

Standard for Safety

UL 1594

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Sewing and Cutting Machines



Underwriters Laboratories Inc. ®

Standard



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January 20, 1995

Standard for

Sewing and Cutting Machines

UL 1594, Second Edition

Accompanying this transmittal notice is a copy of the Second edition of UL 1594.

A CHANGE IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT EXCEPT FOR PARAGRAPHS 11.1.3, 11.1.7, 12.1.1.12, 12.1.1.13, 15.4.1, 15.4.2, 20.3, 21.3, 21.4, 22.6, 24.10, 27.1, 30.3, 30.4, 40.1.2, 40.2.3.1, 58.1.8, 58.1.12, 58.1.13, 59.8, 63.4, SECTION 56, TABLES 12.2, 40.2, AND FIGURE 12.1, WHICH BECOME EFFECTIVE MARCH 13, 1996 AS INDICATED IN THE SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEMS.

THE CURRENT REQUIREMENTS IN EFFECT FOR THE REQUIREMENTS HAVING FUTURE EFFECTIVE DATES ARE LOCATED IN THE BACK OF THE STANDARD.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this standard unless the applicant specifically requests that the product be judged under the current requirements. However, should the applicant elect this option, it should be noted that compliance with all the requirements in this standard will be required as a condition of continued Listing and Follow-Up Services after the effective date and understanding of this should be signified in writing.

Some of the requirements in this standard are substantially in accordance with UL's bulletin on this subject dated August 12, 1994. This bulletin is now obsolete and may be discarded. These new and revised requirements are now issued for and renumbered in accordance with the Second edition.

Revised and/or additional pages may be issued from time to time.

JANUARY 20, 1995

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UL 1594

Standard for

Sewing and Cutting Machines

First Edition – May, 1984

Second Edition

January 20, 1995

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

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

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FOREWORD

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

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

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

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

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

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

INTRODUCTION

1 Scope

1.1 These requirements cover both household and industrial sewing and cutting machines to be employed in accordance with the National Electrical Code.

1.2 These requirements also cover small utilization products, such as vibrator-powered scissors where motion of an operating part is produced by electrical means.

1.3 These requirements do not cover equipment rated more than 600 V; nor do they cover products involving universal motors rated more than 250 V.

1.4 These requirements also cover textile equipment for use in ordinary locations but do not cover equipment intended for use in hazardous locations such as certain textile processing equipment, and yarn handling equipment.

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

2 Glossary

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

2.2 **AUTOMATICALLY CONTROLLED PRODUCT** – A product is considered to be automatically controlled if it complies with one or more of the following conditions:

- a) The repeated starting of the product is independent of any manual control after one complete cycle of operation, after which some form of limit device opens the circuit.
- b) During any single preset cycle of operation, the motor is caused to stop and restart.
- c) When the product is energized, the initial starting of the motor may be intentionally delayed beyond intended, conventional starting.
- d) For a product employing a motor with a separate starting winding, during any single predetermined cycle of operation, automatic changing of the mechanical load reduces the motor speed sufficiently to reestablish starting-winding connections to the supply circuit.

2.3 **DEAD METAL PART** – A metal or other electrically conductive part, accessible or inaccessible, that is not conductively connected to a live part.

2.4 **DIRECTLY ACCESSIBLE MOTOR** – A motor that can be contacted without opening or removing any part of an enclosure or guard.

2.5 HAND-HELD PRODUCT, HAND-GUIDED PRODUCT – A portable product that during intended use is contacted by the hand of the user for purposes of electrical or physical control but not for complete support.

2.6 HAND-SUPPORTED PRODUCT – A product such as an electric scissor, that is physically supported by any part of the user during the performance of its intended functions.

2.7 INDIRECTLY ACCESSIBLE MOTOR – A motor that is 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 a motor that is located or otherwise guarded or enclosed so that it is unlikely to be contacted.

2.8 ISOLATING TRANSFORMER – A transformer having one or more output windings electrically insulated from all other windings.

2.9 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 V and having circuit characteristics in excess of those of a low-voltage circuit.

