning of normal operation. The motor of the hoist is to be allowed to come to full speed after each start, and to come to rest between successive starts.

30 Input Test

30.1 The current input shall not be more than 110 percent of the rated value when the hoist is operated while lifting and lowering with the rated working load applied and when connected to a supply circuit of rated frequency and maximum rated voltage as specified in Table 30.1.

Table 30.1
Values of supply voltages for test

Nameplate rating, volts	Test voltage, volts
110 – 120	120
200 – 208	208
220 – 240	240
254 – 277	277
440 – 480	480
550 – 600	600
601 – 1000	1000

31 Temperature Test

31.1 When tested under the conditions of rated working load, an as-received hoist shall not at any point attain a temperature that may result in a risk of fire or electric shock or damage any materials employed in the hoist.

31.2 For this test, a hoist is to be operated in accordance with the manufacturer's marked duty cycle or if a duty cycle is not provided it is operated continuously by raising and lowering the rated load for 30 minutes. This may be done in increments of not less than 15 feet (4.6 m) and not more than 300 feet (91.4 m). The 30 minute accumulated time includes both up and down operation.

31.3 During this test, a motor-protective device, if provided, shall not open the circuit.

31.4 An optional break-in period of 3 hours of operation may be conducted. During this optional break-in period, measured temperatures at specific points on the hoist shall not exceed the temperatures specified in Table 31.1 by more than 11.5°C (20.0°F).

Table 31.1
Maximum temperatures

Materials and components	°C	(°F)
A. MOTORS		
1. Motor Class A (105)		
Thermocouple method	105	(221)
Resistance method	115	(239)
2. Motor Class E (120)		
Thermocouple method	115	(239)
Resistance method	125	(257)
3. Motor Class B (130)		
Thermocouple method	125	(257)
Resistance method	135	(275)
4. Motor Class F (155)		
Thermocouple method	150	(302)
Resistance method	160	(320)
5. Motor Class H (180)		
Thermocouple method	165	(329)
Resistance method	175	(347)
6. Motor Class N (200)		
Thermocouple method	180	(356)
Resistance method	190	(374)
7. Motor Class R (220)		
Thermocouple method	195	(383)
Resistance method	205	(401)
B. COMPONENTS		
1. Capacitors:		
a. Electrolytic[c]	65	149

Table 31.1 Continued on Next Page

Table 31.1 Continued

Materials and components	°C	(°F)
b. Other types[d]	90	194
2. Fuses[e]	90	194
3. Relay, solenoid, and the like with[a]		
a. Class 105 insulation systems		
Thermocouple method	90	194
Resistance method	110	230
b. Class 130 insulation systems		
Thermocouple method	110	230
Resistance method	120	248
4. Sealing compound	40	104
	less than melting point	
5. Terminals	75	167
C. CONDUCTORS		
1. Rubber- or thermoplastic-insulated wires and cords[f,g]	60	140
D. ELECTRICAL INSULATION – GENERAL		
1. Fiber employed as electrical insulation	90	194
2. Phenolic composition employed as electrical insulation or as a part the deterioration of which could result in a risk of fire or electric shock[g]		
a. Laminated	125	257
b. Molded	150	302
3. Varnished-cloth insulation	85	185
E. SURFACES		
1. Wood or other combustible material, including inside surface of the test enclosure and the surface supporting the product	90	194

[a] At a point of the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by means of a thermocouple may be more than the maximum temperature specified in this table provided the temperature, as measured by the resistance method, is not more than that specified. The temperature measured by means of a thermocouple may be more than the specified value by:

1. 5°C (9°F) for Class A insulation systems on coil windings of an alternating-current motor having a diameter of 7 inches (178 mm) or less, open type.
2. 10°C (18°F) for Class B insulation systems on coil windings of an alternating-current motor having a diameter of 7 inches or less, open type.
3. 15°C (27°F) for Class A insulation systems on coil windings of an alternating-current motor having a diameter of more than 7 inches, open type.
4. 20°C (36°F) for Class B insulation systems on coil windings of an alternating-current motor having a diameter of more than 7 inches, open type.
5. 15°C (27°F) for Class 105 insulation systems on windings of a relay, a solenoid, and the like.
6. 15°C (27°F) for Class 130 insulation systems on windings of a relay, a solenoid, and the like.

