



UL 1492

STANDARD FOR SAFETY

Audio-Video Products and Accessories

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UL Standard for Safety for Audio-Video Products and Accessories, UL 1492

Second Edition, Dated April 30, 1996

Summary of Topics

This revision to UL 1492 dated May 17, 2019 is being issued to add UL 62368-1 as an alternative to UL 60950-1 in paragraph 1.7.

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 revised requirements are substantially in accordance with Proposal(s) on this subject dated March 8, 2019.

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UL 1492

Audio-Video Products and Accessories

Prior to the first edition, the requirements for the products covered by this standard were included in the Standard for Radio Receivers, Audio Systems, and Accessories, UL 1270; Low-Voltage Video Products Without Cathode-Ray-Tube Displays, UL 1409; and Television Receivers and High-Voltage Video Products, UL 1410. Prior to these standards, the requirements were included in UL 492.

First Edition – August, 1992

Second Edition

April 30, 1996

This UL Standard for Safety consists of the Second Edition including revisions through May 17, 2019.

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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B2 GeneralB1

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C1 PurposeC1
C2 GeneralC1

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INTRODUCTION

1 Scope

1.1 These requirements cover audio and video products intended for use on supply circuits in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements, where applicable, cover:

- a) Audio products and accessories intended for household use and involved with the reproduction or processing of audio signals. Examples of such products include amateur radio products, amplifiers, intercommunicating devices, phonographs, radio clocks, radio-phonographs, radio receivers, record players, tape players, tape recorders, transceivers, tuners, tuner-amplifiers, and similar products.
- b) Video products that are intended for household or commercial use, and that receive signals in ways such as off the air, through a CAT/MATV cable system, from a video-recorded medium, or from image-producing units. Examples of such products are video tape recorders; video-receiving, -processing, -recording, -producing, and -amplification products; television-antenna amplifiers; cable television (CAT) converters; television tuners; television receivers and monitors; television cameras; and similar products.
- c) Auxiliary products and accessories intended for use with audio or video products wherein the auxiliary and accessory products are separate and do not perform the desired function, but are used in addition to or as a supplement to products according to (a) and (b). Examples of such products include character generators, editing controllers, video switches and encoders, CRT degaussers, video tape rewinders, head demagnetizers, tape erasers, and similar products.
- d) Video products intended for entertainment purposes in ordinary locations of health-care facilities.
- e) Cellular telephones and similar transceiving devices used on a vehicle, boat, or the like where the telephone interconnects to the telephone network through a radio transmitter and receiver.
- f) Portable audio or video products of the types described in (a) – (c) and (e) that are intended for use with a marine or any other battery circuit as the power supply means.

1.3 Battery chargers and power supplies, whether portable or for permanent installation and not packaged with or specifically referenced in literature packaged with a product but intended for use with audio or video products, are categorized as battery chargers or power supplies and are not covered by these requirements.

1.4 These requirements do not cover products that are covered by the Standard for Commercial Audio Equipment, UL 813.

1.5 Audio or video products intended for use by children are covered by these requirements, but shall also comply with the applicable requirements in the Standard for Electric Toys, UL 696.

1.6 Video products intended for use at mercantile and banking premises to provide a means of recording holdup attempts or similar activities in the area shall also comply with the applicable requirements in the Standard for Surveillance Camera Units, UL 983.

1.7 Circuits in audio or video products intended to connect directly to a telecommunication network shall comply with the applicable requirements in the Standard for Information Technology Equipment Safety – Part 1: General Requirements, UL 60950-1 or the Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

1.8 A separately enclosed non-powered loudspeaker that is not intended for connection to a specific audio amplifying source shall comply with the requirements in the Electronic Industries Association (EIA) Interim Standard IS-33, Recommended Loudspeaker Safety Practices – An Industry Guideline, dated May 1987.

1.9 Deleted

2 General

2.1 Components

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

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

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

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

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

2.2 Undated references

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

3 Glossary

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

3.2 ACCESSIBLE PART – A part located so it can be contacted by a person, either directly or by means of the probe (see Figure 18.1 and 3.43) or a tool (see 18.4.1), or not recessed the required distance behind an opening (see 18.1.2).

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3.3 ADJUSTABLE CONTROL – A control provided for making adjustments necessary to render the product capable of performing its intended functions.

3.4 BARRIER – A part, usually an added part, that is required to comply with requirements involving accessibility, spacings, risk of fire, and the like.

3.5 BRANCH CIRCUIT – A branch circuit is that portion of the building wiring system beyond the final overcurrent device on the power-distribution panel protecting the circuit to the field-wiring terminals in a permanently connected unit or to the receptacle outlet for a cord-connected unit.

3.6 CART – A stand, as defined in 3.45, that is provided with casters, wheels, or rollers to make it mobile.

3.7 CASTER – Any roller or swiveled wheel attached to a stand or product that makes the stand or product mobile.

3.8 CHILD'S PRODUCT – A child's product is one that is decorated or specially constructed (pictures, color, or shape) so as to appeal to children or is advertised (on the product or shipping carton or in advertising literature) by the organization responsible for the product as being intended for use by children.

3.8A COIN/BUTTON CELL BATTERY – A small, single cell battery having a diameter greater than its height.

3.9 COMMERCIAL PRODUCT – A product intended for use in a commercial establishment such as a hotel, a motel, a house of worship, a school, or a business.

3.10 CONDITIONED LAMP – A lamp that has been operated for a minimum of 100 hours.

3.11 CONTAINED ATMOSPHERIC ENERGY (CAE) – The amount of energy resulting from the gas contained within a lamp. The CAE is calculated as follows:

$$CAE = 0.15 (PC - PE) V$$

in which:

PC is the contained pressure in atmospheres,

PE is the external pressure in atmospheres, and

V is the volume in cubic centimeters.

3.12 DEACTIVATED LAMP – A lamp end-of-life failure mode that is caused by the depletion of the filament emission material so that the lamp gasses cannot be ionized. A deactivated lamp may be simulated as follows:

a) For a rapid-start lamp, two lamps are utilized, each with one end connected to one of the lampholders, the other end open-circuited and

b) For an instant-start lamp using a circuit-interrupting lampholder, the lamp is removed and the circuit-interrupting lampholder terminals are short-circuited.

3.13 EXPOSED PART – A part that is subject to handling in normal use. Exposed parts include a phonograph pick-up arm and connections; antenna leads and terminals; grounding leads and terminals; metal parts on the back, top, sides, or front of the overall enclosure; and parts at or near operating controls.

3.14 FIBER – Where the term “fiber” is used in this standard to denote a material usually used as electrical insulation, vulcanized fiber is meant. Cellulose fiberboard, pressboard, fullerboard, or cardboard shall not be used in lieu of fiber. Fishpaper is a designation commonly used in the trade to refer to thin sheets of electrical grade vulcanized fiber.

3.15 FIELD-WIRING TERMINAL – Any terminal to which a supply or other wire can be connected by an installer in the field is a field-wiring terminal.

3.16 FLOOR-MOUNTED (CONSOLE) PRODUCT – A product that is intended to be used and supported on a floor one surface, generally the back, intended to be positioned adjacent to a wall or corner.

3.17 GROUND – Earth ground, unless otherwise specified.

3.18 HAZARD – The term hazard used alone is intended to be interchangeable with the phrase “risk of fire, electric shock, or injury to persons.” If used otherwise, it is intended to be interchangeable with the phrase “risk of.” For example, the phrases “fire hazard” and “risk of fire” are intended to be interchangeable.

3.19 HAZARDOUS ENERGY CIRCUITRY – Circuitry capable of:

- a) Producing a voltage exceeding 42.4 V peak (21.2 V peak for an outdoor-use appliance and where wet contact is likely to occur) or
- b) Delivering more than 15 W into an external resistor, as determined by the methods described in the Power Supply Tests, Section 77.

3.20 HEALTH-CARE FACILITY PRODUCT – product intended for entertainment purposes for use in a hospital, a nursing home, a medical-care center, or a similar health-care facility in which installation is limited to a nonhazardous area in accordance with the National Electrical Code, ANSI/NFPA 70. It is not intended for use in a critical-care area in which a patient may be treated with an externalized electrical conductor, such as a probe, a catheter, or other electrode, connected to the heart; however, the product is likely to be contacted by a patient during his stay in a health-care facility.

3.21 HIGH-PRESSURE LAMP – A lamp in which the contained atmospheric energy (CAE) equals or exceeds 5 Joules cold (de-energized 50°C or less). See 3.11 and 3.32.