2.10 LIVE PART – A part energized with respect to earth or energized with respect to some other part.

2.11 LOW-VOLTAGE CIRCUIT – A circuit involving a peak open-circuit potential of not more than 42.4 V supplied by a primary battery; a Class 2 transformer; or a combination of an isolation transformer and a fixed impedance that (as a unit) complies with all performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

2.12 PORTABLE – Capable of being carried or conveyed.

2.13 REMOTELY CONTROLLED PRODUCT – A product that is out of view of the operator at the starting device.

2.14 SEWING MACHINE TRANSMITTER – A motor, provided with either a mechanically or electrically operated clutch assembly, used to provide rotary drive for an industrial sewing machine.

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

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

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

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

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

4 Units of Measurement

4.1 If a value for measurement is followed by a value in other units, in parentheses, the second value may be only approximate. The first stated value is the requirement.

5 References

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

CONSTRUCTION

6 General

6.1 A product shall employ materials that are acceptable for the particular use, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

7 Frame and Enclosure

7.1 General

7.1.1 A product shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses that it is likely to be subjected to under normal and foreseeable abnormal conditions.

7.1.2 The enclosure of a remotely or automatically controlled product shall be so constructed as to prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the product is supported.

7.1.3 A door or a cover of an enclosure that provides access to any overload-protective device that requires resetting or renewal shall be hinged or otherwise attached in an equivalent manner.

7.1.4 Means shall be provided for holding the door or cover over a fuseholder in a closed position.

7.2 Cast and sheet metal

7.2.1 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 inch (3.2 mm) thick, except that malleable iron may not be less than 3/32 inch (2.4 mm) and die-cast metal may be not less than 5/64 inch (2.0 mm) thick. Corresponding thicknesses of not less than 3/32, 1/16 (1.6 mm), and 3/64 inch (1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that adequate mechanical strength is provided.

7.2.2 An enclosure of sheet metal is to be judged with respect to its size, shape, thickness of metal, and its application, considering the intended use of the complete product. The use of sheet steel having a thickness of less than 0.026 inch (0.66 mm) if uncoated or 0.029 inch (0.74 mm) if galvanized or of nonferrous sheet metal having a thickness of less than 0.036 inch (0.91 mm) is not recommended, except for relatively small areas or for surfaces that are covered or otherwise reinforced.

7.2.3 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) for uncoated steel, not less than 0.034 inch (0.86 mm) for galvanized steel, and not less than 0.045 inch (1.14 mm) for nonferrous metal.

7.3 Polymeric enclosures

7.3.1 Enclosures of polymeric material shall comply with the requirements for enclosures contained in the requirements for polymeric materials for use in electrical equipment evaluations, UL 746C.

Exception No. 1: The Ball Impact Test for portable table top or counter supported products shall be conducted using a 3 ft lbf (4.07 J) impact.

Exception No. 2: A polymeric material having a volume resistivity lower than that required by the Section for Volume Resistivity of UL 746C may only be used if, with the enclosure considered to be a dead metal part, the product complies with the requirements for spacings in Spacings, Section 24 of this standard.

Exception No. 3: For the impact tests specified in Section 24 of UL 746C:

a) Each surface that is likely to be exposed to abuse during normal use is to be tested, but no more than 3 impacts are to be applied to any one sample;

b) In lieu of the requirements for dielectric voltage-withstand, the requirements for accessibility in Accessibility of Uninsulated Live Parts and Magnet Wire, Section 11 of this standard shall be applied after the impact test.

Exception No. 4: For the mold stress-relief distortion requirements specified in Section 30 of UL 746, item D of 30.1 in the section for Consideration of Thermal Endurance of UL 746C is not applicable.

Exception No. 5: For the abnormal operation requirements specified in Section 28 of UL 746C:

a) Cheesecloth need not be applied.

b) There shall be no ignition of the enclosure material, exposure of live part, nor glowing or flaming of the material upon which the product is placed as a result of emission of flame through other than existing openings.