[b] The diameter of a motor is the diameter of the circle circumscribing the stator frame measured in the plane of the laminations, excluding lugs, fins, boxes, and the like, used solely for motor mounting, cooling, assembly, or connection.

[c] For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum temperature on insulating material integral with the capacitor enclosure shall not be more than 90°C (194°F).

[d] A capacitor that operates at a temperature of more than 90°C (194°F) may be evaluated on the basis of its marked temperature limit.

[e] A fuse that has been investigated, and evaluated for use at a higher temperature may be used at that temperature.

Table 31.1 Continued on Next Page

Table 31.1 Continued

Materials and components	°C	(°F)
[f] A rubber-insulated conductor within a Class A insulated motor, a rubber-insulated motor lead, and a rubber-insulated conductor of a flexible cord entering a motor may be subjected to a higher temperature if the conductor is provided with sleeving or a braid that has been investigated and determined acceptable for use at the higher temperature. This does not apply to thermoplastic-insulated wires or cords.		
[g] Phenolic composition and rubber and thermoplastic insulation that has been investigated and determined acceptable for use at higher temperatures may be used at those temperatures.		

31.5 A short length of rubber- or thermoplastic-insulated flexible cord may be exposed to a temperature of more than 60°C (140°F), such as at the terminals. However, the individual cord conductors shall be provided with supplementary heat-resistant insulation with the proper dielectric withstand characteristic. See the Dielectric Voltage-Withstand Test, Section 34.

31.6 All values for temperatures in Table 31.1 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).

31.7 Temperatures are to be measured with thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). When thermocouples are used to determine temperatures in electrical equipment, it is common practice to employ thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument; such equipment is to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire is to be in accordance with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

31.8 If the hoist has a single frequency rating, the test is to be conducted at that frequency. For a hoist rated either for alternating current/direct current or direct current, 60 hertz is to be tested on direct current or 60 hertz alternating current, whichever results in higher temperatures. A product rated 25 – 60 hertz or 50 – 60 hertz is to be tested on 60-hertz alternating current.

31.9 If the hoist incorporates a reel for the power-supply cord, one-third of the length of the cord is to be unreeled for the test.

31.10 Tests are to be conducted under actual operating conditions.

32 Strain-Relief Test

32.1 The strain-relief means of a power-supply cord shall not permit the cord to move in a way that indicates stress would have been transmitted to the cord connections when a 35-pound (15.9-kg) weight is suspended from the hoist by the cord for 1 minute and the strain-relief means is stressed from any angle permitted by the construction of the hoist.

32.2 A power-supply cord shall withstand for 1 minute, 50 ounce-inches (0.35 N·m) of torque applied 1 inch (25.4 mm) from the strain-relief means without damage to the cord and without transmitting the torque to the terminations.

