UL 1323

STANDARD FOR SAFETY

Scaffold Hoists

UL Standard for Safety for Scaffold Hoists, UL 1323

Fourth Edition, Dated April 5, 2007

Summary of Topics

This revision to ANSI/UL 1323 dated January 4, 2023 includes State of Battery Charger Indicator; 3.5, 5.4 and 15.2.

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 30, 2022 and November 25, 2022.

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UL 1323

Standard for Scaffold Hoists

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Fourth Edition

April 5, 2007

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through January 4, 2023.

The most recent designation of ANSI/UL 1323 as an American National Standard (ANSI) occurred on January 4, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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.

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INTRODUCTION

1 Scope

1.1 These requirements cover manual and power-operated type portable hoists intended for use with scaffolds suspended by wire ropes.

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, ANSI/NFPA 70.

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 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b) Is superseded by a requirement in this standard.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.

3.1.2 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.

3.2 ANGLE, FLEET – The angle at which the wire rope exits the winding drum, as measured between the rope before it passes through the rope guide and a line that is perpendicular to the drum axis, tangent to the drum surface, and passing through the center of the rope guide.

3.2.2 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.

3.3 BRAKE, PRIMARY – A brake, automatically applied, that stops the hoist and its rated load under intended operating conditions, when power to the prime mover is interrupted or discontinued.

3.4 BRAKE, SECONDARY – A brake intended to automatically arrest the descent of the hoist and its suspended load when there is an overspeed condition.

3.5 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 AC peak or 60 volts DC, and supplied by:

1) A 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.

3.6 CONTROLLED DESCENT DEVICE – A device intended to allow controlled nonpowered descent of a normally power-operated hoist.

3.7 DRUM, TRACTION – A type of drum that does not accumulate the suspension rope, but ascends or descends the rope as a result of friction between the rope and the drum.

3.8 DRUM, TRANSFER – A drum used to transfer the suspension wire rope from one groove to another groove on the traction drum of a traction hoist.

3.9 DRUM, WINDING – A drum that accumulates the suspension rope in one or more layers.

3.10 ELECTRIC SHOCK – A risk of electric shock is considered to exist at any exposed part if the available open-circuit potential is more than 42.4 volts peak, 30 volts rms, and the available current through a 1500-ohm resistor is more than 5 milliamperes.

3.10.1 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.

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

3.10.3 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.

3.11 HOIST, ELECTRICALLY POWERED – A hoist in which the prime mover is powered by electricity.

3.12 HOIST, MANUALLY POWERED – A hoist in which the hoisting power is derived directly from the operator.

3.13 HOIST, PNEUMATICALLY POWERED – A hoist in which the prime mover is powered by compressed gases.

3.14 HOIST, POWER-OPERATED – Either an electrically powered hoist or a pneumatically powered hoist.

3.15 PRIME MOVER – The source of power for the hoist, exclusive of any speed reducer.

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

a) The hoist;

b) Wire rope (winding drum and tail line);

c) Platform and platform supports;

d) Guard rails;

e) Building ties;

f) Rollers, stand offs, and wire winder;

g) Electrical cords or air supply hoses; and

h) Other related equipment as applicable that may be included on a stage or otherwise lifted by a hoist.

3.17 SHEAVE, DEFLECTION – A sheave used for small directional changes or deflections of the wire rope.

3.18 SHEAVE, DIRECTIONAL – A sheave used to transfer or change the direction of the wire rope.

3.19 SHEAVE, TRACTION – A single-wrap sheave that does not accumulate the suspension rope, but ascends or descends the rope as a result of friction between the rope and the sheave.

3.20 SPEED REDUCER – A device used to reduce the output speed of the prime mover to the desired speed of the hoist.

3.21 SUSPENSION SCAFFOLD – An assembly for supporting workmen and materials by means of wire ropes from an overhead suspension system and arranged and operated to allow raising or lowering to a desired work position.

4 Installation and Operating Instructions

4.1 A hoist shall be supplied with complete operation and maintenance instructions. A copy of the instructions shall be used as a guide in the examination and test of the hoist.

4.2 The instructions shall include the directions and information considered by the manufacturer or private labeler to be necessary for intended installation, maintenance, operation, and use of the hoist.

4.3 The operating instructions shall also include the type designation, the AWG size, the voltage rating, battery ampere-hour capacity for batteries and the maximum length of each type of power-supply cord for use with the hoist.

4.4 The instructions shall indicate how the motor protector is to be reset if a manually reset protector is employed.

4.5 A complete or an abbreviated form of the instructions shall be attached to each hoist. See Markings, All Hoists, Section 72.

4.6 The abbreviated form of instructions shall include:

a) A brief summary of how to operate the hoist,

b) Information on reeving of the wire rope,

c) Instructions for periodic testing of emergency equipment and daily inspection of the wire rope, and

d) Reference to the operator's manual for detailed instructions, and

e) A product marked in accordance with 74.2.8 shall have the statement "For Indoor Use Only" or the equivalent appearing in the instruction manual.

CONSTRUCTION

ALL HOISTS

5 General

5.1 The maximum rated speed at which an unguided suspended scaffold may be moved in a vertical direction shall not exceed 35 feet (10.7 m) per minute. The maximum rated speed at which a suspended scaffold that is guided by pretensioned wire ropes or fixed rails in an enclosed space or hoistway may be moved in the vertical direction shall not exceed 70 feet (21.4 m) per minute, whereby the maximum wire rope speed of a scaffold hoist itself shall not exceed 73 feet (22.3 m) per minute.

5.2 A traction hoist shall not use tail-line counterweights or other externally applied tensioning to develop the frictional forces required to raise and lower the hoist and its rated working load.

5.3 The electrical features of a control box assembly shall be evaluated to the requirements of the Standard for Industrial Control Equipment, UL 508 or the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1. This may include, but is not limited to, AC inverters, DC converters, DC drives, contact blocks, phase control relays, pendant controls and their interconnection.

5.4 When a battery is used as the primary power supply, the battery shall comply with one of the following:

a) Standard for Batteries for Use in Stationary and Motive Auxiliary Power Applications, UL 1973, when the battery is stationary, or

b) Standard for Batteries for Use In Light Electric Vehicle (LEV) Applications, UL 2271, when the battery is mobile.

6 Wire Ropes

6.1 A wire rope shall have a diameter of not less than:

a) 1/4 inch (6.4 mm) for a manually-operated hoist or

b) 5/16 inch (7.9 mm) for a power-operated hoist.

For strength and wear-resistance requirements, see the Wire-Rope Test, Section 45.

7 Drums and Sheaves

7.1 General

7.1.1 A drum in a hoist shall be for use with a suspension wire rope having a diameter of not less than that specified in 6.1.

7.2 Winding drums

7.2.1 The minimum pitch diameter of a multiple-wrap winding drum shall not be less than ten times the diameter of the wire rope used.

Exception: For a manually-operated hoist, the minimum pitch diameter of a multiple-wrap winding drum may be less than ten times the diameter of the wire rope used, but shall not be less than eight times the diameter of the wire rope used.

7.2.2 A winding drum shall be provided with a positive means for attaching the wire rope. The attachment shall comply with the requirement specified in 45.3.

7.2.3 To provide level winding of the wire rope, a winding drum on a powered hoist shall be constructed so that during operation, the suspension wire will wrap without cross-wrapping, improper spooling, or loss of winding.

7.3 Traction drums and traction sheaves

7.3.1 The pitch diameter of a traction drum or traction sheave shall not be less than 18 times the diameter of the wire rope.

7.4 Deflection sheaves

7.4.1 A deflection sheave or roller shall have a minimum pitch diameter of three times the diameter of the wire rope, and shall only be used for wire directional changes of less than 10 degrees.

7.5 Transfer drums and directional sheaves

7.5.1 A transfer drum or directional sheave shall have a minimum pitch diameter of ten times the diameter of the wire rope.

8 Speed Reducers

8.1 A hoist shall have a speed reducer or an equivalent device to obtain a mechanical advantage. The speed reducer or other device shall be of the positive type, such as a worm and gear, spur gears, or bevel gears, and shall not depend on frictional forces for its operation.

9 Shafts, Fillets, Keys, and Splines

9.1 A fillet shall be provided at any point of change in the diameter of the hoist shafts and the sheave shafts to reduce stress concentration in the shafts. Fitted keys, splines, bolts, or machine screws shall be used in all connections subject to torque.