8 Adhesives Used to Secure Parts

8.1 An adhesive that is relied upon to reduce a risk of electric shock, fire, or injury to persons shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

8.2 The requirement in 8.1 also applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

- a) Energize an accessible dead metal part,
- b) Make a live part accessible,
- c) Reduce spacings below the minimum acceptable values, or
- d) Short circuit live parts.

9 Mechanical Assembly

9.1 A product shall be assembled so that it will not be adversely affected by the vibration of normal operation. Brush caps shall be tightly threaded or otherwise constructed to be kept from loosening.

9.2 A switch other than a through-cord switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and shall be kept from turning. See 9.4.

Exception No. 1: A switch need not be kept from turning if all four of the following conditions are met:

- a) The switch is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch.*
- b) The means for mounting the switch makes it unlikely that operation of the switch will cause it to loosen.*
- 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.*

Exception No. 2: A nonserviceable lamp such as a neon light in which the lamp is sealed in a nonremovable jewel, need not be kept from turning if rotation does not reduce spacings below the minimum required values.

9.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be kept from turning or shifting in position, if such motion results in a reduction of spacings below the minimum acceptable values.

9.4 The means used to keep the parts mentioned in 9.2 and 9.3 from turning or shifting is to consist of more than friction between surfaces. For example, a properly applied lock washer is acceptable as the means for keeping a small stem-mounted switch, or other device having a single-hole mounting means, from turning.

10 Protection Against Corrosion

10.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means, if corrosion of such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception: Bearings, laminations, or small parts of iron or steel, such as washers, screws, and the like need not comply with this requirement.

11 Accessibility of Uninsulated Live Parts and Magnet Wire

11.1 General

11.1.1 The requirements in 11.1.2 – 11.2.3 shall apply to uninsulated live parts and magnet wire in circuits other than low-voltage energy limited energy circuits as described in Low-Voltage Limited Energy Circuits, Section 23.

11.1.2 To reduce the likelihood of unintentional contact that may involve a risk of electric shock, an uninsulated live part or magnet wire shall comply with either item (a) or (b).

- a) For an opening that has a minor dimension (see 11.1.6) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 11.1.
- 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 11.1.

Exception: A motor employed in an appliance intended for commercial use other than one used in either a hand-held product or a hand-supported portion of a product need not comply with these requirements if it complies with the requirements in 11.1.3.

11.1.3 With respect to a part or wire as mentioned in 11.1.2, in an integral enclosure of a motor as mentioned in the Exception to 11.1.2:

- a) An opening that has a minor dimension (see 11.1.6) less than 3/4 inch (19.1 mm) is acceptable if:
 - 1) Magnet wire cannot be contacted by the probe illustrated in Figure 11.3;
 - 2) An uninsulated live part cannot be contacted by the probe illustrated in Figure 11.4.
- b) An opening that has a minor dimension of 3/4 inch or more is acceptable if a part or wire is spaced from the opening as specified in Table 11.1.

11.1.3 effective March 13, 1996

11.1.4 The probes mentioned in 11.1.2 and 11.1.3 and illustrated in Figures 11.1 – 11.4 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 Figures 11.1 and 11.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

11.1.5 The probes mentioned in 11.1.2 and 11.1.3 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

11.1.6 With reference to the requirements in 11.1.2 and 11.1.3, 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.

11.1.7 *11.1.7 deleted effective March 13, 1996.*

11.1.8 During the examination of a product to determine whether it complies with the requirements in 11.1.2 or 11.1.3, a part of the enclosure that may be opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

11.1.9 With reference to the requirements in 11.1.2 and 11.1.3, insulated brush caps are not required to be additionally enclosed.