33 Rain Test

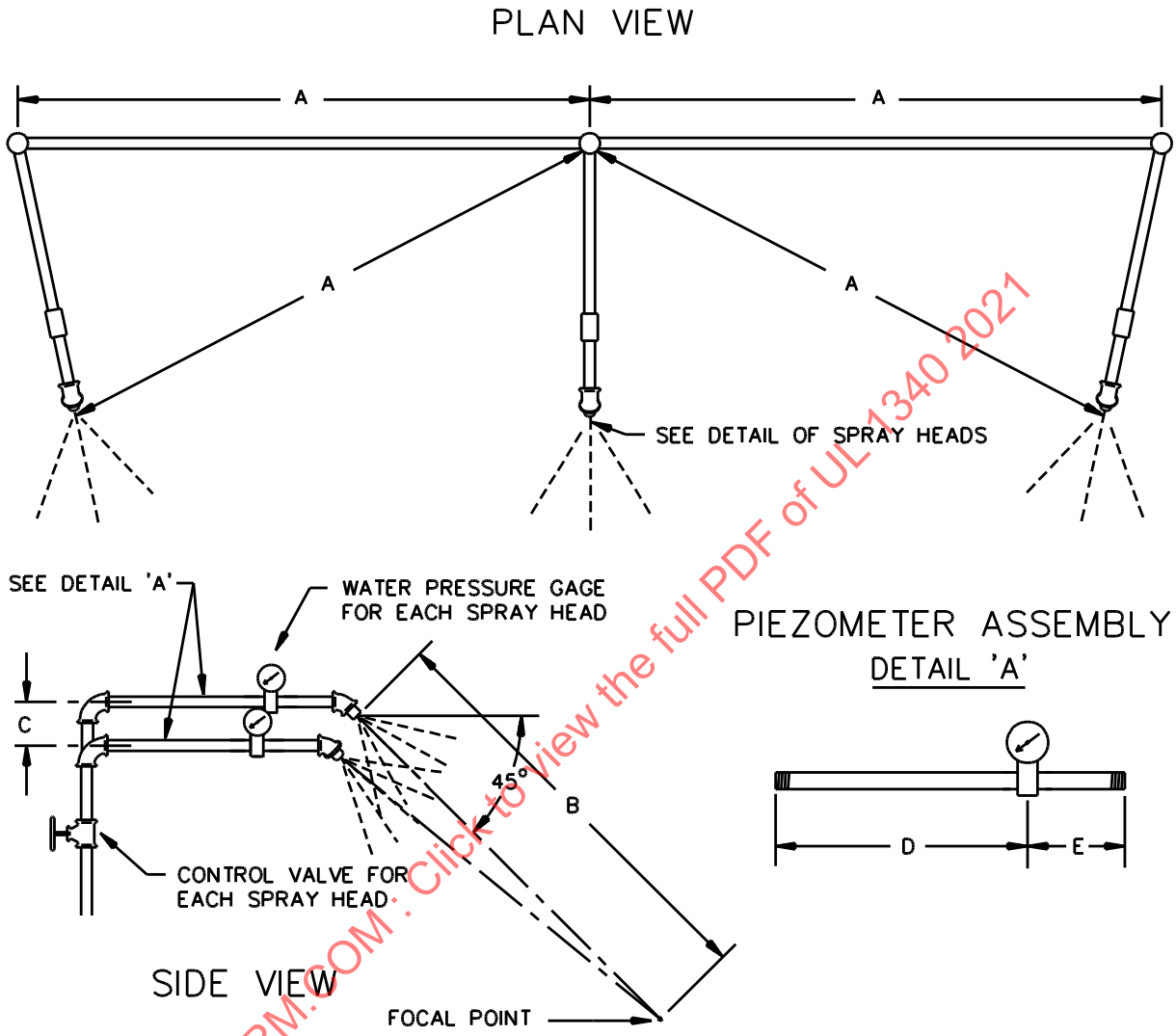
33.1 A hoist rated for outdoor use shall be subjected to a water spray for 1-hour exposures. Water shall not enter an electrical enclosure or come in contact with live parts.

33.2 After each exposure, the hoist shall have an insulation resistance between live parts and dead metal parts of not less than 50,000 ohms and shall comply with the requirements for the Leakage-Current Test, Section 26, and the Dielectric Voltage-Withstand Test, Section 34.

33.3 The test apparatus is to consist of three spray heads mounted in a water supply rack as illustrated in Figure 33.1. Spray heads are to be constructed in accordance with Figure 33.2. The water pressure is to be maintained at 5 psi (34.5 kPa) at each spray head.