10 Manual Cranks

10.1 A means for manually cranking shall be provided on a manually powered hoist, and may be provided on a power-operated hoist. The means of manual cranking shall be arranged so that it can be operated by one person. See 46.2.1.

10.2 Access to the manual crank on a power-operated hoist shall include either:

a) A means to make the prime mover inoperative while under emergency manual operation or

b) A warning marking shall be provided as specified in 74.1.1.

11 Protection Against Corrosion

11.1 Components of a hoist shall be protected against atmospheric corrosion, if malfunction due to corrosion of such components may result in a risk of injury to persons or impair the operation of the hoist.

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

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

Exception No. 1: A component in contact with wire rope is not required to be provided with corrosion protection.

Exception No. 2: A component not directly exposed to the environment, and a drive train component, such as a bearing, a gear, pawls, and a shaft, is considered to be provided with corrosion protection by factory-applied lubricants.

11.3 Metal shall not be used in combinations that can cause galvanic action that could reduce the strength of the components.

12 Lubrication

12.1 Each separate enclosure of a hoist shall be provided with a separate means to maintain lubrication of all moving parts requiring lubrication at all times. Self-sealed, self-lubricating, and dry bearings may be employed.

13 Gears

13.1 Gear material shall be one of the following:

a) Cast or forged alloy steel,

b) Cast or forged ductile or malleable iron, or

c) Cast, forged or wrought bronze.

Cast grey iron shall not be used for load-carrying gears.

MANUALLY POWERED HOISTS

14 General

14.1 In addition to the requirements specified in Sections 1 – 13, a manually powered hoist shall comply with the requirements in this section and Sections 39 – 49, 73, and 74, as applicable.

14.2 A winding-drum hoist shall be equipped with a driving pawl and a locking pawl that will automatically engage when the driving pawl is released during operation of the hoist.

14.3 A gripping type hoist shall be constructed so that during use the hoist is engaged on the suspension rope at all times, including travel in both directions.

14.4 A manually-operated hoist shall be provided with a means to prevent rapid handle movement, fast unspooling, or uncontrolled descent.

14.5 A positive cranking force shall be required to raise or lower a manually-operated hoist. See 46.2.1.

14.6 A secondary brake supplied with a manually operated hoist shall comply with the requirements in Secondary Brakes, Section 37.

ELECTRICALLY POWERED HOISTS

15 General

15.1 In addition to the requirements specified in Sections 1 – 13, an electrically powered hoist shall comply with the requirements in Sections 16 – 32, 35 – 66, and 69 – 74, as applicable.

15.2 When a battery is used as the primary power supply, a battery charge indicator shall be provided on the hoist.

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

16.1 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 16.5) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 16.1.

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 16.1.

Exception No. 1: A motor need not comply with these requirements if it complies with the requirements in 16.2.

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 16.2.

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.

Table 16.1
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

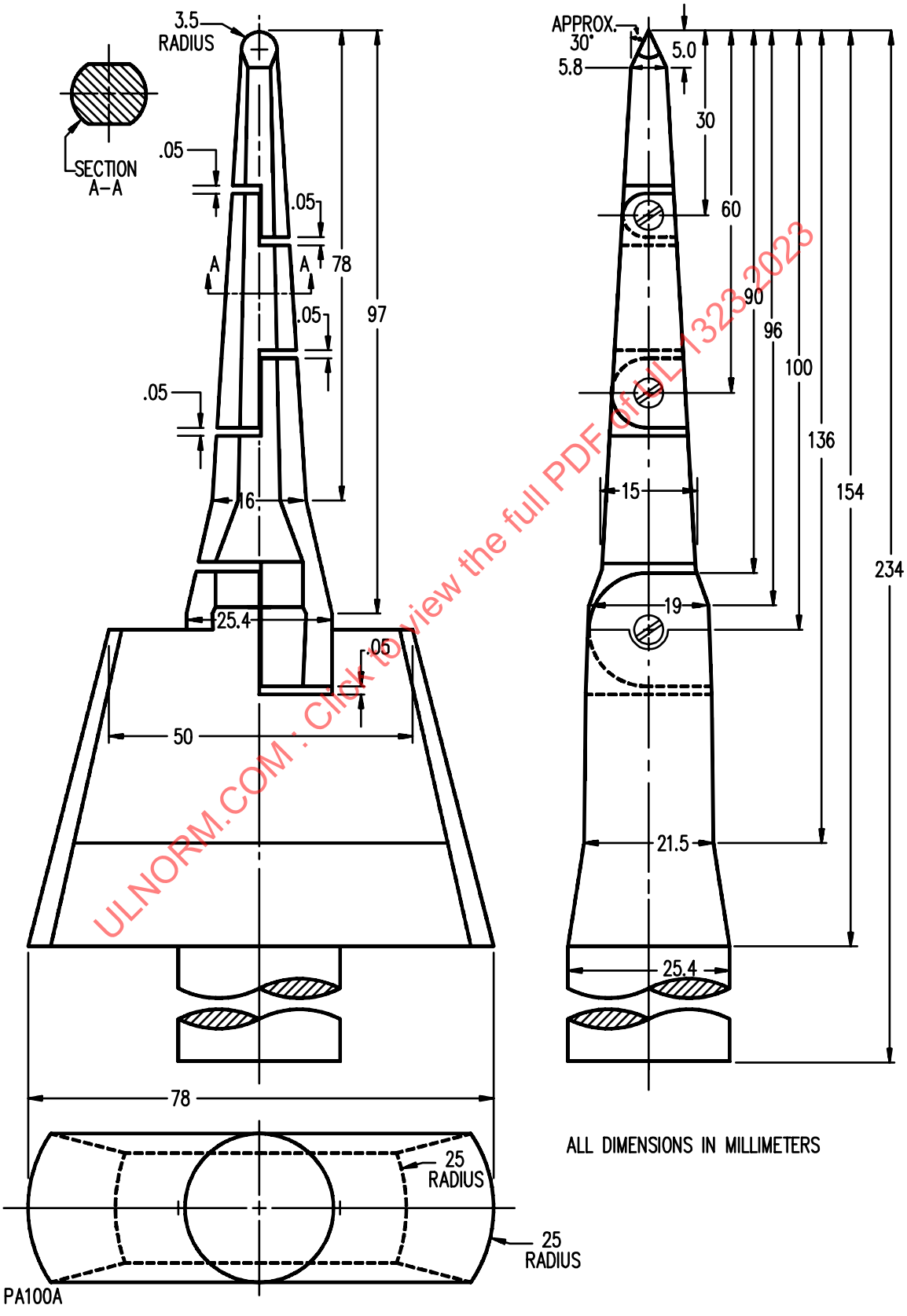
Minor dimension of opening,[a]		Minimum distance from opening to part,	
inches	(mm)[b]	inches	(mm)[b]
3/4	19.1	4-1/2	114
1	25.4	6-1/2	165
1-1/4	31.8	7-1/2	190
1-1/2	38.1	12-1/2	318
1-7/8	47.6	15-1/2	394
2-1/8	54.0	17-1/2	444

[a] See 16.5.

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

Figure 16.1

Articulate probe with web stop



16.2 Regarding a part or wire in an integral enclosure of a motor mentioned in Exception No. 1 to 16.1:

a) An opening that has a minor dimension (see 16.5) 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 16.2;

2) Film-coated wire cannot be contacted by the probe illustrated in Figure 16.3;

3) In a directly accessible motor (see 16.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 16.4; and

4) In an indirectly accessible motor (see 16.6), an uninsulated live part cannot be contacted by the probe illustrated in Figure 16.2.

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 16.1.