Table 11.1
Minimum acceptable distance from an opening to
a part that may involve a risk of electric shock

Minor dimension ^a of opening		Minimum distance from opening to part	
Inches ^b	(Millimeters ^b)	Inches ^b	(Millimeters ^b)
3/4	(19.1)	4-1/2	(114.0)
1 ^c	(25.4)	6-1/2	(165.0)
1-1/4	(31.8)	7-1/2	(190.0)
1-1/2	(38.1)	12-1/2	(318.0)
1-7/8	(47.6)	15-1/2	(394.0)
2-1/8	(54.0)	17-1/2	(444.0)
d		30	(762.0)

^a See 11.1.6
^b Between 3/4 and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.
^c Any dimension less than 1 inch applies to a motor only.
^d More than 2-1/8 inches, but not more than 6 inches (152.0 mm).

Figure 11.1
Articulate probe with web stop

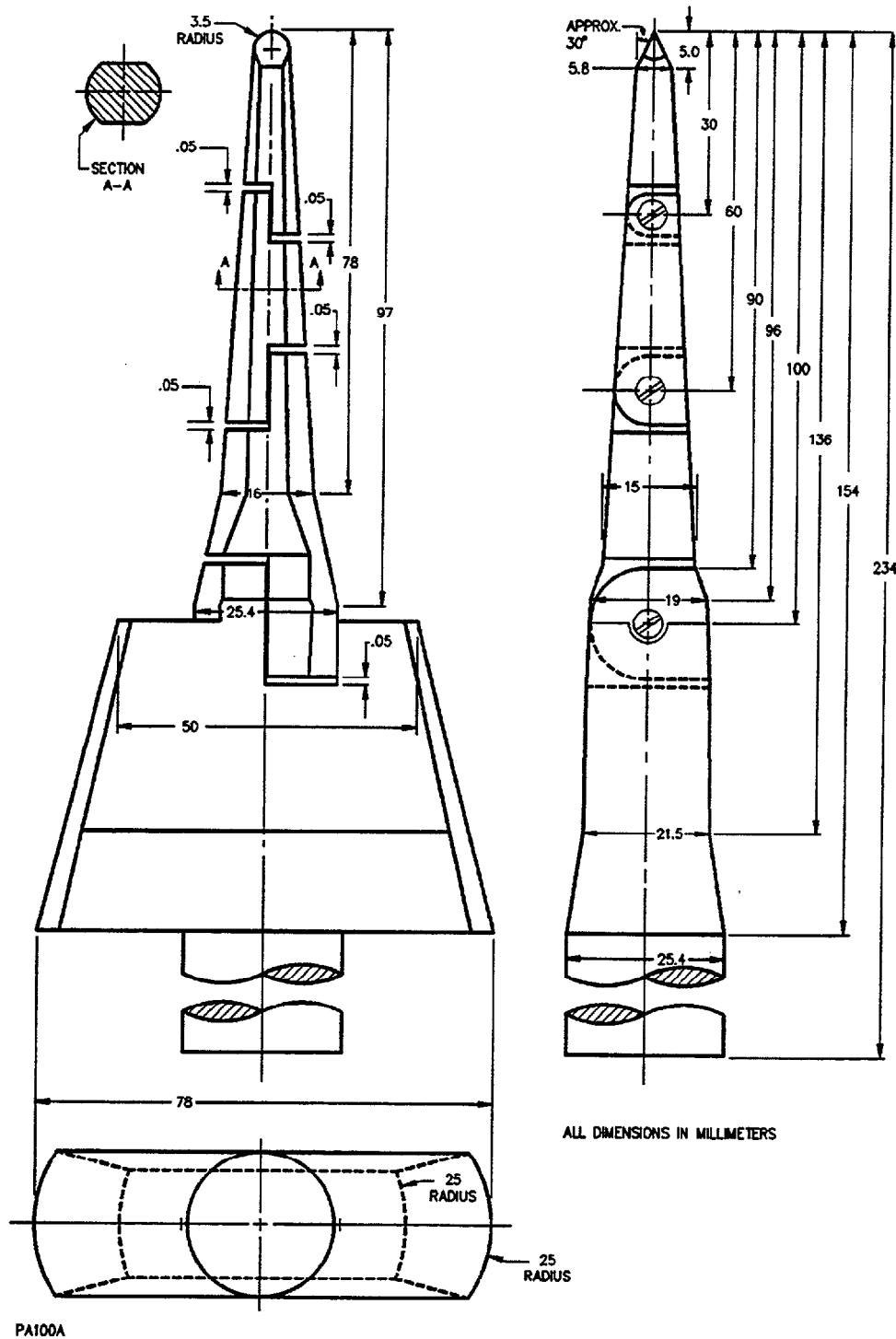


Figure 11.2
Straight probe

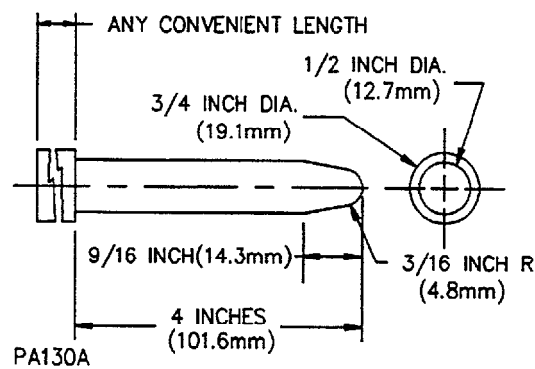
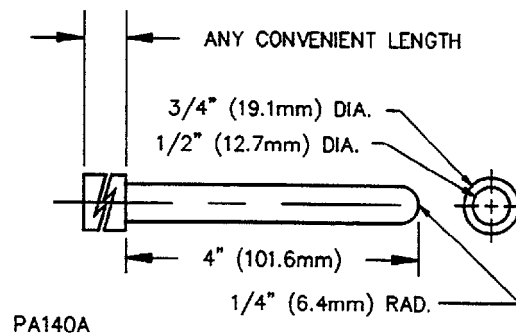


Figure 11.3
Straight probe



SA1788A

11.2.3 Means shall be provided for holding the door or the cover over a fuseholder in a closed position.

12 Supply Connections

12.1 Cord-connected products

12.1.1 Cords and plugs

12.1.1.1 A product intended to be connected to the power-supply circuit by means of a power-supply cord shall be provided with a flexible cord and an attachment plug acceptable for the connection.

12.1.1.2 The power-supply cord shall have a voltage rating not less than the rated voltage of the product, and shall have an ampacity that is not less than the current input to the product as measured during the input test or the rating of the product, whichever is higher.

12.1.1.3 The power-supply cord shall be as specified in Table 12.1, or shall be of a type at least equally serviceable for the application.