Figure 33.1

Rain-test spray-head pipe rack

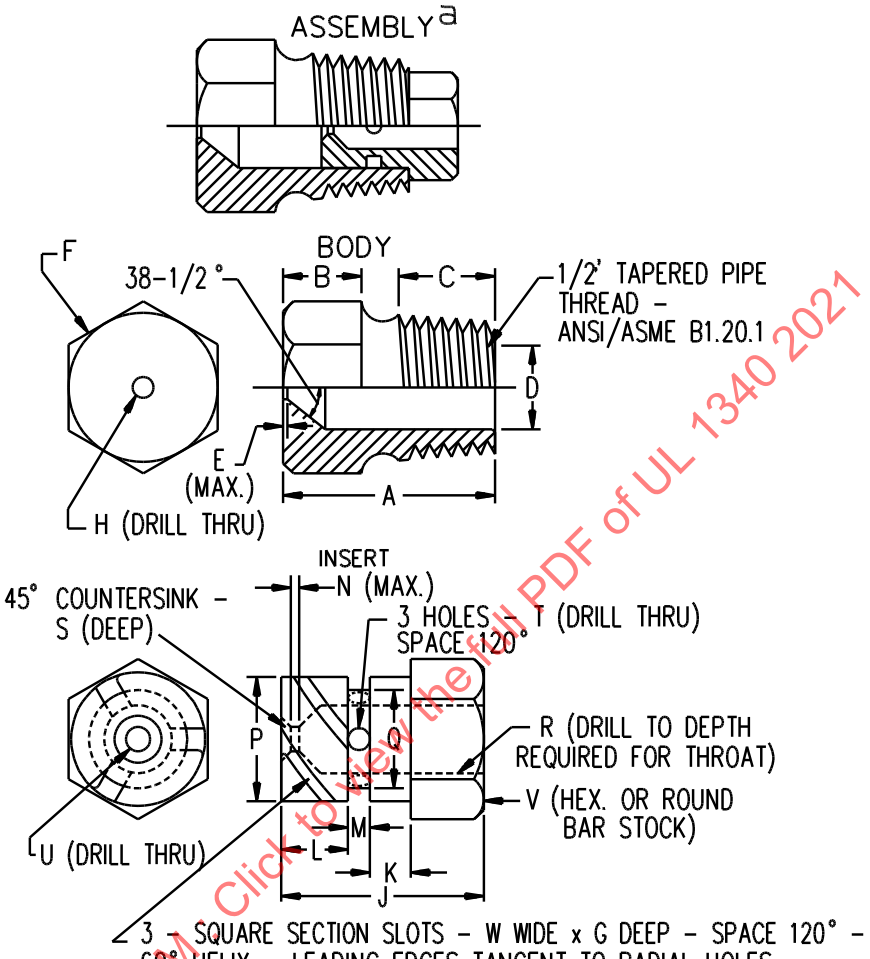


Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101E

Figure 33.2

Rain-test spray head assembly



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

33.4 The hoist is to be examined to determine that all electrical parts, including motor windings, are not wetted and that there is no water within the enclosures of electrical parts prior to rain exposure.

33.5 The hoist is to be positioned in the focal area of the three spray heads so that the greatest quantity of water will enter the hoist.

33.6 The hoist is to be operated so that electrical components are energized. The hoist is to be tested under intended conditions considered most likely to cause water to enter electrical enclosures or contact electrical components. It may be necessary to operate the hoist under various modes or to de-energize the hoist if more adverse conditions could result. Each exposure is to be for 1 hour.

33.7 The insulation resistance is to be measured 1 minute after application of the voltage obtained by using the series-voltmeter method or the equivalent, and a direct-current circuit. After measurement of the insulation resistance, the entire hoist is to be subjected to the Leakage-Current Test, Section 26, and the Dielectric Voltage-Withstand Test, Section 34.

33.8 The hoist is to be dried prior to the second or subsequent exposures unless without such preparation, the insulation resistance between live parts and dead metal parts is greater than 50,000 ohms.

34 Dielectric Voltage-Withstand Test

34.1 An essentially sinusoidal 60-hertz potential of 1000 volts plus twice the rated voltage is to be applied between live parts and dead metal parts of the hoist for 1 minute. The temperature of the hoist is to be the same as the value recorded during the Temperature Test, Section 31. There shall not be dielectric breakdown.

Exception: If a hoist employs an induction motor rated less than 1/2 horsepower (373 W output) and 250 volts or less, the test potential for the motor, but not for the remainder of the hoist, is to be 1000 volts.

34.2 When applying the Exception to 34.1 to a motor not rated in horsepower, the appropriate table of the National Electrical Code, NFPA 70, is to be used which 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 motor is marked for use on alternating current only; otherwise, the table applying to direct-current motors is to be used.

35 Power Failure Test

35.1 A hoist is to be loaded with its rated load and raised approximately 5 inches (12.5 cm). The power to the hoist is then disconnected for one minute. The load shall not slip or lower. After the test, the hoist shall operate as intended.

36 Tests on Switches and Controllers

36.1 General

36.1.1 When subjected to the appropriate test specified in 36.1.3 – 36.4.2 and with no test load on the hoist, a switch shall perform as intended. There shall be no electrical or mechanical malfunction of the switch and no emission of molten metal or flame from the enclosure of the switch. See 36.1.4.

36.1.2 The fuse in the grounding connection shall not open during the test.

36.1.3 The hoist is to be connected to a grounded power-supply circuit of rated frequency and maximum rated voltage as described in 31.8 and Table 30.1, unless otherwise specified. During the tests, exposed dead metal parts of the hoist are to be connected to ground through a 3-ampere cartridge fuse so that any single-pole, current-rupturing device will be located in the ungrounded conductor of the supply circuit. If the hoist is intended for use on direct current or on direct current as well as on alternating current, the exposed dead metal parts of the hoist are to be connected so as to be positive with respect to any single-pole, current-rupturing control device.