Figure 16.2

Probe for moving parts and uninsulated live parts

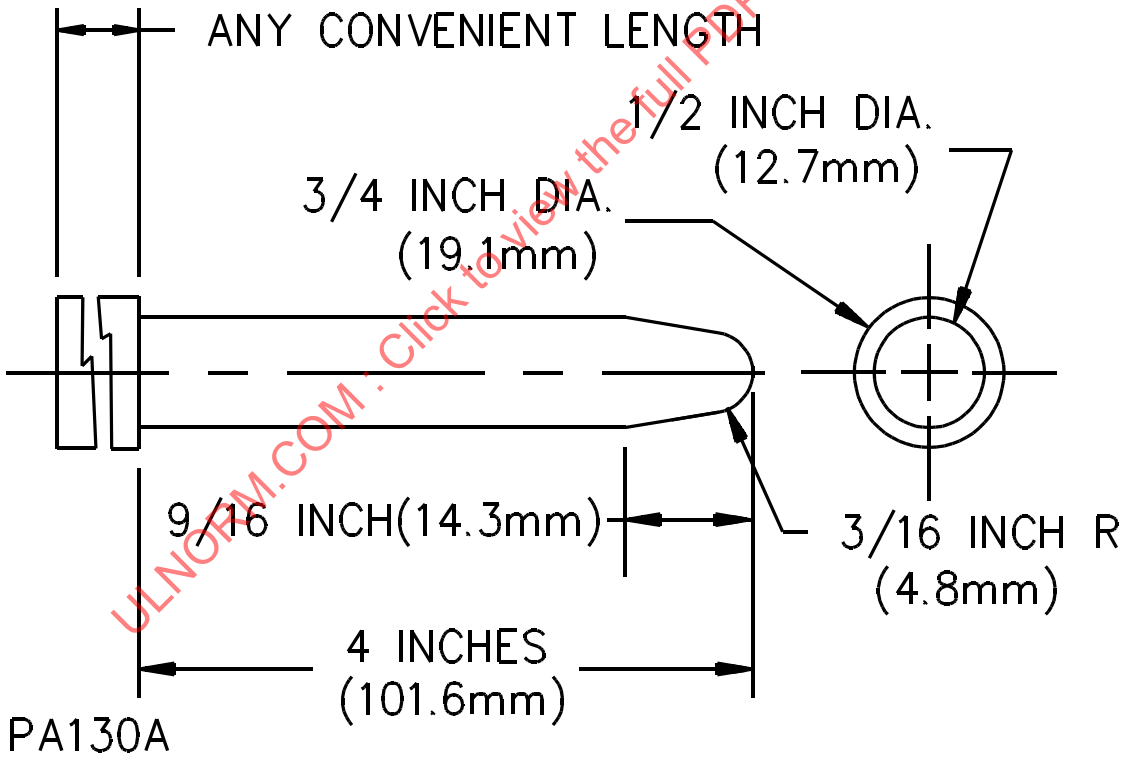


Figure 16.3

Probe for film-coated wire

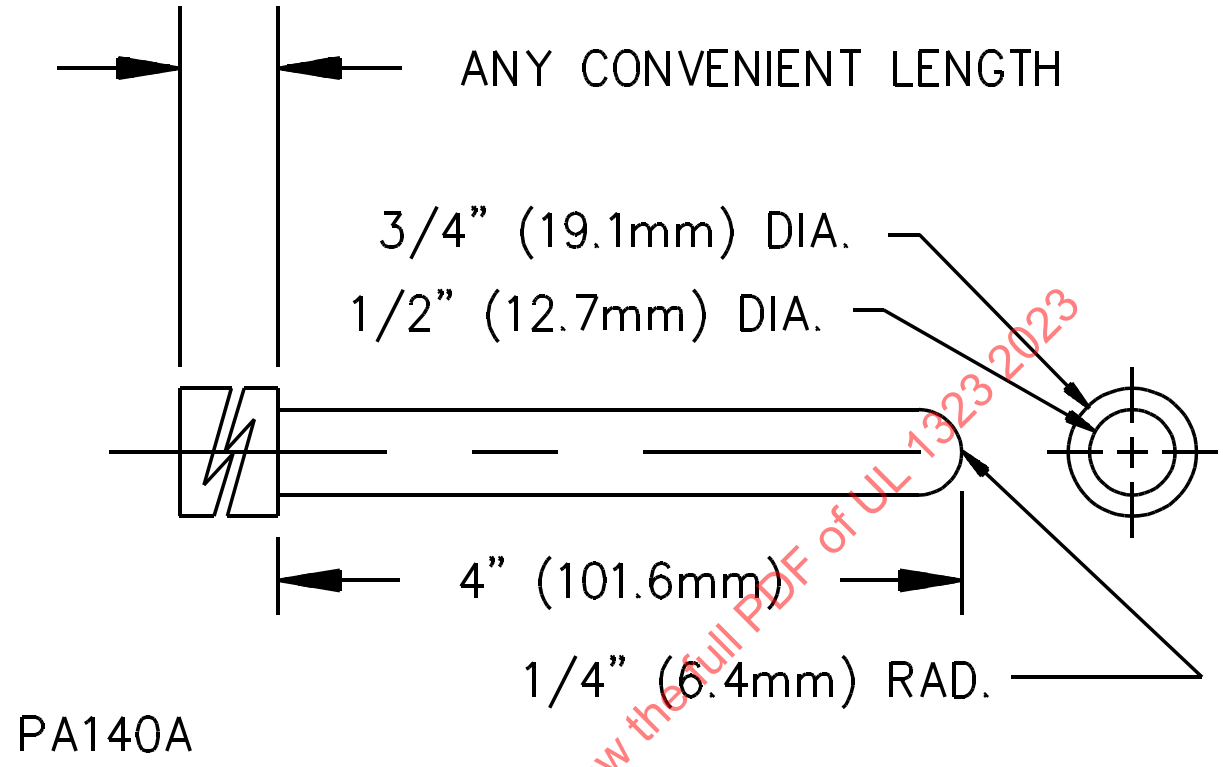
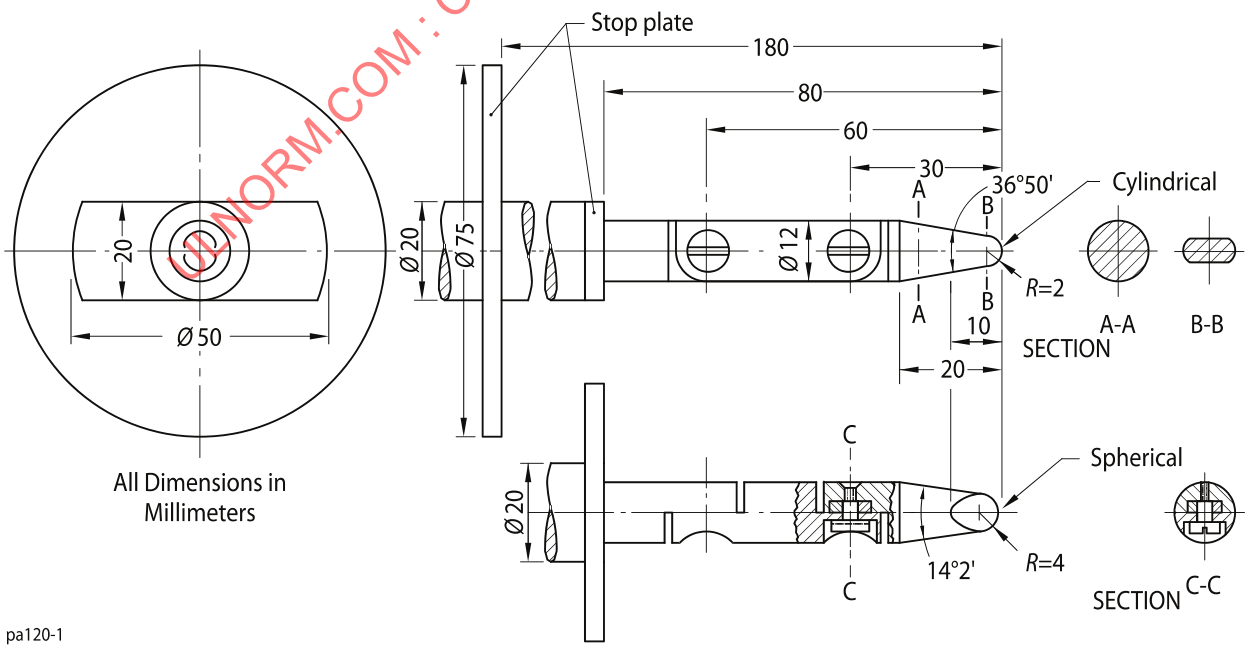


Figure 16.4

IEC articulate probe



16.3 The probes mentioned in 16.1 and 16.2 and illustrated in Figure 16.1 – Figure 16.4 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 16.1 and Figure 16.4 shall be applied in any possible configuration, and if necessary, the configuration shall be changed after insertion through the opening.

16.4 The probes mentioned in 16.3 and 16.5 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.

16.5 With reference to the requirements in 16.1 and 16.2, 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.

16.6 With reference to the requirements in 16.2, 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.

16.7 During the examination of a hoist to determine compliance with the requirements in 16.1 or 16.2, 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.

16.8 With reference to the requirements in 16.1 and 16.2, insulated brush caps are not required to be additionally enclosed.

17 Protection of Service Personnel

17.1 An uninsulated live part of a hoist involving a risk of electric shock shall be located or enclosed so that protection from unintentional contact will be provided while lamps or fuses are changed, or during other intended operations.