12.1.1.4 For a product not specifically mentioned in Table 12.1, Type SJ, SJT, or equivalent cord is ordinarily required if the product is intended for commercial use, and Type SP-1, SPT-1 or equivalent if the product is intended for household use.

Table 12.1
Cords for products

Product	Types of cord
Cloth-cutting machines:	
Household (includes scissors)	SP-2, SPT-2, SPE-2, SV, SVE, SVT
Commercial	SJ, SJT, SJE
Commercial textile equipment	S, ST, SE
Knitting machines:	
Household	SP-2, SPT-2, SPE-2, SV, SVE, SVT
Commercial	S, ST, SE
Sewing machines:	
Household	SP-2, SPT-2, SPE-2, SV, SVE, SVT
Transmitters	S, ST, SE

12.1.1.5 The power-supply cord shall not be less than 5 feet (1.52 m) long.

12.1.1.6 The length of an attached power-supply cord includes the attachment plug. The length of a cord set includes the attachment plug and cord-connector body.

12.1.1.7 A household product intended for use with a detachable cord set shall be provided with terminal pins that will not accommodate a standard flatiron or appliance plug.

12.1.1.8 The attachment cap shall have an ampacity not less than the current input to the product as measured during the input test or the rating of the product, whichever is higher, and a voltage rating equal to the rated voltage of the product. If a product is acceptable for adaptation for use on two or more different values of voltage by field alteration of internal connections, the attachment plug provided with the product shall be acceptable for the voltage for which the product is intended to be connected when shipped from the factory. See 58.1.4.