3.22 HIGH-VOLTAGE PART – Any part that operates continuously at or above 2500 volts peak.

3.23 HIGH-VOLTAGE PRODUCT – A product that incorporates high-voltage parts.

3.24 HOUSEHOLD PRODUCT – A product intended for use in the home.

3.25 INSTANT-START LAMP CIRCUIT – A circuit that uses a high open-circuit voltage to start lamps that usually have a single contact at each end.

3.26 INTERLOCK – A mechanism that de-energizes parts involving a risk of electric shock or injury to persons before they become accessible to the user when the enclosure of the part is opened or a cover is removed.

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3.27 IN-WALL MOUNTED PRODUCT – A product that appears intended for in-wall mounting, has provisions for mounting ears or flanges, or is provided with in-the-wall mounting instructions. The product would be placed inside a wall cavity with some part of the product located behind the plane of the wall.

3.28 ISOLATING TRANSFORMER – A device containing two or more coils of insulated wire that transfers alternating-current energy by electromagnetic induction from one winding to another. The coil connected to the supply circuit is referred to as the primary. Any coil isolated from the primary is referred to as a secondary winding. The primary and secondary windings are not conductively connected and therefore the transformer provides electrical isolation of the secondary circuit or circuits from the primary circuit.

3.29 LAMP COMPARTMENT – A compartment that encloses a projection lamp. The housing may be metallic or polymeric, and include a glass diffuser or lens, a metal canopy, a screen, or the like.

3.30 LINE CONNECTED OR DIRECT CONNECTED – Generally used to mean that there is no electrical isolation (such as by an isolating power transformer) between any of the circuits of the product and the branch circuit supplying electrical energy to the product.

3.31 MAJOR ENCLOSURE PART – A part that:

- a) Forms more than 50 percent of the area of any surface of an enclosure, such as the front, back, top, bottom, or either side and
- b) Is needed to comply with the requirements to reduce the risk of fire, electric shock, or injury to persons, or to reduce the likelihood of mechanical damage to internal parts.

For the purpose of this definition, the surface area of a part is considered to be the surface area encompassed by the perimeter of the part, including the area composed of holes, perforations, and deletions within the boundaries of the part. If an enclosure surface is formed by separate sections, those sections that perform the same enclosure function are to be considered together; and both the evaluation of the part and the computation of the surface area are to be based on the composite surface. See Figure 3.1.

3.32 MEDIUM PRESSURE LAMP – A lamp in which the contained atmosphere energy (CAE) is greater than 0.5 Joule and less than 5 Joules. See 3.11 and 3.21.

3.33 MINOR DIMENSION OF OPENING – The diameter of the largest sphere that can pass through the opening.

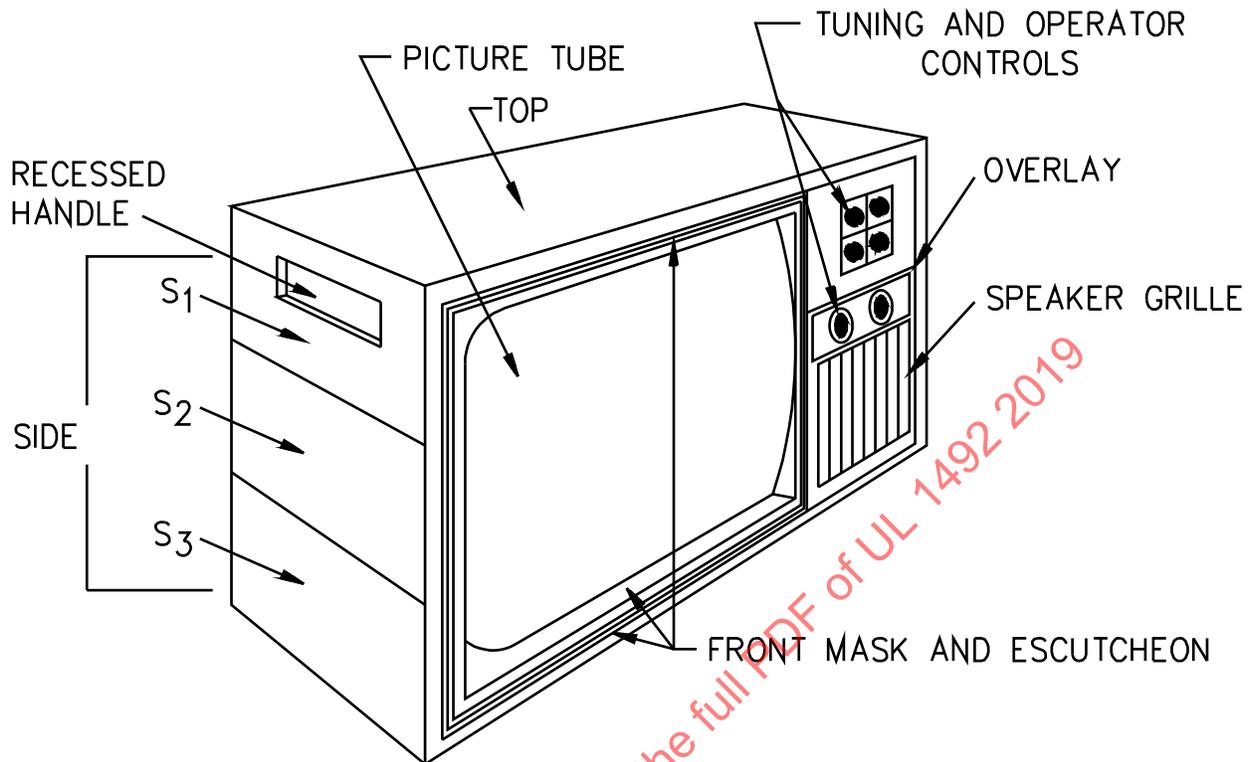
3.34 OPERATING CONTROL – A control, usually a knob, a pushbutton, or a lever, provided to enable the user to cause the product to perform its intended function, without the use of tools, when the product is in normal operating condition.

3.35 ORDINARY TOOLS – Flat-blade and cross-head screwdrivers, nut drivers, and pliers.

3.36 OUTDOOR LOCATION – An unprotected location exposed to weather.

3.37 PICTURE TUBE SIZE, DETERMINATION OF – The maximum dimensions of the bulb of the tube determine the tube diagonal, diameter, or equivalent area.

Figure 3.1
Examples of some major enclosure parts



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MAJOR ENCLOSURE PARTS:

a) TOP – The top surface is a single continuous piece of material comprising 100 percent of the surface and is considered to be a required part of the enclosure. Therefore, it is a major enclosure part.

b) FRONT – The front surface is composed of several parts and materials, including the front mask and escutcheon, the tuning and operator controls, the speaker grille, the picture tube, and an overlay around the tuning and operator controls. The tuning and operator controls, overlay, and speaker grille are not major enclosure parts, even though they are required parts of the enclosure, because they do not form more than 50 percent of the front surface. The surface area is computed for each part individually because they do not perform the same enclosure function. The front mask and escutcheon is a major enclosure part because when computing the surface area encompassed by the perimeter of the part – including the area composed of openings for the picture tube, the tuning and operator controls, and the speaker grille– the resulting area comprises more than 50 percent of the front surface.

c) SIDE – The side surface is composed of several parts and materials, including the recessed handle and three panels (S₁, S₂, and S₃). The recessed handle is not a major enclosure part, even though it is a required part of the enclosure, because it does not form more than 50 percent of the side surface. The panels S₁, S₂, and S₃ are major enclosure parts, even though each panel by itself does not form more than 50 percent of the side surface, because the three parts perform the same enclosure function, and when taken together, they form more than 50 percent of the side surface.

3.38 PORTABLE HIGH-VOLTAGE PRODUCT – A high-voltage product that complies with one or more of the following:

- a) It can be operated from self-contained batteries and is provided with a carrying handle or similar carrying means and has a mass less than or equal to 9 kilograms,
- b) It can be operated from self-contained batteries and has no carrying handles or other similar carrying means and has a mass less than or equal to 1 kilogram when weighed without batteries, and
- c) Any high voltage product that can be operated from self-contained batteries and might be held in one hand during any phase of normal operation regardless of mass.

3.39 PORTABLE PRODUCT – A product, other than a high-voltage product (see 3.38), that complies with one or more of the following:

- a) It is provided with a carrying handle or similar carrying means and has a mass less than or equal to 18 kilograms.

Exception: Rack-mounted product handles are not considered to be carrying handles

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- b) It has no carrying handles or other similar carrying means and has a mass less than or equal to 1 kilogram when weighed without batteries and is likely to be moved frequently.
- c) Any product that might be held in one hand during any phase of normal operation regardless of mass.

Exception: Lightweight products such as preamplifiers, tuners, tape decks, decoders, or noise reduction units that depend upon connection to other products to be functional and by virtue of this are not frequently moved from one location to another are not considered to be portable.