17.2 Live parts shall be arranged and enclosure covers located without presenting a risk of electric shock to persons while removing and replacing a cover during servicing indicated in the operating instructions.

17.3 An electrical component that may require examination, adjustment, servicing, or maintenance while energized shall be located and mounted with respect to other components and to grounded metal parts so that it is accessible without subjecting the serviceperson to a risk of electric shock. Access to a component for servicing shall not be impeded in the direction of access by another component or wiring.

17.4 Protection against risk of electric shock may be obtained by:

a) Placement of live parts so they are recessed at least 1/8 inch (3.2 mm) from the plane of the front of the fixed portion of the enclosure;

b) Placement of devices mounted at the face of a wiring compartment so that they are at least 1/8 inch from the front edge of the wiring compartment; or

c) Incorporation of projections or guards to effect a construction equivalent to the 1/8-inch recess.

18 Electrical Component Enclosures

18.1 General

18.1.1 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.

18.1.2 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 18.1.1.

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

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

18.1.5 Electrical enclosures shall comply with the Rain Test, Section 59.

18.2 Nonmetallic enclosures

18.2.1 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.

18.2.2 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 18.1.

Table 18.1
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 18.3.1.4.

[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.

18.2.3 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.

18.3 Metallic enclosures

18.3.1 General

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

18.3.1.2 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.

18.3.1.3 Sheet metal of an enclosure shall have a thickness not less than that specified in Table 18.1 and Table 18.2.

18.3.1.4 With reference to Table 18.1 and Table 18.2, 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 18.2
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		

Table 18.2 Continued on Next Page

Table 18.2 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Minimum thickness,
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch (mm)

[a] See 18.3.1.4.

[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.

18.3.1.5 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.

18.3.2 Corrosion protection

18.3.2.1 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.

18.3.2.2 Corrosion tests are to be conducted on the paint noted in 18.3.2.1(b) unless an evaluation can determine the suitability of the paint's composition.

18.3.2.3 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 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 or Steel Articles for 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 48. An annealed coating shall also comply with 18.3.2.8.

c) A zinc coating conforming with 18.3.2.4 (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 18.3.2.2.

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 48.

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 18.3.2.1(b) and 18.3.2.2 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 48, 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 18.3.2.6 may be used.

18.3.2.4 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 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 or Steel Articles for 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 48.

c) Two coats of an organic finish of the epoxy or alkyd resin or other outdoor paint on each surface. See 18.3.2.2.

d) Any one of the means specified in 18.3.2.3.

Exception: Other metallic or nonmetallic coatings that have been determined to provide equivalent protection as described in 18.3.2.6 may be used.

18.3.2.5 The requirements in 18.3.2.4 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.

18.3.2.6 With reference to 18.3.2.3 – 18.3.2.5, 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 18.3.2.3(a) or 18.3.2.4(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.

18.3.2.7 Test specimens of a finish as described in 18.3.2.1, 18.3.2.3(c), 18.3.2.4(c) or 18.3.2.6 (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.

18.3.2.8 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.

18.3.2.9 The requirements in 18.3.2.8 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.

19 Supply Connections

19.1 General

19.1.1 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: A hoist may employ a connector base for connecting an extension cord.

19.1.2 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.

19.1.3 A power-supply cord or extension cord that is made available for use with a hoist shall be of Type SJ, SJT, SO, SOO, ST, STO, STOO or of a type at least equally serviceable for the particular application.

19.1.4 A power-supply cord or extension cord shall comply with the outdoor-use requirements specified in the Standard for Cord Sets and Power-Supply Cords, UL 817.

19.1.5 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.

19.1.6 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 74.2.4.

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

19.1.8 An attachment plug may be of the locking type.

19.1.9 An attachment plug shall be provided with a weather sleeve to prevent the entrance of moisture during the Rain Test, Section 59.

19.1.10 A weather sleeve shall be constructed so that it will withstand, without visible signs of cracking or deterioration, the effects of oxygen aging as determined by the Accelerated-Aging Test, Section 58.

19.1.11 Weather sleeves made of plastic shall meet the flammability tests in accordance with the Horizontal Burning Test (HB) specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

19.1.12 The power supply from the battery shall comply with one of the following and shall be considered with respect to the intended use temperatures and conditions of service:

a) The Standard for Thermoplastic-Insulated Wires and Cables, UL 83;

b) The Standard for Flexible Cords and Cables, UL 62;

c) Outline for Welding Cable, UL 1276;

d) The Standard for Electrical Cables for Boats, UL 1426; or

e) The Standard for Machine-Tool Wires and Cables, UL 1063.

Exception: This requirement does not apply to wiring located in a LVLE circuit.

19.1.13 Wiring located within the battery compartment shall comply with one of the following and shall be considered with respect to the intended use temperatures and conditions of service:

a) Outline for Battery Lead Wire, UL 2726; or

b) Outline for Low Voltage Battery Cable, UL 4127;

c) For wiring smaller than 6 AWG, the requirements in 12.1 would apply and the effects of acid exposure need not be evaluated.

19.2 Strain relief

19.2.1 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 53. 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.

19.3 Bushings

19.3.1 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.

19.3.2 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.

20 Internal Wiring

20.1 General

20.1.1 The internal wiring of a hoist shall consist of appropriately sized wires or appliance wiring material with insulation thicknesses, as specified in Table 20.1. 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 20.1
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.

20.1.2 Appliance wiring material insulation with thickness less than that specified in Table 20.1 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.

20.1.3 *Deleted*

20.1.4 A flexible cord used for external interconnection shall be provided with bushings and strain relief in accordance with 19.2.1 – 19.3.2.

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

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

20.1.6 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.

20.1.7 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).

20.2 Wiring methods

20.2.1 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.

20.2.2 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.

20.2.3 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.

20.2.4 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.

20.2.5 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.

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

20.2.7 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.

20.2.8 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.

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

20.2.10 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.

20.2.11 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.

20.2.12 The wiring assembly shall be constructed and located so as to exclude water from electrical enclosures in accordance with 59.1.

21 Grounding

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

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

21.3 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.

21.4 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;

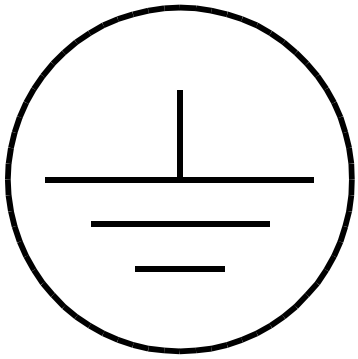
e) A marking on a wiring diagram provided on the product; or

f) The grounding symbol illustrated in Figure 21.1 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 21.1

Grounding symbol



IEC417, Symbol 5019

21.5 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.

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

21.7 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.

22 Bonding for Grounding

22.1 General

22.1.1 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.

22.1.2 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 65, in the as-received condition only.

22.1.3 Except as indicated in 22.1.6 – 22.1.8 and 22.1.10, 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 serviceperson.

22.1.4 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.

22.1.5 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.

22.1.6 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 serviceperson unless it is likely that servicing will be done while the main unit is energized after disassembly.

22.1.7 Metal parts, such as adhesive-attached metal-foil marking, screws, handles, and the like, need not comply with the requirements in 22.1.1 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.

22.1.8 The requirements in 22.1.1 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.

22.1.9 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.

22.1.10 A metal panel or cover employed as described in (a) – (c) need not comply with the requirement in 22.1.1 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.

22.1.11 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.

22.2 Construction and connections

22.2.1 Bonding conductors

22.2.1.1 The requirements in 22.2.1.2 – 22.2.1.7 apply only to materials depended upon for bonding and that have been evaluated for use as electrical conductors.

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

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

22.2.1.4 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.

22.2.1.5 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.

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

a) The AWG size specified in Table 22.1 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 61.1.

Table 22.1
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 Zinc-Coated Rigid-Steel Conduit, ANSI C80.1.

[c] Trade size in accordance with the Specification for Zinc-Coated Metallic Tubing, 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.

22.2.1.7 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 62.

22.2.2 Resilient rubber mountings

22.2.2.1 The requirements in 22.2.2.2 – 22.2.2.9 apply only to resilient rubber mountings that are depended upon for bonding.

22.2.2.2 An electrical bonding member across a resilient rubber mounting shall be of metal. Conductive rubber compounds (loaded rubber) shall not be used for bonding.