12.1.1.9 A 3- to 2-wire, grounding-type adapter shall not be provided with a product.

12.1.1.10 A product provided with special-use pin terminals shall be constructed so that no live parts will be exposed to unintentional contact either during or after placement of an intended plug on the pins in the intended manner.

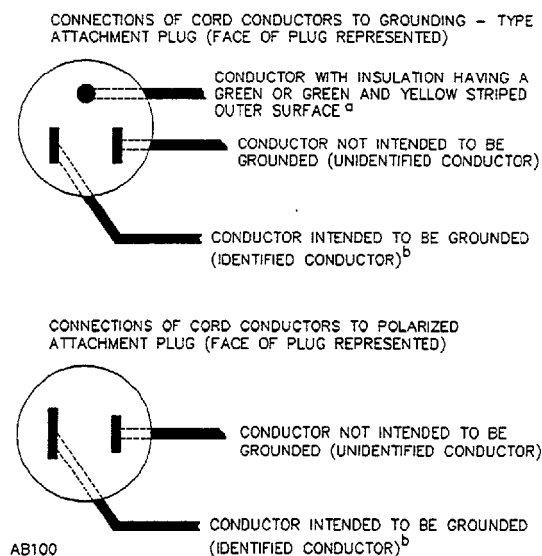
12.1.1.11 With reference to 12.1.1.10 a pin guard shall be provided such that:

- a) A flat straight edge placed in any position, across and in contact with edges of the plug opening without the plug in place, will not contact any current-carrying pin and
- b) The probe illustrated in Figure 11.1 will not contact any current carrying pin when the probe is inserted through any opening created by aligning the plug with its face in the plane perpendicular to the axis of, and tangent to the end of the farthest projecting current-carrying pin.

12.1.1.12 A product intended for connection to a nominal 120 V circuit shall have a polarized attachment plug (2-blade polarized or 3 wire-grounding). The connections to the attachment plug shall be in accordance with Figure 12.1 and Table 12.2.

12.1.1.12 effective March 13, 1996

Figure 12.1
Connections to attachment plugs



^a In the above illustration, the blade to which the green conductor is connected may have a U-shaped or a circular cross section.

^b Signifies a conductor identified in accordance with Table 12.2.

Figure 12.1 effective March 13, 1996

Table 12.2
Polarity identification of flexible cords

Method of identification	Acceptable combinations	
	Wire intended to be grounded ^a	All other wires ^a
Color of braids on individual conductors	Solid white or natural gray – without tracer	Solid color other than white or natural gray – without tracer
	Color other than white or natural gray, with tracer in braid	Solid color other than white or natural gray – without tracer
Color of insulation on individual conductors	Solid white or natural gray ^b	Solid color other than white or natural gray
	Light blue ^c	Solid color other than light blue, white, or natural gray.
Color of separators	White or natural gray ^c	Color other than white or natural gray
Other means	Tin or other white metal on all strands of the conductor ^d	No tin or other white metal on the strands of the conductor
	A stripe, ridge, or groove on the exterior surface of the cord ^d	
^a A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor. See 12.1.1.12 and Figure 12.1. ^b Only for cords – other than Type SP-2 or SPT-2 – having no braid on any individual conductor. ^c For jacketed cord. ^d Only for Type SP-2 and SPT-2 cords.		

Table 12.2 effective March 13, 1996

12.1.1.13 A product rated 120 V shall have the circuit conductors in the flexible cord connected to the plug and to the wiring in the product so that any of the following devices used in the primary circuit are connected in an ungrounded side of the line: the center contact of an Edison-base lampholder, a single-pole switch, a fuseholder, any other single-pole overcurrent protective device, and an automatic control with a marked off position.

12.1.1.13 effective March 13, 1996

12.1.1.14 A product not intended to be moved during use may be provided with not more than 8 feet (2.44 m) of Type S, SO, ST, or STO cord and an attachment plug for supply connection. The investigation of such a feature will include consideration of the utility of the product and the necessity of having it readily detachable from its source of supply by means of a plug.