3.40 POWER-SUPPLY CORD – The cord provided to connect the product to the supply circuit.

3.41 PREHEAT LAMP CIRCUIT – A lamp connected in series with a reactance ballast and the combination in parallel with a manual or automatic starter.

3.42 PRINTED-WIRING ASSEMBLY – A printed-wiring board on which separate components have been added.

3.43 PROBE – An instrument used to determine accessibility of a live part. See Figure 18.1.

3.44 RAPID-START LAMP CIRCUIT – A circuit using continuously heated lamp filaments, along with an open-circuit voltage for the ballast to start the lamp without a starter.

3.45 STAND – A structure intended to support a product.

3.46 SUPPLY CIRCUIT – The branch circuit supplying electrical energy to the product.

3.47 TABLE-TOP PRODUCT – A product that is intended to be used and supported on a table, a bench, a shelf, and the like, or mounted in a product rack. If provided with carrying handles or other similar carrying means, its mass is more than 9 kilograms for high voltage products or 18 kilograms for other than high voltage products; if no carrying handles or other similar carrying means are provided, its mass is more than 1 kilogram. Also includes products exempted in 3.38(a), 3.38(b), 3.39(a), and 3.39(b).

3.48 UNDERCABINET PRODUCT – A product intended to be secured to the bottom surface of a cabinet mounted over a countertop.

3.49 UNRELIABLE COMPONENT – Any rectifier, vacuum tube, transistor, electrolytic capacitor, integrated circuit (both true and hybrid), or similar electrical or electronic component.

3.50 USER-SERVICING – The replacing, cleaning, adjusting, and similar maintenance operations intended to be accomplished by the user. See User-Servicing, Section 15.

3.51 WET LOCATION – In direct contact with earth ground, and locations subject to saturation with water.

CONSTRUCTION

ALL PRODUCTS

4 General

4.1 The requirements in this Section apply to all products within the scope of this standard. They are supplemented by requirements in separate Sections that apply to a specific product.

4.2 The construction of the product shall be such that the product complies with each of the following:

- a) The operation and user-servicing of the product does not result in a risk of fire, electric shock, or injury to persons;
- b) The materials and components are used within their electrical, mechanical, and temperature limits; and
- c) The assembly protects the components and wiring from being displaced or damaged.

4.3 The materials, components, and wiring referred to in 4.2 and elsewhere in this standard are to be those involving a risk of fire, electric shock, or injury to persons unless specifically indicated otherwise.

5 Combination Units

5.1 An audio or video product (such as a tuner, tape deck, phonograph, video camera, or the like) used as an integral part of a high voltage product is considered a combination unit and shall comply with all of the requirements for high voltage products.

Exception: An audio or video product used with a high-voltage product as part of a combination unit need only comply with the requirements for that particular product, if the combination complies with both of the following items:

- a) The high-voltage product and the audio or video product are located in separate compartments of the combination unit and*
- b) The barrier or barriers that form the high-voltage product compartment are formed of a material and contain openings that comply with the requirements for a high-voltage product enclosure when judged as if the other compartments did not exist.*

6 Double Insulated Products

6.1 A product that complies with the requirements in the Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097, as well as the applicable requirements in this standard, may be marked in accordance with 127.12.1 and 127.12.2.

7 Undercabinet Products

7.1 In addition to the applicable requirements in this standard, an undercabinet product shall comply with all of the following:

- a) It shall be provided with a power-supply cord in accordance with Table 24.1;
- b) It shall comply with the enclosure impact tests described in Table 98.1;
- c) It shall comply with the Temperature Test, Section 68, when mounted in accordance with 104.2 and 104.3;
- d) It shall comply with the Undercabinet Elevated Ambient Test, Section 105;
- e) It shall comply with the Undercabinet Increased Moisture Test, Section 106; and
- f) It shall comply with the Undercabinet Mounting Security Test, Section 107.

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7.2 An undercabinet product shall be provided with all the necessary hardware for mounting the product using ordinary tools in accordance with the manufacturer's installation and operation instructions specified in Installation, Operation, and Other Instructions, Section 130. These installation and operation instructions are to be used to set-up the undercabinet product for the tests specified in 7.1.

7.3 An undercabinet product shall be provided with means for routing the power-supply cord and with cord storage or a means so that excess cord does not hang down.

8 Outdoor-Use and Wet-Location Products

8.1 A product intended for outdoor use or for use in wet locations shall:

- a) Be provided with a Type SJ or heavier service power-supply cord, or a type determined to be equivalent, rated for outdoor use;
- b) Be grounded as described in Grounding, Grounding Impedance, and Continuity, Section 28, or double-insulated as described in the Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097;
- c) Withstand the Outdoor-Use Wetting Test, Section 103; and
- d) Withstand the ultraviolet light exposure test described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: Products not intended for outdoor use need not withstand the ultraviolet light exposure test described in UL 746C.

8.2 A product is considered to be intended for outdoor use or for use in wet locations if it complies with one or more of the following:

- a) It is provided with a means (handles, wheels, rollers, or similar manipulatory devices) making it transportable;
- b) Its mass is less than 35 kilograms;
- c) It can be operated from a battery; and
- d) The product-manufacturer's literature (instruction manual, use-and-care information, advertising or promotional material, or packaging) indicates or implies outdoor or wet location use of the product when connected to an AC source of supply.

Exception: A product as described in 8.2(a), 8.2(b), or 8.2(c) that is marked as specified in 128.3.1 (Outdoor use or wet location warning marking) is not intended for outdoor use or for use in wet locations.

8.3 A product that is connected to primary circuit power and is intended to be permanently installed and operated in an outdoor location shall comply with 8.1 (a) and (b) and employ an enclosure that complies with the requirements for Type 3 enclosures in the Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations, UL 50.

9 Multiple-Supply-Circuit-Voltage Products

9.1 A product using a supply-circuit voltage selector shall be tested in accordance with the Multiple-Voltage Product Test, Section 80, without resulting in a risk of fire or electric shock. The product shall be provided with instructions and marked in accordance with 127.10.1 – 127.11.2.

9.2 A product that can be set to different rated supply-circuit voltages shall be constructed so that the indication of voltage to which the product is set is externally visible and preferably in the area adjacent to the rating information. See 127.11.1.

9.3 If the product is provided with more than one voltage-setting device or selector, it shall be made clear as to how all devices or selectors are to be set. See 127.11.2.

9.4 The construction of the supply-circuit voltage selector shall be such that the supply-circuit voltage setting cannot be unintentionally changed.

9.5 If the product is constructed so that the supply-circuit voltage selector setting can be changed by the user, the action of changing the voltage selector setting shall also change the supply-circuit voltage indication.

10 In-Wall Mounted Product

10.1 An in-wall mounted product shall be investigated for its suitability for the purpose and shall be provided with installation instructions in accordance with 130.6.1.

Exception: A product that by construction appears to be intended for in-wall mounting but that is not evaluated for the application shall be marked in accordance with 127.14.1 and need not comply with this requirement

10.2 An in-wall mounted product shall be provided with means for permanent connection to the primary circuit power in accordance with Supply Connections – Permanently Connected Products, Section 25.

11 Fire

11.1 A risk of fire is considered to exist if the open-circuit voltage between any two points in a circuit is equal to or greater than 2500 volts peak or if power of more than 15 watts can be delivered into an external resistor connected between the two points. See the Power Supply Tests, Section 77.

12 Electric Shock

12.1 Product leakage current

12.1.1 The leakage current at any accessible part shall not be more than 0.5 milliamperere when tested in accordance with 67.1.1 – 67.2.3 if the open-circuit potential between the accessible part and earth ground or any other accessible part is more than 42.4 volts peak for an indoor product or where wet contact is not likely to occur and 21.2 volts peak for an outdoor product or where wet contact is likely to occur.

12.2 Electric shock during user-servicing

12.2.1 General

12.2.1.1 The risk of electric shock is considered to exist at any part exposed only during user-servicing if:

- a) The open-circuit potential between the part and earth ground or any other simultaneously accessible parts (see 67.1.2) exceeds the value specified in Table 12.1 and

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b) Any one or more of the following conditions exist:

- 1) A continuous current flow through a 500-ohm resistor exceeds the limits specified in Table 12.2,
- 2) A combination of magnitude and duration of peak current flow through a 500-ohm resistor exceeds the limits specified in 12.2.2.1, and
- 3) A combination of capacitance and voltage exceeds the limits specified in 12.2.3.1 or 12.2.3.2.