22.2.2.3 Electrical bonding shall be such that there is a path for electric current regardless of the manner in which the motor is rotated with respect to the base.

22.2.2.4 A bonding member shall be welded, clamped, riveted, secured by screws, or secured by a means that has been determined to be equivalent.

22.2.2.5 A bonding member shall be secured by a means that will retain the member if a motor is removed from its base. A connection that is necessary to remove intentionally, such as a screw or a bolt, at one or both ends of a bonding member complies with this requirement.

22.2.2.6 A bonding member shall be so enclosed, located, or otherwise protected to reduce the risk of damage during handling or installation.

22.2.2.7 If a metal part of a resilient rubber mounting also serves as a bonding path, it shall be inherently resistant to corrosion or shall be plated or finished to protect against corrosion. See 63.1.1.

22.2.2.8 Metal parts in a bonding path shall be compatible so that there will be negligible or no electrolytic action between dissimilar metals.

22.2.2.9 A bonding member shall have the flexibility to withstand normal mechanical stress due to vibration.

22.2.2.10 If a motor is intended to be used in an application where weather, atmospheric conditions, contaminants, or the like might cause deterioration of the bonding means, these factors are to be considered and additional tests may be necessary.

23 Mounting of Components

23.1 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.

23.2 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.

23.3 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.

23.4 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.

24 Capacitors

24.1 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 18.1 and Table 18.2, and the terminals are securely enclosed.

24.2 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 31.1.

24.3 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.

25 Insulating Material

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

25.2 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.

25.3 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.

26 Motors

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

26.2 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.

26.3 A motor-protective device shall not open the circuit during intended operation of the hoist. See the Temperature Test, Section 52.

26.4 If a motor is provided with impedance protection, it shall comply with the Standard for Impedance Protected Motors, UL 1004-2. If a motor is provided with an inherent thermal protector, it shall comply with the Standard for Thermally Protected Motors, UL 1004-3.

26.5 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.

26.6 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.

27 Receptacles

27.1 A convenience receptacle, if provided on a hoist, shall be a grounded type rated for 120 volts AC, shall not be rated less than 15 amperes, and shall be provided with integral ground fault circuit interrupter protection.

27.2 If installed on a hoist, a convenience receptacle shall be protected by an overcurrent protective device provided as an integral part of the hoist assembly. The protective device shall not be rated more than the convenience receptacle. More than one convenience receptacle rated 15 amperes on a circuit is considered protected by a 20 ampere overcurrent protective device.

Exception: An integral protective device is not required if the hoist control circuitry is arranged to electrically disconnect the receptacle whenever power is applied to the hoist motor.

27.3 The face of a receptacle shall:

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

b) Project at least 0.015 inch (0.38 mm) beyond a conductive surrounding surface.

27.4 Attachment plugs and receptacles employed for connection of the hoist shall be in accordance with the applicable requirements in the Standard for Attachment Plugs and Receptacles, UL 498.

28 Switches and Controllers

28.1 Each hoist shall have its own separate movement control that shall be guarded against unintentional actuation.

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

28.3 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 56.

28.4 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.

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

28.6 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.

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

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

29 Interlock Switches

29.1 Internal spacings of an interlock switch shall be as specified under the "Safety Controls" heading in Table 31.1.

29.2 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 28.

30 Uninsulated Live Parts

30.1 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 59.

31 Spacings

31.1 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 31.1. 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 31.1 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 31.1
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 – 1000 volts,					
		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.

31.2 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 31.1.

31.3 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 31.1.

31.4 If an isolated dead metal part is interposed between:

a) Live parts of opposite polarity,

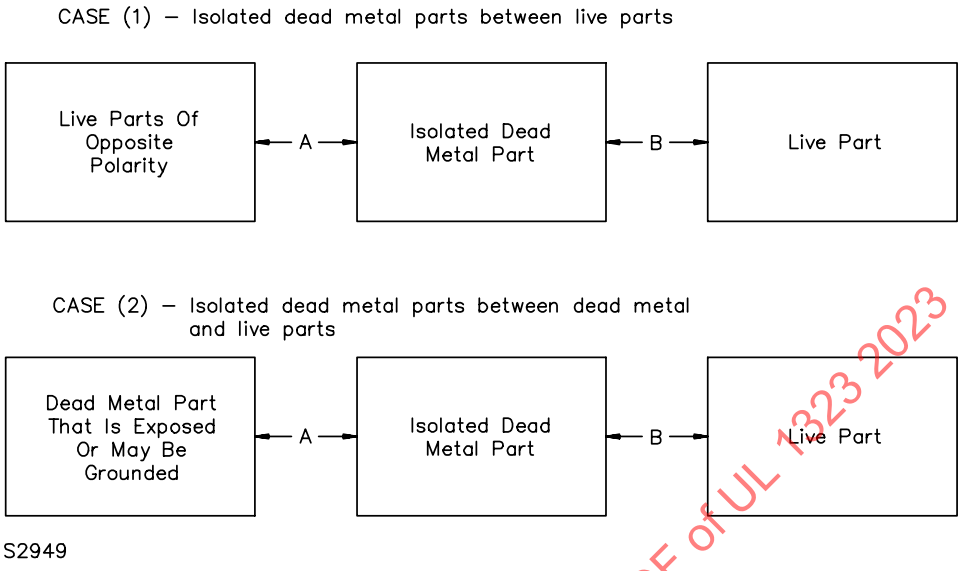
b) A live part and an exposed dead metal part, or

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 31.1. Also, see Figure 31.1.

Figure 31.1

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 31.1.

31.5 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.

31.6 Internal spacings in a motor shall comply with the spacing requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

32 Printed-Wiring Boards

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

PNEUMATICALLY POWERED HOISTS

33 General

33.1 In addition to the requirements specified in Sections 1 – 13, a pneumatically powered hoist shall comply with the requirements in Sections 34 – 48, 67, 68, and 72 – 74.

34 Components

34.1 Exterior pressure confining parts of air system components shall be constructed of metal, except for gaskets, hoses, and filters that are protected by a metal guard.

34.2 Cast iron shall not be employed for pressurized fittings or tubing.

34.3 The operating control employed for the hoisting function may not be provided with a means for locking in the run position.

POWER-OPERATED HOISTS

35 General

35.1 These requirements apply to electrically-powered and pneumatically-powered hoists.

35.2 A power-operated hoist shall be constructed so that it must be powered when descending.

Exception No. 1: A manual crank that allows descent of the hoist without power may be provided. The crank operating mechanism shall not allow free wheeling of the crank.

Exception No. 2: A power-operated hoist may be provided with a controlled descent device for use in the event of power failure. The controlled descent device shall comply with the requirements in 35.4 – 35.8.

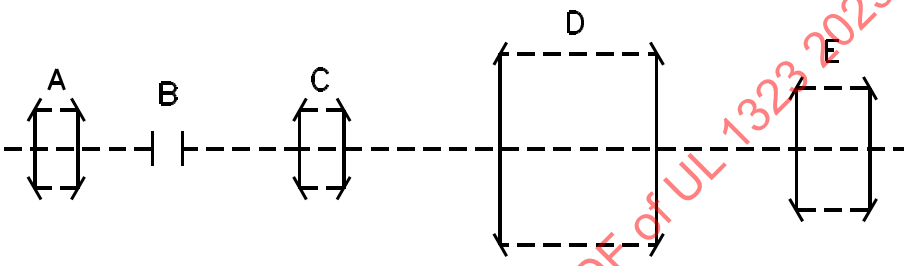
35.3 A means shall be provided to maintain the wire rope under tension when being spooled onto the drum. This means shall prevent tension from being released from the wire rope when the load is removed from the wire rope (such as when the scaffolding is resting on the ground).

35.4 A controlled descent device shall be independent of the primary and secondary brake. It shall be isolated from the hoist system, unless intentionally held in engagement, by means of a clutch, switch or other mechanism. See Figure 35.1 for a schematic of a hoist system denoting the required application of a controlled descent device.

Exception: If provided with a marking complying with 74.4.1, a hoist construction may be used that provides automatically actuated controlled descent operation in the event of a primary brake failure. This construction would not provide a controlled descent disconnect device; see Item B in Figure 35.1.

Figure 35.1

Hoist system schematic



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A – Controlled descent device.

B – Disconnect device (must be manually engaged to the hoist drive train).

C – Primary brake.

D – Hoist drum or sheave.

E – Secondary brake.

35.5 Any component of a hoist, the failure of which could initiate unintentional operation of the controlled descent device, shall comply with the requirements of the Strength Test, Section 42.