12.1.2 Strain relief

12.1.2.1 Strain relief shall be provided so that mechanical stress including a rotational stress, on any external cord will not be transmitted to terminals, splices, or interior wiring.

12.1.2.2 A metal strain-relief clamp or band used with Type SP-2 or lighter general-use rubber-insulated cord shall be provided with auxiliary insulation over the cord for mechanical protection.

12.1.2.3 A clamp of any material is not acceptable for use on Type SVT, SVE, SVTO, SPE-2, or SPT-2 cord.

Exception No. 1: The construction may be acceptable if the cord is protected by varnished-cloth tubing or the equivalent under the clamp.

Exception No. 2: A clamp that has been investigated and found to be acceptable need not comply with this requirement. See 43.3.

12.1.2.4 For types of thermoplastic-insulated cord, heavier than Type SPT-2, SPE-2, SVE, SVT or SVTO, a clamp may be employed without auxiliary insulation if it is determined that the design of the clamp will not damage the cord insulation.

12.1.2.5 Means shall be provided to prevent a flexible cord from being pushed into a product through a cord-entry hole if such displacement may subject the cord to mechanical damage or exposure to a temperature higher than the cord is rated, or may reduce a spacing, such as to a metal strain-relief clamp, below the minimum acceptable value.

12.1.2.6 If a knot in a flexible cord serves as strain relief, the surface that the knot may contact shall be free from sharp edges, burrs, fins, and other projections likely to damage the cord.

12.1.3 Bushings

12.1.3.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall be substantial, reliably secured in place, and shall have a smooth, well-rounded surface that the cord may bear against.

12.1.3.2 The insulating bushing shall be provided if;

- a) Type SP-2, SPE-2, SPT-2, or other cord lighter than Type SV is employed,
- b) The wall or barrier is of metal, or
- c) The construction is such that the cord may be subjected to strain or motion.

Exception: An insulated metal grommet having insulating material that is not less than 1/32 inch (0.8 mm) thick and that completely fills the space between the grommet and the metal may be used instead of the insulating bushing.

12.1.3.3 A cord hole in wood, porcelain, phenolic composition, or other nonconducting material having a smooth, rounded surface is considered to be equivalent to a bushing.

12.1.3.4 A separate bushing shall not be made of wood or of hot-molded shellac-or-tar compositions.

12.1.3.5 A vulcanized fiber bushing shall not be less than 3/64 inch (1.2 mm) thick and so formed and secured in place that it will not be adversely affected by conditions of ordinary moisture.

12.1.3.6 A separate soft-rubber, neoprene, or polyvinyl chloride bushing shall not be employed in the product.

Exception No. 1: A separate soft-rubber, neoprene, or polyvinyl chloride bushing may be employed in the frame of a motor or in the enclosure of a capacitor attached to a motor provided that:

a) The bushing is not less than 3/64 inch (1.2 mm) thick, and

b) The bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substances having a deleterious effect on the compound employed.

Exception No. 2: A bushing of any of the materials mentioned above may be employed at any point in a product if used in conjunction with a type of cord for which an insulating bushing is not required. If a bushing of one of these materials is used anywhere in the product, the edges of the hole in which the bushing is mounted are to be smooth and free from burrs, fins, and the like.

12.1.3.7 At any point in a product, a bushing integrally molded of the same material as the supply cord is acceptable on a Type SP-2, SPE-2, SPT-2 or heavier cord if the built-up section is not less than 1/16 (1.6 mm) thick at the point where the cord passes through the enclosure.

12.2 Permanently-connected products

12.2.1 General

12.2.1.1 Except as noted in 12.1.1.14 a product intended for permanent connection to a power supply shall have provision for connection of one of the wiring systems that would be acceptable for the product.

12.2.2 Terminal compartment

12.2.2.1 A terminal box or compartment shall be provided on all products intended to be permanently connected and located so that the connections may be readily inspected after the product is installed without moving the product. Electrical components shall not be mounted on the door or cover of the terminal box or compartment.