12.2.2 Transient

12.2.2.1 The duration of a transient current— unidirectional or alternating – through a 500-ohm resistor, connected between any part exposed only during user-servicing and earth ground or any other accessible part, shall satisfy the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I} \right)^{1.43}$$

in which:

T is the duration, measured in seconds, from the time that the instantaneous value of the current first exceeds 7.1 milliamperes until the time that the current falls below 7.1 milliamperes and remains so for at least 1 second (typical calculated values appear in Table 12.3) and

I is the peak current in milliamperes— this current shall not exceed 809 milliamperes regardless of duration.

12.2.3 Stored-energy

12.2.3.1 The capacitance between capacitor terminals that are accessible during user-servicing shall satisfy the following:

$$C \leq \frac{88,400}{E^{1.43} (\ln E - 1.26)} \quad \text{for } E \text{ less than or equal to } 400 \text{ volts}$$

$$C \leq 35,288E^{-1.5364} \quad \text{for } E \text{ greater than } 400 \text{ volts}$$

in which:

C is the capacitance of the capacitor in microfarads and

E is the potential in volts across the capacitor prior to discharge. *E* is to be measured 5 seconds after the capacitor terminals are accessible by the removal or opening of an interlocked cover, or the like. Typical calculated values are shown in Table 12.4.

12.2.3.2 A part involving a potential of more than 40 kilovolts peak is to be investigated to determine whether or not it involves a risk of electric shock.

12.2.3.3 The blades of an attachment plug are considered to be accessible parts that may result in the discharge of a capacitor when short-circuited.

Table 12.1
Maximum voltages

Wave form		Fundamental frequency, hertz		Maximum volts ^a	
				Wet contact likely to occur,	
Alternating voltage, direct voltage, and combinations of both		Greater than	But not greater than	no ^b	yes
Where the change in instantaneous voltage for all durations equal to 5 percent of the period of the fundamental frequency of the wave form is not more than 20 volts for dry locations and 10 volts for wet locations ^c	Where the instantaneous voltage does not reverse in polarity	Any	Any	60 volts peak	30 volts peak
	Where the instantaneous voltage does reverse in polarity	Any	Any	60 volts peak and 84.8 volts peak-to-peak ^d	30 volts peak and 42.4 volts peak-to-peak ^d

Table 12.1 Continued on Next Page

Table 12.1 Continued

Wave form		Fundamental frequency, hertz		Maximum volts ^a	
				Wet contact likely to occur,	
Alternating voltage, direct voltage, and combinations of both	Polarity reversal	Greater than	But not greater than	no ^b	yes
		Where the change in instantaneous voltage for any duration equal to 5 percent of the period of the fundamental frequency of the wave form is greater than 20 volts for dry locations and 10 volts for wet locations ^c	Where the instantaneous voltage does not reverse in polarity	0	3
3	4			55 peak	27.5 peak
4	5			50 peak	25 peak
5	6			45 peak	22.5 peak
6	7			40 peak	20 peak
7	8			35 peak	17.5 peak
8	9			30 peak	15 peak
9	10			25 peak	12.5 peak
10	200			24.8 peak	12.4 peak
200	300			26 peak	13 peak
300	400			28 peak	14 peak
400	500			31 peak	15.5 peak
500	600			34 peak	17 peak
600	700			37 peak	18.5 peak
700	800			41 peak	20.5 peak
800	900	46 peak	23 peak		
900	1000	51 peak	25.5 peak		
1000	1400	56 peak	28 peak		
1400	e	60 peak	30 peak		

^a The maximum output voltage regardless of load shall be measured with the input voltage applied per Table 63.1.

^b Wet contact not likely to occur generally refers to indoor or sheltered locations that are not normally associated with water or other liquids

^c The change in instantaneous voltage at any 5 percent of the period of the fundamental frequency of the wave form shall be determined by taking any 18-degree segment along the wave form and determining the change in instantaneous voltage in that segment. See Figure 12.1.

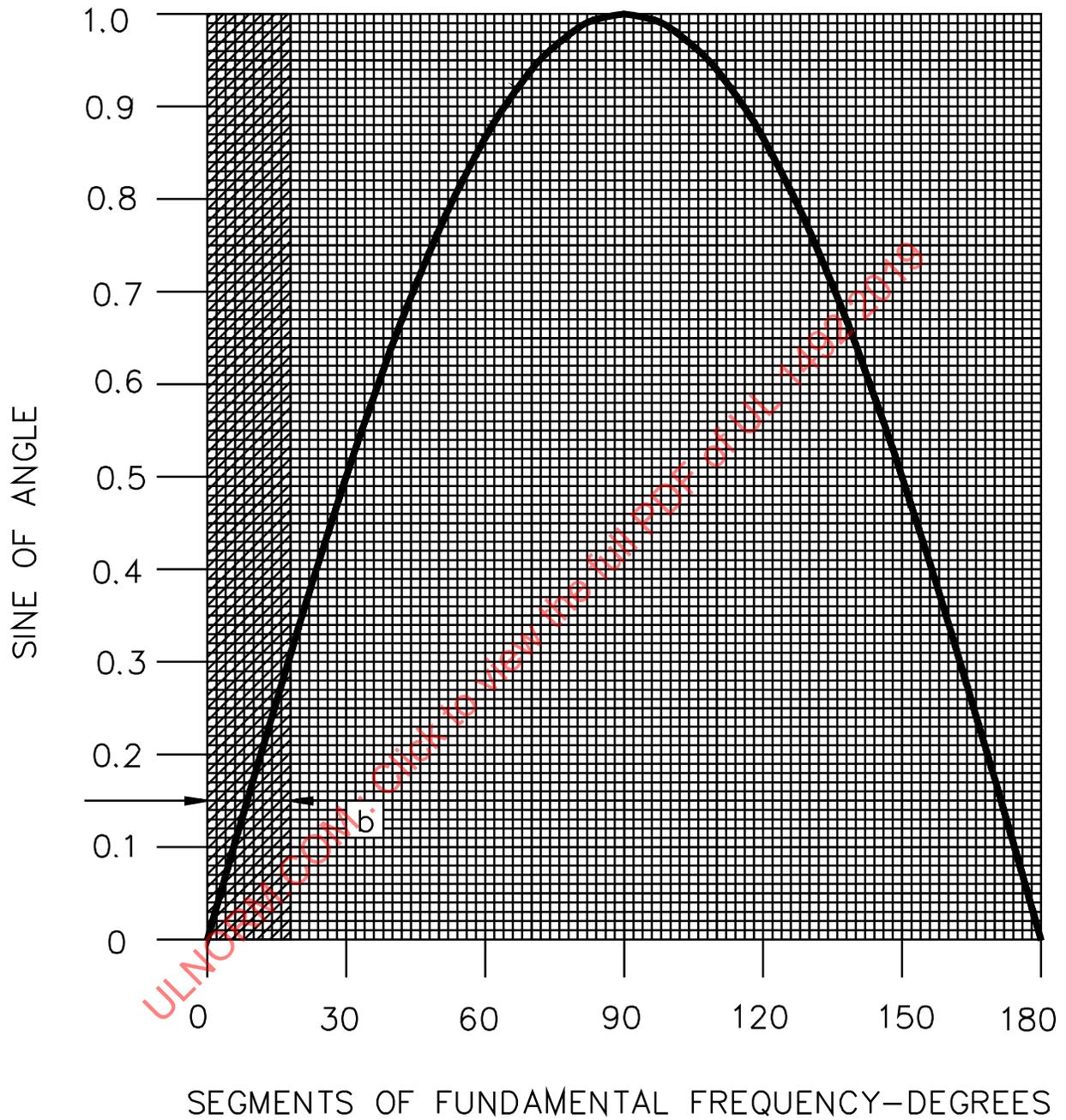
^d For a sinusoidal wave, 84.8 volts peak-to-peak equals 30 volts rms.

^e No upper limit.

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Figure 12.1
Sine wave^a



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^aValues of the sine for angles from 0 – 180 degrees.

^bEighteen-degree (5 percent) segment if started at zero.

Table 12.2
Maximum current during user-servicing

Alternating voltage, direct voltage, and combinations of both	Fundamental frequency, hertz ^a		Maximum current in milliamperes through a 500-ohm resistor	
	Greater than	But not greater than	Where the instantaneous voltage does not reverse in polarity, peak	Where the instantaneous current does not reverse in polarity, peak-to-peak
Where the change in instantaneous voltage for all durations equal to 5 percent of the period of the fundamental frequency of the wave form is not more than 3.3 milliamperes	0	100	14.2	14.2
	100	500	18.8	18.8
	500	1000	22.0	22.0
	1000	2000	28.2	28.2
	2000	3000	34.6	34.6
	3000	4000	39.2	39.2
	4000	5000	44.0	44.0
	5000	6000	50.2	50.2
	6000	b	55.0	55.0
Where the change in instantaneous voltage for all durations equal to 5 percent of the period of the fundamental frequency of the wave form is more than 3.3 milliamperes	0	3	10.0	No values determined
	3	4	9.2	
	4	5	8.3	
	5	6	7.5	
	6	7	6.7	
	7	8	5.8	
	8	9	5.0	
	9	10	4.2	
	10	200	4.1	
	200	300	4.3	
	300	400	4.7	
	400	500	5.2	
	500	600	5.7	
	600	700	6.2	
	700	800	6.8	
800	900	7.7		
900	1000	8.5		
1000	1400	9.3		
1400	b	10.0		

^a Straight line interpolation between adjacent values in the table shall be used to determine the maximum current values corresponding to frequencies not shown in the table.