35.6 A hoist provided with a controlled descent device shall have a manual actuator on the secondary brake. The manual actuator shall operate as intended with the hoist in any mode of operation and with or without power to the hoist.

35.7 A controlled descent device shall be actuated only by a control that:

a) Requires constant pressure for actuation and

b) Simultaneously releases the primary brake.

Deactuation of the control shall engage the primary brake. The hoist shall be capable of normal up or down operation after use of the controlled descent mode.

35.8 A controlled descent mode of operation shall cause a rate of descent that is not greater than 1.5 times the normal descent speed of the hoist when operated with rated load.

36 Primary Brakes

36.1 A power-operated hoist shall be provided with a primary brake. The primary brake shall be connected to the drum or drive train of the hoist by a positive means. The connection shall not be through friction devices, belts, roller chains, or clutches.

36.2 A primary brake shall automatically engage when power to the prime mover is interrupted.

37 Secondary Brakes

37.1 A hoist shall be provided with an automatic, emergency-type secondary brake that complies with the requirements in the Accelerating-Descent Speed Test, Section 44.

37.2 A traction hoist shall be provided with an automatic, emergency-type secondary brake that complies with the requirements in the Operation Test – Hoist Run-Off, Section 43, and the Accelerating-Descent Speed Test, Section 44. All hoists shall comply with the requirements in Section 44.

37.3 A secondary brake shall be independent of the drive train of each hoist. The actuating mechanism of a secondary brake may be separate from the brake. The secondary brake of a traction hoist shall act directly on the suspension wire rope. The secondary brake of a winding-drum hoist shall act on either the suspension wire rope or directly on the drum or drum extension.

37.4 The secondary brake shall not be used to stop and hold the suspended load, except under overspeed conditions or when it may be manually actuated in accordance with 37.5. Under normal hoist operating conditions, such a brake shall not engage before the hoist and load have stopped their descent due to engagement of the primary brake.

37.5 A secondary brake may be provided with a manual actuator. The actuator shall require only a momentary contact to actuate the brake and maintain braking action and shall be arranged so that it cannot bypass the secondary brake.

37.6 A secondary brake shall include a provision for periodic testing under simulated overspeed conditions.

37.7 A secondary brake shall not be rendered inoperative by outside contamination when maintained as intended.

38 Load-Limiting Devices

38.1 A load-limiting device that is provided on a power-operated hoist in order to comply with the requirements in 46.1 shall:

a) Be integral with or permanently attached to the hoist and

b) Disconnect power to the prime mover of a hoist that is ascending if the load applied to the hoist exceeds 300 percent of the rated working load.

The construction may prevent ascent only or ascent and descent, but instructions accompanying the hoist shall clearly inform the user of the protection provided. See the Load-Limiting Test, Section 46.

38.2 If a load-limiting device is provided, it shall be constructed so that after adjustment and setting at the factory, it cannot be reset in the field to a position that would allow the hoist to lift a greater weight. A field adjustable setting may be provided to limit the lifting capacity to a lesser weight.

38.3 Compliance with the requirement in 38.2 relating to adjustment results if the adjustment cannot be made with commonly available hand tools, for example, a wrench or a screwdriver.

38.4 A shear pin shall not be used as a load-limiting device and shall not be positioned in the system so that the primary and secondary brakes may become ineffective.

Exception: A shear pin may be used to further limit the lifting capacity of the hoist. In such cases, the shear pin shall limit the lifting capacity to a value that is greater than 125 percent of the rated load and less than the maximum load lifted by the hoist during the Load-Limiting Test, Section 46. The shear pin shall not be relied upon to comply with the requirements of the Load-Limiting Test, Section 46.

39 Guards

39.1 A pulley, belt, gear, and all other moving parts of a power-operated hoist shall be enclosed or guarded to reduce the risk of injury to persons.

39.2 A guard that must be removed for lubricating, reeving, or similar adjustments or operations shall:

a) Be hinged or equivalently attached and

b) Remain in the open position after opening.

39.3 A guard required by 39.1 shall be of metal or of an equivalent material that has been evaluated. Among the factors that are to be taken into consideration when evaluating a nonmetallic guard or enclosure are:

a) The mechanical strength,

b) Resistance to impact, and

c) Resistance to atmospheric aging.

PERFORMANCE

ALL HOISTS

40 Normal-Operation Test

40.1 General

40.1.1 A hoist shall ascend or descend as intended when either the manual crank is operated or the prime mover is activated while the hoist is carrying 125 percent of its rated working load.

40.1.2 The primary brake shall stop the controlled descent of a hoist carrying 125 percent of its rated load and shall hold the hoist without slippage.

40.1.3 A traction hoist carrying 125 percent of its rated working load shall not drop or jerk while ascending or descending.

40.1.4 The tests are to be initiated while the hoist is held suspended as intended by the primary brake. Winding-drum hoists are to be tested while the maximum number of layers of wire rope specified by the manufacturer are wrapped around the drum.

40.1.5 For a manually powered hoist, two as-received sample hoists are to be tested. For a power-operated hoist, one sample is to be tested in the as-received condition and one sample is to be tested after being subjected to the Endurance Test, Section 55.

41 Endurance Test – Actuating Mechanisms for Power-Operated Hoists

41.1 An interlock switch or actuating mechanism shall function as intended before and after being subjected to 6000 cycles of operation.

41.2 An interlock switch used with an electrically powered hoist is to be tested at the voltage and amperage it is intended to control. See Table 49.1.

41.3 An interlock actuating mechanism used with a pneumatically powered hoist is to be tested at either:

a) The hoist's marked inlet pressure or

b) The pressure the interlock is intended to control when supplied with pressure at the marked inlet value.

41.4 An actuating mechanism used with an electrically powered hoist is to be tested at the voltage and amperage it is intended to control. See Table 49.1.

42 Strength Test

42.1 A hoist, while suspended, is to be loaded for 5 minutes to four times its rated working load. No load-bearing component of a hoist shall give way, deform, or weaken so as to result in a risk of injury to persons.

42.2 After the test load is released, the gear train and other hoist components shall operate as intended.

42.3 The hoist is to be prepared for test by securing the power shaft of the suspended hoist from rotating, applying the test load, and disengaging all brakes, including the primary brake.

42.4 The test load is to be applied at the point of intended loading in such a way that the test load will be transmitted throughout the speed-reduction system, starting at the output of the manual or prime-mover power shaft and extending through the hoist's drum or sheave.

42.5 After completion of the tests specified in 42.1 and 42.2, the power shaft of the prime mover is to be rotated the number of turns that produce one-quarter of the hoist's total speed reduction. The tests are then to be repeated.

43 Operation Test – Hoist Run-Off

43.1 The secondary brake of a traction hoist shall catch and stop a loaded hoist where the traction drive portion of the hoist is run off the lower end of the support rope. The hoist, while supporting 100 percent of its rated working load, shall be run at its maximum speed off the end of the support rope.

43.2 The secondary brake shall catch, stop, and hold the loaded hoist stationary for 2 minutes.

44 Accelerating-Descent Speed Test

44.1 A secondary brake intended to stop the hoist instantaneously shall stop the uncontrolled descent of a hoist carrying 125 percent of its rated working load before the hoist and load travel a vertical distance of 12 inches (305 mm).

44.2 A secondary brake of the decelerating type shall stop the uncontrolled descent of a hoist carrying 125 percent of its rated working load before the hoist and load travel a vertical distance of 20 inches (508 mm).

44.3 After the secondary brake stops descent of the hoist as specified in 44.1 or 44.2, the brake shall hold the hoist and load stationary for 2 minutes.

44.4 For each type of secondary brake tested, two sample hoist assemblies are to be tested: one sample in the as received condition, and one sample previously subjected to the Endurance Test, Section 55.

44.5 One test is to be conducted on each of two hoist samples. One sample is to be the sample subjected to the Endurance Test, Section 55, and is to use the same wire rope that was used in the Endurance Test. The other sample is to use a rope intended for the hoist that is in good condition and not exhibiting any breakage or bird-caging of strands, or other signs of abuse.

44.6 The primary brake is to be deactivated for this test. The hoist is to be allowed to descend at an accelerating speed until stopped by the secondary brake mechanism.

45 Wire-Rope Test

45.1 A wire rope employed during the Endurance Test, Section 55, and the Accelerating-Descent Speed Test, Section 44, shall not show:

a) Internal damage to the strands or individual wires,

b) Bird-caging or breakage of any wire rope strands or individual wires, or

c) Kinks or cuts.