12.2.2.2 A wiring space or compartment intended to enclose wires shall be free of any sharp edge, burr, fin, moving part, or the like, that may abrade the insulation on conductors or otherwise damage the wires.

12.2.2.3 A terminal compartment intended for connection of a supply raceway shall be attached to the product so as to be kept it from turning.

12.2.2.4 If it is intended that supply connections be made directly to a motor, the terminal compartment on the motor shall comply with the requirements for terminal compartments in the Standard for Electric Motors, UL 1004.

12.2.3 Wiring terminals and leads

12.2.3.1 A product intended to be permanently connected shall be provided with wiring terminals for the connection of conductors having an ampacity acceptable for the product.

12.2.3.2 A field-wiring terminal is a terminal to which a wire is intended to be connected in the field, unless the wire and a means of making the connection such as a pressure wire connector, soldering lug, soldered loop, or crimped eyelet factory-assembled to the wire, are provided as a part of the product.

12.2.3.3 Wiring terminals for the supply conductors — excluding the ground conductor — shall be provided with a pressure wire connector securely fastened in place; for example, firmly bolted or held by a screw.

Exception No. 1: A soldering lug may be used.

Exception No. 2: A No. 10 or larger wire binding screw or stud-and-nut combination may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm²) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in place.

Exception No. 3: A No. 8 screw or stud-and nut-combination may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm²) conductor.

12.2.3.4 A wiring terminal shall be kept from turning.

12.2.3.5 The free length of a lead inside an outlet box or wiring compartment shall be 6 inches (152.4 mm) or more if the lead is intended for field connection to an external circuit. The leads provided for connection to the branch-circuit supply shall have an ampacity rating not less than that of a conductor of the next smaller size than that acceptable for the rating of the product.

Exception: The lead may be less than 6 inches long if the use of a longer lead might result in a risk of fire or electric shock.

12.2.3.6 A wire-binding screw shall thread into metal.

12.2.3.7 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick and shall not have less than two full threads in the metal.

Exception: A plate not less than 0.030 inch (0.76 mm) thick, is acceptable if the tapped threads have adequate mechanical strength.

12.2.3.8 A terminal plate formed from stock having the thickness specified in 12.2.3.7 may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

12.2.3.9 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size specified in 12.2.3.1 under the head of the screw or washer.

12.2.4 Identified terminals and leads

12.2.4.1 A product intended to be permanently connected rated 125 or 125/250 V (3-wire) or less and employing a lampholder of the Edison-screw-shell type, or a single-pole switch or overcurrent-protective device other than an automatic control without a marked off position, shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit.

12.2.4.2 A terminal intended for the connection of a grounded supply conductor shall be of or plated with metal that is substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of that terminal shall be clearly shown in some other manner, such as on a permanently attached wiring diagram.

12.2.4.3 A lead intended for the connection of a grounded power-supply conductor shall be colored white or natural gray color and shall be readily distinguishable from the other leads.

12.2.4.4 Wiring compartments or the equivalent for field-wiring terminals of low-voltage circuits shall be separate from wiring compartments for other terminals.

13 Current-Carrying Parts

13.1 A current-carrying part shall be of silver, stainless steel, copper, a copper alloy, or other similar metal.

13.2 Iron or steel shall not be used as a current-carrying part.

Exception: Iron or steel provided with a corrosion-resistant coating may be used for a current-carrying part;

a) If acceptable in accordance with 3.1 — 3.4, or

b) Within a motor or associated governor.

14 Insulating Materials

14.1 Material used for mounting an uninsulated live part or as electrical insulation shall comply with the requirements for direct support materials described in the requirements for polymeric materials for use in electrical equipment evaluations, UL 746C.

14.2 Vulcanized fiber minimum 1/32 inch (0.8 mm) thick may be used for insulating bushings, washers, separators, and barriers, but not as the direct support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock.

14.3 Small molded parts, such as brush caps, shall be constructed to have the necessary mechanical strength and rigidity to withstand the stresses of actual service. Brush caps shall be secured or located so that they are protected from mechanical damage that might result during intended use.