^b No upper limit.

Table 12.3
Electric shock transient

Maximum current in milliamperes peak through 500-ohm resistor	Maximum time in seconds of envelope containing excursions greater than 7.1 milliamperes peak
Less than 7.1	Not applicable
7.1	7.22
8.5	5.58
10.0	4.42
12.5	3.21
15.0	2.48
17.5	1.99
20.0	1.64
22.5	1.39
25.0	1.19
40.0	0.609
50.0	0.443
60.0	0.341
70.0	0.274
80.0	0.226
90.0	0.191
100.0	0.164
150.00	0.092
200.0	0.061
250.0	0.044
300.0	0.034
350.0	0.027
400.0	0.023
450.0	0.019
500.0	0.016
600.0	0.012
700.0	0.010
809.0	0.0083
Greater than 809.0	Not acceptable – see 12.2.2.1

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Table 12.4
Electric shock – stored energy

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
40,000	0.0030
35,000	0.0037
30,000	0.0047
25,000	0.0062
20,000	0.0087
15,000	0.0135
10,000	0.0252
7,000	0.0437
5,000	0.0732
4,000	0.103
3,000	0.160
2,500	0.212
2,000	0.299
1,500	0.465
1,250	0.616
1,000	.0868
900	1.02
800	1.22
700	1.50
600	1.90
500	2.52
400	3.55
380	3.86
360	4.22
340	4.64
320	5.13
300	5.71
280	6.40

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Table 12.4 Continued

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
260	7.24
240	8.27
220	9.56
200	11.2
180	13.4
160	16.3
140	20.5
120	26.6
100	36.5
90	43.8
80	53.8
70	68.0
60	89.4
50	124
45	150
42.4	169 ^a
40	186 ^a
35	239 ^a
30	319 ^a
25	452 ^a
21.2	625 ^a
Less than 21.2	Any ^a

^a Any value is acceptable for indoor use. These values are only for outdoor-use or where wet contact is likely to occur.

13 Injury to Persons

13.1 General

13.1.1 A risk of injury to persons is considered to exist if one or more of the following conditions are present:

- a) Power-operated moving parts, such as gears and linkages, are accessible during normal operation. See 13.2.1;

- b) Sharp edges, burrs, or projections are present that can cause injury to persons during user assembly, operation of the product, or user-servicing. See the Sharp Edge Test, Section 97; and
- c) The product, or the product on a cart or stand used with it, is unstable. See the Injury to Persons Tests, Section 96.

13.2 Power-operated moving parts

13.2.1 In applying the requirement in 13.1.1, accessibility of power-operated moving parts such as gears and linkages is to be judged using the articulated probe illustrated in Figure 18.1. The accessibility requirements are to be applied after the installation or assembly of parts provided by the manufacturer has been completed in accordance with the instructions provided by the manufacturer. The requirement does not apply to:

- a) A pick-up arm assembly, turntable, or similar part on the top surface of a record changer or player;
- b) A tape reel or tape drive mechanism that must be exposed for normal use. However, gears and linkages are to be judged for accessibility if the construction permits those parts to move with a tape reel, cartridge, or cassette removed from its operating position; or
- c) Gears and linkages that are accessible only after lifting a side or corner of a spring-mounted motor (changer chassis) board. Accessibility to power-operated moving parts is to be judged with a record changer or a similar device in its normal playing position. Spring-mounted, suspended, or similarly mounted motor boards are to be held captive so they cannot be easily removed or lifted out from the mounting surface.

13.3 Carts

13.3.1 With regard to 13.1.1(c), a cart that has a shelf that is more than 1 m above the floor and that is intended for use in schools, institutions, health-care facilities, or like locations where children are likely to move the cart, shall comply with the Standard for Tall Institutional Carts for Use with Audio-, Video-, and Television-Type Equipment, UL 1667.

14 Product and Accessory Assembly

14.1 User-mechanical assembly (addition of legs, casters, decorative parts, and the like) of a product or accessory shall be such that all of the following requirements are met:

- a) Assembly shall require one or more of the following:
 - 1) No tools,
 - 2) Only ordinary tools. See 3.35, and
 - 3) Tools supplied with the assembly by the manufacturer
- b) All parts required shall be provided.
- c) Assembly instructions shall be provided. See Installation, Operation, and Other Instructions, Section 130.

d) Assembly instructions shall not cause the user to commit an act that in itself might result in a risk of fire, electric shock, or injury to persons.

14.2 Products or accessories intended to be installed by qualified service personnel need not comply with 14.1 (a) and (d). Such products or accessories shall be provided with the marking described in 130.1.3 and the installation instructions required in 130.1.1.

15 User-Servicing

15.1 User-servicing includes:

a) Replacement of a battery.

Exception No. 1: A battery that is intended to be and is soldered in place is not considered to be user-serviceable.

Exception No. 2: A battery intended to energize a memory circuit, or other similar use, when the product is not connected to a nominal 120- or 240-V supply circuit and that is not intended to be serviced by the user, identified on the outside of the product, or mentioned in the instruction manual or other user literature as being a part to be serviced by the user is not considered to be user-serviceable.

b) Replacement of a fuse or vacuum tube.

Exception No. 1: A fuse or vacuum tube that is intended to be and is soldered in place is not considered to be user-serviceable.

Exception No. 2: A fuse or vacuum tube that is not readily perceptible by the user is not considered to be user-serviceable. A fuse or vacuum tube is not readily perceptible if it is located within a chassis, compartment, or enclosure within the overall product. If the enclosure has a cover, it shall be one that does not need to be opened or removed in the operation or user-servicing of the product, can be opened or removed only with a tool, and cannot be discarded. A fuse or vacuum tube is readily perceptible if the fuse or vacuum tube can be ascertained visually or by touch during the operation or user-servicing of the product, or if the fuse or vacuum tube is cited either by information that appears on the outside surface of the product or by literature accompanying the product.

Exception No. 3: A plug-in vacuum tube or clipped-in-type fuse that is within a compartment provided with the marking described in 129.1.1 (No user-serviceable parts compartment warning) whether or not the fuse or vacuum tube is readily perceptible by the user is not considered to be user-serviceable.

c) Replacement of an incandescent lamp, whether it is a single lamp or one of a series or parallel string, intended for connection directly across the supply circuit that is a nominal 120 or 240 V, or replacement of a fluorescent lamp (for example, a low-pressure, mercury, electric-discharge lamp with a fluorescent coating), or a low-pressure or medium-pressure, electric-discharge lamp.

Exception No. 1: A lamp that is intended to be and is soldered in place is not considered to be user-serviceable.

Exception No. 2: A neon lamp (for example, an electric-discharge lamp with neon as the filling gas) is not considered to be user-serviceable.

Exception No. 3: A low-voltage (less than 30 V rms) vacuum-fluorescent (VF) display device is not considered to be user-serviceable.

Exception No. 4: A lamp that is located within a compartment bearing a marking described in Graphical Symbols and Supplemental Marking, Section 129, and the literature provided with the product does not instruct the user to service the lamp is not considered to be user-serviceable.

d) User adjustments that can be accomplished with the product in operation and without defeating the interlock or opening covers not intended to be opened by the user, such as:

- 1) Adjustment of a marked control or component with or without ordinary tools or
- 2) Adjustment of an unmarked control or component without a tool.

e) Any operation described or depicted in the operating instructions, or in any other literature accompanying the product.

f) Cleaning and demagnetizing of tape heads, as specified in the operating instructions.

g) Cleaning of lenses, cabinet, and the like.

h) Cleaning of a picture-tube face or window, if access to the parts to be cleaned can be gained using ordinary tools and without removing the chassis or the picture tube from the cabinet. During the cleaning operation, live parts are considered protected if the front cover of a picture-tube enclosure can be opened for cleaning or other user-servicing only after first opening an interlocked cover and, if the warning described in 135.1.1 (Removable front cover warning) is located on the cabinet where readily visible when the front cover is opened.

i) Setting a supply-circuit voltage mechanism.

j) Removing a cover.

k) Opening a door.