45.2 After being subjected to the Endurance Test, Section 55, and the Accelerating-Descent Speed Test, Section 44, a wire rope of the size and type required by 72.4 shall not break when pulled with a force equal to the greater of the following two values:

a) Eighty percent of the manufacturer's rated ultimate tensile strength of the wire rope in the as received condition.

b) Six times the rated working load of the hoist.

Exception: The wire rope from a traction hoist is to be investigated after 500 cycles of the Endurance Test.

45.3 An attachment to the wire drum shall not break when pulled with a force equal to four times the rated working load of the hoist. The load shall be applied as a direct pull on the cable in a direction tangential to the drum at the cable connection and with no turns of cable on the drum.

46 Load-Limiting Test

46.1 Power-operated hoists

46.1.1 The prime mover of a power-operated hoist shall stall or the power shall be automatically disconnected when attempts are made for the hoist to lift, from a static condition, and carry three or more times its rated working load.

46.1.2 A load-limiting device of a power-operated hoist shall disconnect power to the prime mover for an ascending (and a descending if so designed) scaffold when a test load of 300 percent of the rated working load is applied to the hoist. Testing of the control switch is to be conducted in conjunction with the endurance test specified in 41.1.

46.1.3 If a shear pin is used to further limit the lifting capacity of a hoist, the shear pin shall be removed and replaced by a steel pin before the load-limiting test is conducted. The hoist shall comply with the requirements without use of a shear pin. The test is to be repeated with the factory supplied shear pin in place and the lifting capacity noted. The pin shall shear at a load equal to or less than that recorded without the shear pin, but greater than 125 percent of rated load.

46.2 Manually operated hoists

46.2.1 The mechanical advantage offered by the gear reduction system and manual crank or lever operator shall not permit lifting of a load in excess of three times the rated working load of the hoist. For a lever-operated hoist, a force of 200 pounds (890 N) is to be applied to the end of the lever at 90 degrees and in the direction to raise the hoist. For a crank-operated hoist, a force of 75 pounds (337 N) is to be used.

47 Accelerated-Corrosion Test

47.1 A secondary brake mechanism shall comply with the requirements in the Accelerated-Descent Speed Test, Section 44, after conditioning in a salt-spray environment as specified in 47.2 – 47.8.

47.2 Other than as noted in 47.3, the secondary brake mechanism, except for self-lubricated bearings and bearings of a type not requiring frequent replenishment of the lubricant, is to be taken apart and freed of lubricant by washing in a degreasing solvent or solution prior to salt-spray exposure.

47.3 Disassembly and removal of lubricant prior to salt-spray exposure is not required when the following conditions are met:

a) The sample is subjected to the salt-spray exposure after previously being subjected to the Endurance Test, Section 55.

b) The mechanism is not provided with additional lubrication during or after the Endurance Test, Section 55.

c) The mechanism is provided with an enclosure that protects the mechanism from contamination.

d) The enclosure meets the requirements in 16.4.

e) The instruction manual provides adequate information concerning periodic lubrication, including the time interval and proper lubrication methods.

f) No additional lubrication is provided prior to subjecting the hoist to the Accelerating-Descent Speed Test, Section 44, as required in 47.8.

47.4 The apparatus for salt-spray (fog) testing is to consist of:

a) A fog chamber with the interior measuring 48 by 30 by 36 inches (1.2 by 0.8 by 0.9 m),

b) A salt solution reservoir,

c) A supply of conditioned compressed air,

d) One dispersion tower constructed in accordance with the Standard Practice for Operating Salt Spray (Fog) Testing Apparatus, ASTM B117-94, for producing a salt fog,

e) Specimen supports,

f) Provision for heating the chamber, and

g) The necessary means of control.

47.5 The dispersion tower for producing the salt fog is to be located in the center of the chamber and is to be supplied with humidified air at a pressure of 17 – 19 psi (117 – 131 kPa) so that the salt solution is aspirated as a fine mist or fog into the interior of the chamber.

47.6 The salt solution is to consist of 5 percent by weight of common salt (sodium chloride) in distilled water. The pH value of the collected solution is to be between 6.5 and 7.2 with a specific gravity of 1.0255 to 1.0400 at 25°C (70°F). The temperature of the chamber is to be maintained at 35 ±1°C (95 ±2°F) throughout the test.

47.7 Drops of solution that accumulate on the ceiling or cover of the chamber are to be diverted from dropping on the specimens. Drops of solution that fall from the specimens are not to be recirculated, but are to be removed by a drain located at the bottom of the apparatus.

47.8 After reassembly, including replacement of protective covers, the device is to be placed in the test chamber as intended in service for 72 hours. At the completion of the exposure time, the device is to be lubricated and, without adjustment or further attention, subjected to the Accelerating-Descent Speed Test, Section 44.

48 Metallic-Coating-Thickness Test

48.1 The method of determining the thickness of a zinc or cadmium coating is described in 48.2 – 48.9.

48.2 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.

48.3 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.

48.4 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).

48.5 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.

48.6 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.

48.7 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.

48.8 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.

48.9 To calculate the thickness of the coating being tested, select from Table 48.1 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 48.7.

Table 48.1
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

Table 48.1 Continued on Next Page

Table 48.1 Continued

Temperature,		Thickness factors, 0.00001 inches (0.00025 mm) per second	
°F	(°C)	Cadmium plating	Zinc plating
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

ELECTRICALLY POWERED HOISTS

49 General

49.1 Unless otherwise specified, values of the supply voltages for the performance tests shall be as specified in Table 49.1.

Table 49.1
Values of supply voltage for tests

Test	Test procedure reference	Voltage rating of device and corresponding test potential, volts[a,b]						
		110 – 120	200 – 208	220 – 240	254 – 277	440 – 480	550 – 600	601 – 1000
Endurance	41.2 and 41.4	120	208	240	277	480	600	1000
Leakage-Current	Section 50	120	208	240	277	480	600	1000
Input	Section 51	120	208	240	277	480	600	1000
Temperature	Section 52							
AC		120	208	240	277	480	600	1000
DC		115		230				
Abnormal-Operation	Section 54	120	208	240	277	480	600	1000
Overload	Section 56	120	208	240	277	480	600	1000
Overvoltage and Undervoltage	Section 57							
Overvoltage, AC or DC		132	229	264	305	528	660	1100
Undervoltage, AC		102	177	204	235	408	510	900
Undervoltage, DC		96	166	192	222	384	480	
Short Circuit	Section 61	120	208	240	277	480	600	1000

Table 49.1 Continued on Next Page

Table 49.1 Continued

Test	Test procedure reference	Voltage rating of device and corresponding test potential, volts[a,b]						
		110 – 120	200 – 208	220 – 240	254 – 277	440 – 480	550 – 600	601 – 1000

[a] If the rating of the product does not fall within the voltage ranges specified, the product is to be tested at the nominal voltage rating of the attachment plug provided on the product. See 74.2.1 and 74.2.2.

[b] For the tests, the product shall be connected to the supply source using that power-supply and extension cord intended for use with the product and providing a total of 250 feet (76 m) of electrical supply cord. If an integral reel and power-supply cord are provided as part of the hoist, testing shall be conducted with the length of cord to be supplied with the product. In either case, if the electrical supply cord recommended by the manufacturer is less than 250 feet, the hoist shall be tested with that maximum length of cord recommended by the manufacturer.

50 Leakage-Current Test

50.1 The leakage current of a cord-connected hoist rated for a nominal 250-volt or less supply when tested in accordance with 50.3 – 50.7 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.

50.2 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.

50.3 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 16. 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.

50.4 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.

50.5 The measurement circuit for leakage current is to be as illustrated in Figure 50.1. 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.

50.6 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.

50.7 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 49.1. The test sequence, with reference to the measurement circuit in Figure 50.1 is to be as follows:

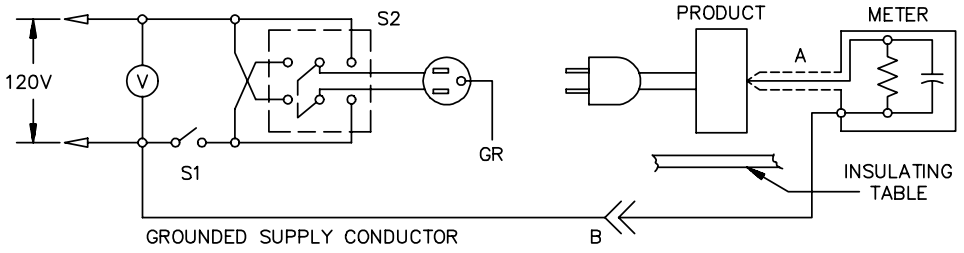
a) With switch S1 open, the hoist is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2, with the hoist switching devices in all their normal operating positions.