36.1.4 A switch is not required to be subjected to these tests if it:

a) Controls an induction motor and has the required horsepower rating or

b) Is interlocked so that it will never have to break the locked-rotor current.

36.2 Speed-changing switches

36.2.1 A switch or other device for changing the speed of the motor (other than an on/off switch) is to be subjected to 50 cycles of operation.

36.2.2 Each cycle is to consist of:

a) Operating the motor at one speed;

b) Throwing the switch to cause operation at the other speed; and

c) Changing the setting back to the position that produces in the first value of speed.

36.3 Motor-reversing switches

36.3.1 A switch or other device for reversing the motor is to be subjected to 25 cycles of operation.

36.3.2 Each cycle is to consist of:

a) Throwing the switch to the position in which the motor rotates in one direction;

b) Allowing it to attain full operating speed in that direction;

c) Throwing the switch to the position in which rotation is reversed without pause in any intermediate off position (if the switch will not perform this function, it is to be thrown to the off position as briefly as possible);

d) Allowing the motor to attain normal speed in that direction; and

e) Reversing and rotation again by throwing the switch to the initial on position.

36.4 Other switches

36.4.1 A switch or other device that controls the hoist motor and that is not one of the types covered by 36.2.1 and 36.3.1 is to be subjected to 50 cycles of operation of making and breaking the locked-rotor current of the hoist. The test voltage of the component is to be measured when the hoist is operated at the overload-test voltage specified in Table 30.1.

36.4.2 The rotor of the motor is to be locked in position and the switch is to be operated at a rate of not more than 10 cycles per minute, unless a faster rate of operation is agreeable. The motor is to be left in the on position as briefly as possible.

37 Short-Circuit Test – Bonding Conductors

37.1 A bonding conductor smaller than specified in 13.2.1.6 shall not open when carrying, for the time specified in Table 37.1, a current that equals twice the rating of the branch-circuit overcurrent device (see 13.2.1.6) but not less than 40 amperes.

Table 37.1
Duration of current flow bonding-conductor test

Overcurrent-device rating, amperes	Minimum duration current flow, minutes
30 or less	2
31 – 60	4
61 – 100	6

37.2 A bonding conductor, regardless of size, shall not open when tested as specified in 37.3 – 37.5.

37.3 The circuit for the short-circuit test is to have a power factor of 0.9 – 1.0 and is to be limited to the current specified in Table 37.2 at the short-circuit voltage specified in Table 30.1. The open-circuit voltage of the test circuit is to be 100 – 105 percent of the specified voltage.

Table 37.2
Bonding conductor short-circuit test

Combined rating of device						
Volt-amperes, single-phase	Volt-amperes, three-phase	Volt-amperes, direct-current	Horsepower	(W Output)	Volts	Circuit capacity, amperes
0 – 1176	0 – 832	0 – 624	1/2 maximum	373 maximum	0 – 250	200
0 – 1176	0 – 832	0 – 624	1/2 maximum	373 maximum	251 – 1000	1000
1177 – 1920	833 – 1496	625 – 1128	Over 1/2 – 1 maximum	Over 373 – 746 maximum	0 – 1000	1000
1921 – 4080	1497 – 3990	1129 – 3000	1 – 3	746 – 2200	0 – 250	2000
4081 – 9600	3991 – 9145	3001 – 6960	3 – 7-1/2	2200 – 5600	0 – 250	3500

37.4 The circuit is to be connected through a nonrenewable fuse, the characteristics of which are such that the fuse will not open in less than 12 seconds when carrying twice its rated current. One test is to be performed on each of three samples of the bonding conductor subject to the test.

37.5 The fuse mentioned in 37.4 is to have a current rating equal to that of the branch-circuit overcurrent device to which the equipment will be connected, but not less than 20 amperes.

38 Impedance Test – Bonding Conductors

38.1 The impedance between two parts connected by a bonding conductor shall not be more than 0.1 ohm.

38.2 A 60-hertz alternating current of at least 20 amperes from a power supply of not more than 12 volts is to be passed from the point of connection of the equipment-grounding means to a metal part in the grounding circuit. The resulting drop in potential is to be measured between the two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points. The grounding conductor of a power-supply cord is not to be considered in this measurement.