16 Spacings

16.1 General

16.1.1 A minimum spacing of 3.0 mm over surface and through air shall be maintained between uninsulated parts conductively connected to the supply circuit (for example, the primary circuit) and each of the following:

- a) Uninsulated parts of opposite polarity,
- b) Accessible conductive parts (includes pressed wood and similar material), and
- c) An uninsulated part, in other than the supply circuit, where breakdown could result in a risk of electric shock.

Exception No. 1: This requirement does not apply if the location and relative arrangement of parts are such that permanent separation is provided such as on connectors, printed-wiring boards, and the like.

Exception No. 2: This requirement does not apply to the internal spacings of components but does apply to their external parts.

Exception No. 3: This requirement does not apply where a different spacing is required to comply with Double Protection, Section 44, or Double Protection for High-Voltage Products, Section 52.

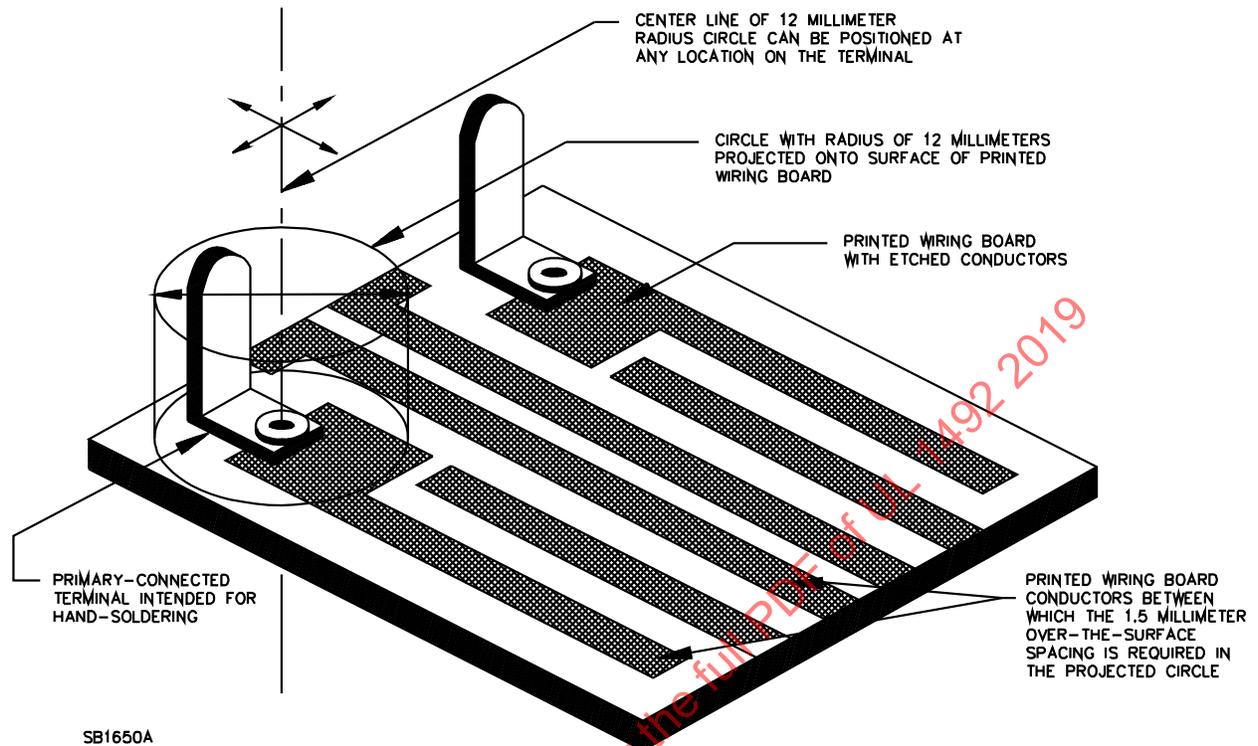
16.1.2 If a printed-wiring board has primary-connected hand-soldered terminals, a 1.5-mm over-surface spacing shall be maintained between the printed-wiring conductors connected to the terminal and all other printed-wiring conductors located in the adjacent area (see 16.1.3).

16.1.3 For the purpose of 16.1.2, the adjacent area is that described by a 12-mm radius circle about the hand-soldered terminal. See Figure 16.1.

16.1.4 When measuring spacings through air or over surface between parts where hand soldering is involved, the spacing may need to be measured assuming production accumulations of solder on parts and lead connections as illustrated in Figure 16.2.

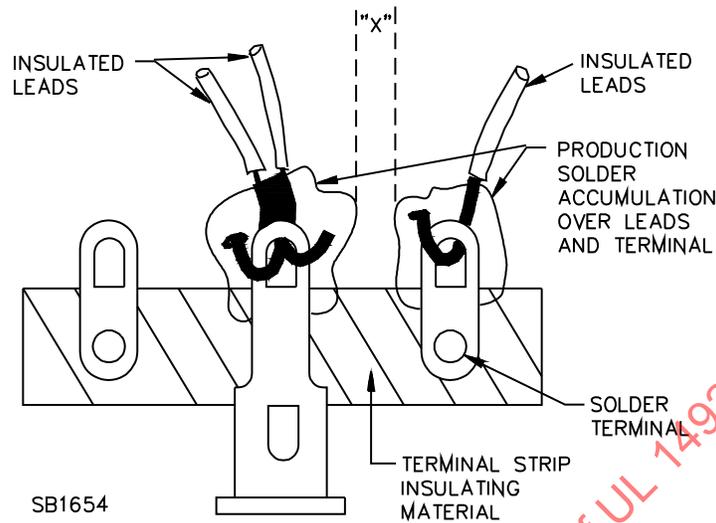
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Figure 16.1
Measurement of over-surface spacings on printed-wiring boards with primary-connected, hand-soldered terminals



NOTE – Example only to illustrate 16.1.2 and 16.1.3.

Figure 16.2
Measurement of spacings between parts where hand-soldering is involved



NOTE – Example only to illustrate 16.1.4.

X = 3.0 mm spacing to be maintained between hand-soldered parts assuming production solder accumulations.

16.1.5 When determining the permanent separation between parts – for example, between a resistor and adjacent components – consideration shall be given to the location of the part, abuse during assembly and servicing, length and diameter of the integral leads, and consistency of positioning the part during factory assembly. If a question exists as to the part positioning, a force of 2 N is to be applied to the part in any direction permitted by the construction. The force is to be applied until there is no further movement during application of the force. The minimum spacing is to be measured after the force has been removed and the part has repositioned itself.

16.2 Insulating barrier in lieu of spacings

16.2.1 A barrier or liner of polymeric, fiber, or similar material (other than the enclosure), used where spacings would otherwise be unacceptable between uninsulated parts of opposite polarity or between such parts and accessible conductive parts, according to 16.1.1 and 16.1.2, shall comply with each of the following:

- a) It shall be of a material complying with the requirements for insulating materials;
- b) It shall be of a material that complies with the requirements in Table 20.1;
- c) It shall comply with the applicable tests specified in the Strength of Enclosure Tests, Section 98, if it is likely to be handled during use or user-servicing of the products;
- d) It shall be held in place by a means other than friction between surfaces;
- e) It shall be located so that it is not likely to be damaged by operation of the product; and

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- f) It shall have a minimum thickness of 0.70 mm; 0.35 mm when used in conjunction with an air space.

Exception: Insulation that is built into a component need not comply with 16.2.1.

16.3 Fuse and fuse clip

16.3.1 A minimum spacing of 3.0 mm over surface and through air shall be maintained between the uninsulated parts of a fuse and fuse clip that involve electric shock and each of the following:

- a) Uninsulated parts of opposite polarity and
- b) Accessible conductive parts.

The spacing shall be measured with the fuse in place.

Exception: The minimum spacing need not be maintained when a barrier that complies with 16.2.1 is provided.

16.4 Picture tube conductive coating

16.4.1 If a risk of electric shock results from an electrical connection between the external conductive coating of the picture tube and the picture-tube mounting means – straps, brackets, and the like – that contact the tube, there shall be a spacing of 12 mm minimum between the conductive coating and the mounting means. The spacing shall be measured over the surface of the tube.

16.5 Field-wiring terminals

16.5.1 The spacing between field-wiring terminals of opposite polarity, and the spacing between a field-wiring terminal and any other uninsulated metal part not of the same polarity, shall not be less than that specified in Table 16.1.

Table 16.1
Spacings at field-wiring terminals

Potential involved, volts	Minimum spacings		
	Between field-wiring terminals, through air or over surface, millimeters	Between field-wiring terminals and other uninsulated metal parts not always of the same polarity ^a	
		Over surface, millimeters	Through air, millimeters
250 or less	6.0	6.0	6.0
More than 250	12.0	12.0	9.0

^a Applies to the sum of the spacings involved where an isolated dead-metal part is interposed.