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.

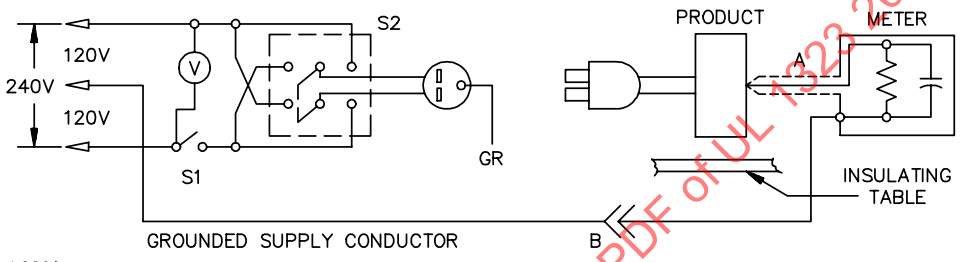
Figure 50.1

Leakage-current measurement circuits



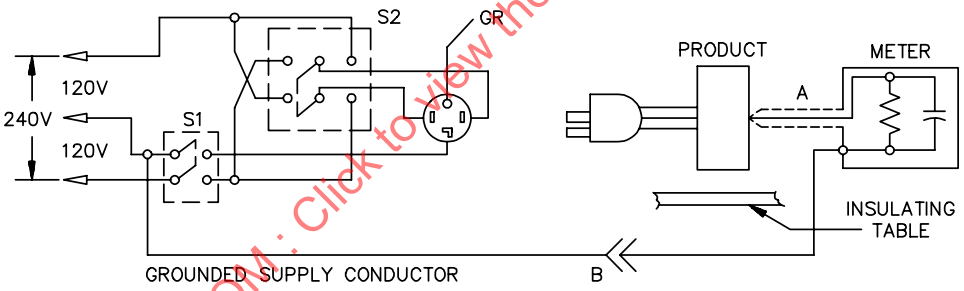
LC100

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.

50.8 Normally a sample will be carried through the complete leakage-current test, as specified in 50.7, without interruption for other tests. With the concurrence of those concerned, the leakage-current test may be interrupted for the purpose of conducting other nondestructive tests.

51 Input Test

51.1 The current input shall not be more than 110 percent of the rated value when the hoist is operated with the rated working load applied and when connected to a supply circuit of rated frequency and maximum rated voltage as specified in Table 49.1.

51.2 When a battery is used as the primary power supply, the current input shall not exceed the battery's maximum rated discharge current.

52 Temperature Test

52.1 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.

52.2 For this test, a hoist is to be operated continuously so as to raise and lower 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.

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

52.4 With the concurrence of those concerned, a 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 52.1 by more than 11.5°C (20.0°F).

52.5 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 terminals. However, the individual cord conductors should be provided with supplementary heat-resistant insulation with the proper dielectric withstand characteristic. See the Dielectric Voltage-Withstand Test, Section 60.

52.6 All values for temperatures in Table 52.1 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).

52.7 Temperatures are to be measured with thermocouples consisting of wires not larger than No. 24 AWG (0.21 mm^2) and not smaller than No. 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 No. 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.

Table 52.1
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
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		

Table 52.1 Continued on Next Page

Table 52.1 Continued

Materials and components	°C	(°F)
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.

[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.

52.8 If the hoist has a single frequency rating, the test is to be conducted at that frequency. 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. If a battery is used during testing as the primary power supply, the battery shall be fully charged.

52.9 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.

52.10 Tests are to be conducted under actual operating conditions. However, if agreeable to those concerned, loading may be accomplished by means of a dynamometer or generator set.

52.11 During the optional break-in period, the hoist may be allowed to cool to near ambient temperature after each time it has been subjected to continuous 30 minutes of operation as described in 52.2. A motor protective device, if provided, shall not open the circuit during the optional break-in period.

52.12 If the length of the power supply cord:

a) Exceeds 250 feet (76 m) and is of a type and AWG size recommended by the manufacturer (see 4.3) and

b) Causes a voltage drop from the power source to the hoist motor terminals such that the motor is provided with a voltage less than its rating,

the temperature test is to be repeated with the reduced voltage or a cord of the type, size, and length recommended by the manufacturer. For the voltage drop determination, the voltage is to be measured at the motor terminals under the same conditions specified for the Input Test, Section 51. However, the maximum length of the power supply cord is to be provided.

53 Strain-Relief Test

53.1 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 75-pound (34-kg) weight is suspended from the hoist by the cord and the strain-relief means is stressed from any angle permitted by the construction of the hoist.

53.2 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.

54 Abnormal-Operation Test

54.1 If a hoist employs either a semiconductor, one or more semiconductor junctions, a capacitor, or a combination of these, no risk of fire, electric shock, or injury to persons shall result when either the semiconductor, the junctions, or the capacitor is short- or open-circuited.

Exception: This requirement does not apply to capacitors used in capacitor motors.

54.2 A hoist provided with an externally operated voltage-selection switch shall operate without risk of fire or electric shock under any combination of voltage settings and branch-circuit connections.

54.3 The hoist is to be connected to a grounded supply of rated frequency and maximum rated voltage (see Table 49.1) and operated at no load while short- or open-circuited conditions, as specified in 54.1 are introduced one at a time.

54.4 During the tests described in 54.3, the hoist is to be connected in series with a nontime-delay fuse of the maximum current rating that can be accommodated by the fuseholder of the branch circuit to which the product could be properly connected. There shall not be risk of electric shock or fire prior to the operation of the fuse.

54.5 Exposed dead metal parts of the hoist are to be connected to ground through a 3-ampere fuse. The fuse shall not open during the test.

54.6 Results shall show no indication of unintended operation of the hoist. If there is indication of a component malfunction during operation of the hoist, the malfunction shall not be such as to present a risk of injury to persons.

55 Endurance Test

55.1 A hoist shall operate as intended for 1000 cycles while carrying 100 percent of the rated working load. There shall be no signs of breakage, wear, or malfunction. No repairs or adjustments shall be necessary.

55.2 One cycle of operation is to consist of one ascent and one descent over a minimum vertical travel distance necessary to cycle the wire rope completely either:

a) Through all wire rope related parts, on a traction hoist or

b) Through four turns or a minimum of 30 feet (9.1 m), whichever is greater, on a winding-drum hoist.

55.3 The primary brake is to be applied whenever the hoist changes direction. The rate of cycling is to be adjusted to prevent overheating of the motor.

55.4 Once tested, the hoist is to be subjected to the Accelerating-Descent Speed Test, Section 44.

56 Tests on Switches and Controllers

56.1 General

56.1.1 When subjected to the appropriate test specified in 56.1.3 – 56.4.2 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, no undue pitting or burning of the contacts, and no emission of molten metal or flame from the enclosure of the switch. See 56.1.4.

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

56.1.3 The hoist is to be connected to a grounded power-supply circuit of rated frequency and maximum rated voltage as described in 52.8 and Table 49.1, 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.

56.1.4 A switch need not be subjected to these tests if:

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

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

56.2 Speed-changing switches

56.2.1 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.

56.2.2 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.

56.3 Motor-reversing switches

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

56.3.2 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.

56.4 Other switches

56.4.1 A switch or other device that controls the hoist motor and that is not one of a type covered by 56.2.1 and 56.3.1 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 49.1.

56.4.2 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 to those concerned. The motor is to be left in the on position as briefly as possible.

57 Overvoltage and Undervoltage Tests – Electromagnets

57.1 An electromagnet for use on direct current shall:

a) Withstand continuous application of 110 percent of its rated voltage without damage to the operating coil and

b) Operate as intended at 20 percent less than rated voltage.

57.2 An electromagnet for use on alternating current shall:

a) Withstand a continuous application of 110 percent of its rated voltage without damage to the operating coil and

b) Operate as intended at 15 percent less than rated voltage.

57.3 For a device having a voltage rating within one of the ranges specified in Table 49.1, the overvoltage and undervoltage test voltages specified in Table 49.1 are to be employed for a device having a voltage rating in those ranges.

57.4 For electromagnet operation at minimum voltage as specified in 57.1 and 57.2, the contactor coil is to be subjected to the rated line voltage until constant temperatures are reached. It is then to be tested immediately for closing at the minimum voltage.