17 Enclosures

17.1 General

17.1.1 A product shall be provided with an enclosure. The enclosure shall render parts involving a risk of electric shock or injury to persons inaccessible and shall protect the internal parts of the product from mechanical damage when such damage to parts might result in a risk of fire or electric shock. See Sections 97 – 99, 102, and 103.

17.1.2 A product enclosure that is comprised of two or more parts secured together solely by an adhesive shall be subjected to the Adhesive Securement Test, Section 100.

Exception: The test described in 100.2 does not apply to separately enclosed loudspeakers intended for connection to an audio amplifying source limited in accordance with 70.1.

17.1.3 A viewing screen that is integrally mounted to a projection-type television and that is not considered to be part of the required enclosure is to be removed when determining compliance with 17.1.

17.1.4 The enclosure of an in-wall mounted product shall not be provided with unused openings.

17.1.5 A metal enclosure for an in-wall mounted product shall have a minimum thickness of 1.35 mm uncoated.

17.2 Glass dial window

17.2.1 A glass dial window that covers live parts shall be of tempered glass not less than 4.8 mm thick, or shall withstand the impact test described in 98.11.1 – 98.11.4.

17.3 Polymeric enclosure

17.3.1 An enclosure of polymeric material shall comply with the requirements in Table 20.1.

Exception No. 1: A polymeric enclosure of a separately enclosed loudspeaker intended for connection to an audio amplifying source limited in accordance with 70.1 need only be rated HB, determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 2: For other than high voltage and in-wall mounted products, refer to the special construction option requirements in 17.4.1.

Exception No. 3: A polymeric enclosure of an in-wall mounted product shall have a minimum flammability rating of 5V.

17.3.2 A part, such as a control knob, a cover, a dial, a window, a switch casing, a handle, and the like, that is mounted in or over a cabinet opening and serves as a barrier to live parts, shall be considered as a part of the enclosure.

Exception: A control shaft is considered to be a barrier.

17.4 Special construction option for other than high-voltage products

17.4.1 If all those components that involve hazardous-energy circuitry as defined in 3.19, or involve the risk of injury to persons, or both, are individually or collectively enclosed in a material such as metal or one having a flammability classification of V-0 and the individual or collective enclosures comply with the appropriate mechanical strength tests in the Strength of Enclosure Tests, Section 98, the other components that in themselves do not involve hazardous-energy circuitry or the risk of injury to persons, and the overall enclosure of such components (which is not considered a required enclosure) need only have flammability characteristics of HB.

17.4.2 The individual or collective enclosures mentioned in 17.4.1 shall not be provided with holes or louvers that allow the circulation of air. Butt joints (where two surfaces are fastened together end-to-end) shall not be used unless joined by welding or equivalent means. See (a), (b), and (c) in Figure 17.1 for examples of unacceptable butt joints.

Exception No. 1: Holes for the entrance of wires only may be provided if the unused portion of any hole is no larger than 130 mm² in area. Any hole provided for lead wires, but not so used, shall be closed by metal or a material having a flammability classification of V-0.

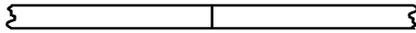
Exception No. 2: Butt joints provided with an overlap in contact with each other of at least 1.5 mm are acceptable. See (d), (f), and (g) in Figure 17.1 for examples of acceptable butt joints with overlap. See (e) in Figure 17.1 for an example of an unacceptable overlap construction.

Exception No. 3: Enclosure constructions other than the construction described in Exception No. 2 to 17.4.2 that meet the intent of the requirements by preventing the spread of fire to other areas of the product are acceptable.

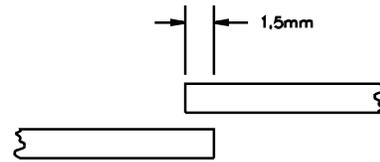
17.4.3 Hook-up wiring in hazardous-energy circuitry shall have mechanical protection in the form of an enclosure as described in 17.4.1; however, interconnecting wiring of Type SPT-2 or NISPT-2 or heavier flexible cord, or an appliance wiring material construction that has been determined to be equivalent to Type SPT-2 or NISPT-2 cord need not have additional mechanical protection if strain and push-back relief are provided.

17.4.4 For test requirements see Figure 17.2; the Special Option Tests, Section 73; and the Power Supply Tests, Section 77.

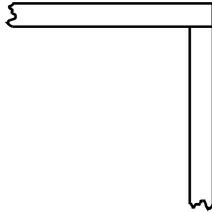
Figure 17.1
Some examples of butt joints



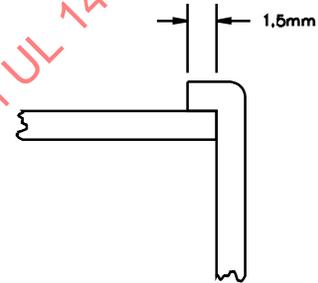
a) Unacceptable - Ends contact each other without additional joining means.



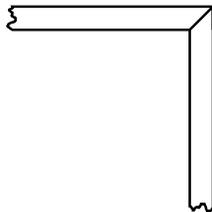
e) Unacceptable - Surfaces overlap each other by at least 1.5 mm but are not in contact with each other.



b) Unacceptable - End and surface contact each other without additional joining means. Vertical piece might contact horizontal piece any place along its surface.

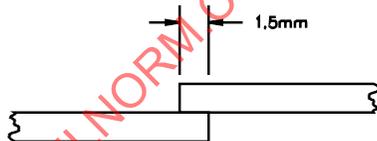


f) Acceptable - See drawing (d).

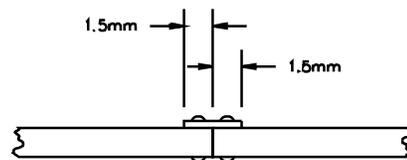


c) Unacceptable - Ends contact each other without additional joining means.

Note: (a), (b), and (c) would be acceptable if the ends and/or surfaces were joined by welding or other equivalent means.

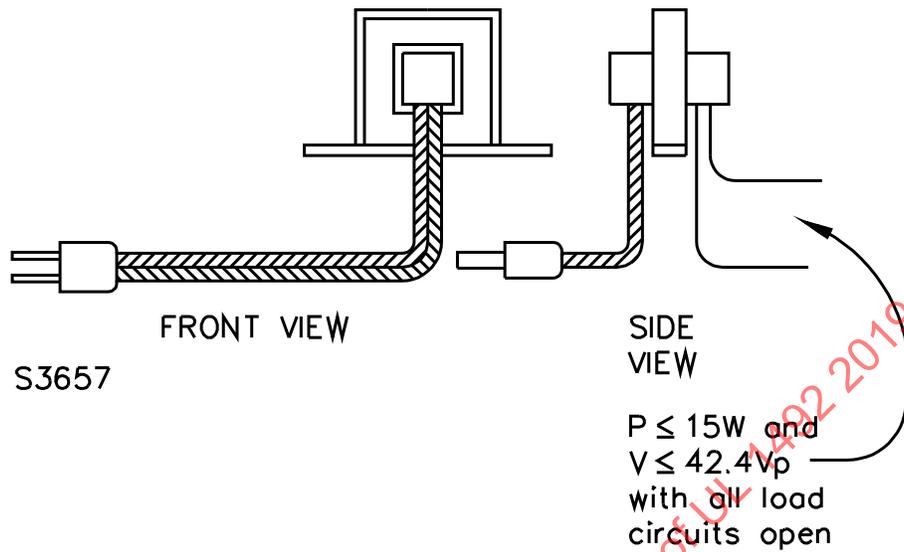


d) Acceptable - Surfaces overlap each other by at least 1.5 mm and are in contact.



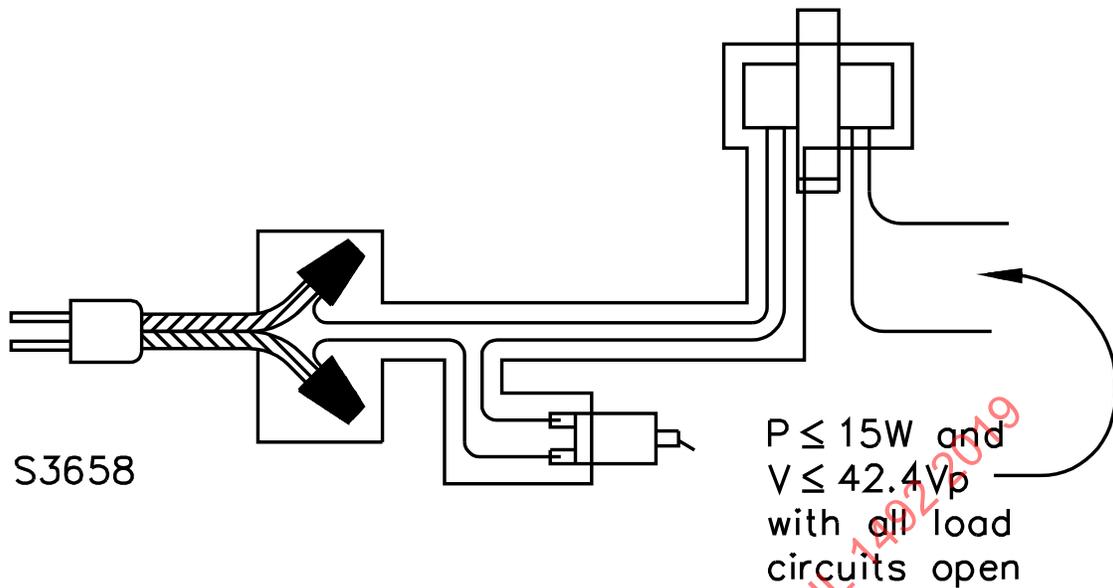
g) Acceptable - Ends additionally secured together by piece which overlaps joint at least 1.5 mm.

Figure 17.2
Enclosing of components (special construction option, 17.4.1)



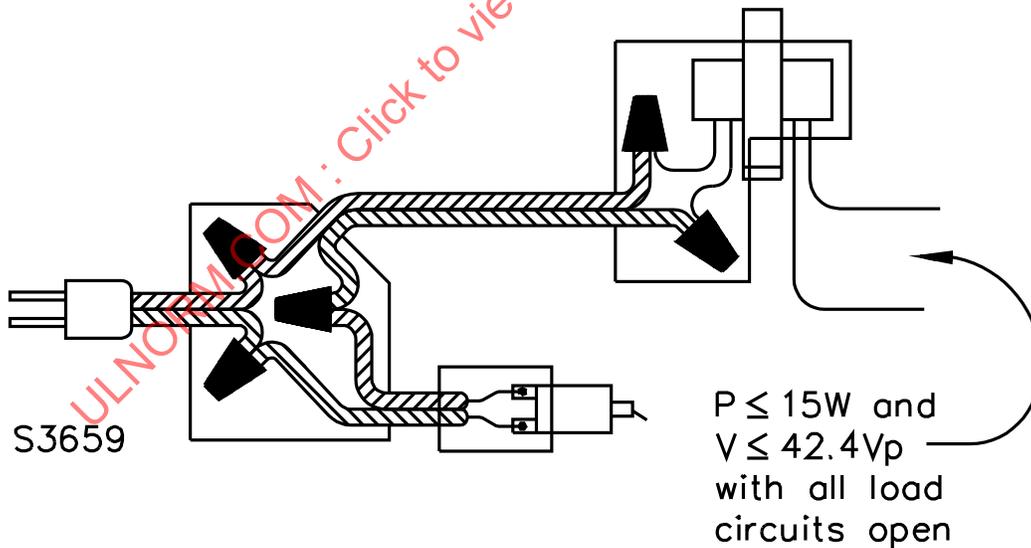
a) Power-supply cord terminates inside power transformer end bell; end bells over both sides of coil; secondary delivers less than or equal to 15 watts of power with load and less than or equal to 42.4 volts peak open circuit.

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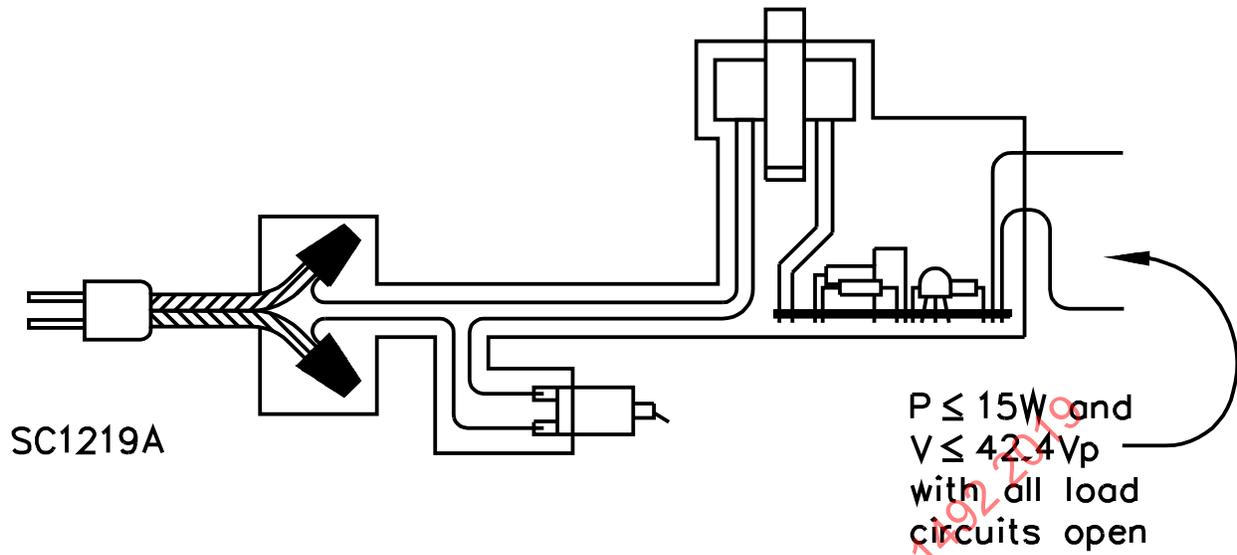


b) Power transformer without end bells; primary switch, connectors and primary connected appliance wiring material enclosed in metal or V-0 material; secondary delivers less than or equal to 15 watts of power with load circuit open and less than or equal to 42.4 volts peak open circuit.

Figure 17-2 (Cont'd)



c) Power transformer without end bells; primary switch, connectors and primary wiring of power transformer enclosed in metal or V-0 material; interconnecting wiring is SPT-1 cord; secondary delivers less than or equal to 15 watts of power with load circuit open and less than or equal to 42.4 volts peak open circuit.



d) Power transformer without end bells; primary switch, connectors, primary and secondary wiring of power transformer and printed-wiring board with hazardous components enclosed in metal or V-0 material; output delivers less than or equal to 15 watts of power with load circuit open and less than or equal to 42.4 volts peak open circuit.

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18 Accessibility of Parts

18.1 Articulated probe

18.1.1 An accessible part of a product shall not involve a risk of electric shock.

18.1.2 The accessibility of a live part shall be determined by Table 18.1.

Table 18.1
Recessing of live parts

Maximum width of slots ^a – millimeters	Diameter of round holes – millimeters	Minimum distance between opening and live part ^{b,c} – millimeters
Less than 25	Less than 25	Probe ^{d,e} + X – 3.0
25 but not more than 50	More than 25 but not more than 50	5D + X
More than 50 but not more than 75	More than 50 but not more than 75	6D + X
More than 75	More than 75	7D + X
		Not acceptable

^a A high-voltage product enclosure shall have no opening that will accept the entrance of a 25-mm diameter sphere.

^b D is the diameter of the largest sphere that passes through the opening.

^c X is 3.0 mm for each 1000 V peak or fraction thereof at the live part. The voltage is to be measured with the product connected to a supply circuit as described in 63.5.1 and 63.5.2 and adjusted as described in 69.1.1.

^d See Figure 18.1 for a description of the probe. No force is to be applied to the probe to determine accessibility.

^e The tapered portion of the probe shall not contact a live part operating at a potential of 1000 V peak or less.

18.1.3 Friction-fit knobs, snap covers, and similar loose parts can be removed or opened when evaluating accessibility.

18.1.4 When using the probe shown in Figure 18.1, the probe is to be used only as a gauge and inserted with minimal force. The probe may be articulated to any position before, during, or after its full insertion into an opening by rotating the probe with the moveable sections straight or in any possible position resulting from bending one or more sections in the same direction.

18.2 Protective screens and barriers

18.2.1 Protective screens or barriers, openings larger than those covered in Table 18.1, irregular openings, and openings in flexible materials are to be given consideration with regard to the intent of the requirements.

18.3 Chassis-mounting bolts

18.3.1 Live parts are to be inaccessible after chassis-mounting bolts are loosened during installation as intended to reduce vibration. Chassis-mounting bolts not specifically intended to prevent further loosening, except by the use of a tool, are to be loosened the maximum amount likely to occur in service in determining the inaccessibility of live parts.

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Figure 18.1
Articulated probe with web stop

