

UL 987

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Stationary and Fixed Electric Tools

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Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Stationary and Fixed Electric Tools, UL 987

Sixth Edition, Dated August 5, 1994

Revisions: This Standard contains revisions through and including April 4, 2005.

Summary of Topics

These revisions are being issued to correct the future effective date information for the revised table saw requirements that were revised on January 31, 2005.

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The following table lists the future effective dates with the corresponding reference.

Future Effective Date	References
January 31, 2008 for new products submitted for investigation January 31, 2014 for currently Listed products	Paragraphs 2.4.1 – 2.4.5 and Section 40A

The new and revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated February 25, 2005. The bulletin(s) is now obsolete and may be discarded.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfonet.ul.com/ulforeword.html>

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-4A	January 31, 2005
4B	August 6, 1999
4C	September 14, 2000
4D	August 6, 1999
5	June 30, 1998
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8A-8B	January 31, 2005
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15-16	August 6, 1999
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UL 987

Standard for Stationary and Fixed Electric Tools

Prior to the sixth edition, the requirements for Light Industrial Tools now covered by this standard were included in the Standard for Light Industrial Tools, UL 1624.

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Sixth Edition

August 5, 1994

The most recent designation of ANSI/UL 987 as an American National Standard (ANSI) occurred on January 5, 2005.

This ANSI/UL Standard for Safety, which consists of the Sixth edition with revisions through January 31, 2005, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-NBK Standard Department, 333 Pfingsten Rd., Northbrook, IL, 60062-2096.

The Department of Defense (DoD) has adopted UL 987 on May 20, 1976. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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

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APPENDIX A

Standards for Components.....	A1
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INTRODUCTION

1 Scope

1.1 These requirements cover cord-connected or permanently-connected stationary and light industrial electric tools for use in accordance with the National Electrical Code, ANSI/NFPA 70 and provided with a means for:

- a) Grounding the tool on a branch circuit rated not more than 600 volts and employing no universal motor rated more than 250 volts; or
- b) Providing double insulation for a tool on a branch circuit involving a potential of not more than 150 volts to ground.

1.2 These requirements also cover accessories and attachments for use with tools included in 1.1 if the accessories or attachments are:

- a) Identified by catalog number or equivalent product designation in the instruction manual for the tool; or
- b) Packed with the tool.

Specific requirements are outlined in Sections 74 – 77.

1.3 These requirements do not cover any of the following:

- a) Portable tools;
- b) Automated machine tools intended for production line use;
- c) Garage equipment with the exception of bench type brake lathes;
- d) Painting equipment; or
- e) Other equipment covered by individual requirements.

1.3 revised March 7, 1997

1.4 A stationary or fixed electric tool intended to be remotely or automatically controlled, or a permanently connected tool intended for continuous duty are judged on the basis of compliance with the requirements in this standard, insofar as they are applicable, and further examination and test to determine whether the tool is acceptable for the purpose.

1.5 These requirements do not cover accessories or attachments that:

- a) Are not packed with the tool; or
- b) Are not identified by catalog number or equivalent product designation in the instruction manual provided with the tool.

Accessories or attachments mentioned in mini-catalogs or flyers may or may not be provided with the tool.

1.6 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 or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the 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 does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.6 revised September 14, 2000

2 Terminology

2.1 In the following text, a requirement that applies only to a specific class or classes of stationary, fixed, and light industrial electric tools is so identified by a specific reference in the requirement to the class or classes of equipment involved. Absence of such specific reference or use of the term tool indicates that the requirement applies to all of the classes of equipment covered by this standard unless the context indicates otherwise.

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

2.3 ACCESSORY – A device that is attached only to the spindle of the tool. Accessories include carbide tipped saw blades, wire brushes, and shaper cutters.

2.4 ATTACHMENT – A device attached to the housing or other component of the tool that may or may not attach to the spindle. Attachments include tables to convert bench mounted tools to floor mounted tools, and devices that facilitate the use of tools such as a saw dust collection device.

2.4.1 RIVING KNIFE – A device located behind and in the plane of the saw blade, within the cutting capacity of the blade and in a fixed proximity to the blade through an entire depth of cut and bevel operating range of the blade, with an intended function to prevent blade pinching and reduce the risk of blade binding.

2.4.2 RIVING KNIFE/SPREADER COMBINATION – A device that functions as a riving knife, but can be extended beyond the cutting capacity of the blade so that a blade guard and/or antikickback pawls can be mounted thereto.

2.4.3 SPREADER – A device located behind and in the plane of the saw blade, extending beyond the cutting capacity of the blade through an entire depth of cut and bevel operating range of the blade, primarily utilized for mounting the blade guard and/or antikickback pawls.

2.4.4 STATIONARY TOOL – Electric motor-operated or magnetically-driven machine so designed that the motor and the machine form an assembly which does not require support by hand and the material on which the machine performs the work is brought to the machine.

Added 2.4.4 effective January 31, 2008 for new product submittals or January 31, 2014 for currently Listed products.

2.4.5 TRANSPORTABLE TOOL – A stationary tool that is cord connected and is easily transported to the work site by one person, simple devices to facilitate transportation may be incorporated, e.g. handles, wheels and the like.

2.5 TOOL – A stationary or light industrial tool as specified in 1.1.

3 Components

3.1 Except as indicated in 3.2, a component of a tool 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.

3.1 revised September 14, 2000

3.2 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.

3.2 revised September 14, 2000

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

3.3 revised September 14, 2000

3.4 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.

3.4 revised September 14, 2000

4 Units of Measurement

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

4.1 revised September 14, 2000

CONSTRUCTION

5 General

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

5.2 A motor for a tool provided with a means for grounding may be shipped detached from the tool if both the motor and the tool comply with the applicable requirements in 7.5, 9.5, 9.6, 12.1.7, 14.19, 14.20, 15.1 – 15.4, 68.6, 69.9, 69.10, 72.1.4, and 72.1.5.

5.3 The motor of a double insulated tool shall be shipped attached to the tool.

6 Frame and Enclosure

6.1 General

6.1.1 A tool shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

6.2 Enclosures of metallic materials

6.2.1 Cast-metal portions of an enclosure shall not be thinner than the minimum acceptable values specified in Table 6.1.

Table 6.1
Minimum acceptable thickness of a cast metal enclosure

Metal	Flat surfaces		Curved, ribbed, or otherwise reinforced surfaces, and surfaces having a size or shape providing the required mechanical strength,	
	Inch	(mm)	Inch	(mm)
Die-cast metal	5/64	(2.0)	3/64	(1.2)
Cast malleable iron	3/32	(2.4)	1/16	(1.6)
Other cast metal	1/8	(3.2)	3/32	(2.4)

6.2.2 Among the factors to be considered when judging an enclosure of sheet metal shall be the size, shape, and thickness of the metal all with respect to the application and intended use of the tool.

6.2.3 Among the factors to be considered when judging an enclosure of magnesium shall be the combustibility and resistance to arcing of the metal.

6.2.4 Sheet metal to which a wiring system is intended to be connected in the field shall have a thickness not less than the minimum acceptable value specified in Table 6.2.

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Table 6.2
Minimum acceptable thickness of a sheet metal surface to which a wiring system is intended to be connected in the field

Metal	Surfaces to which a wiring system is intended to be connected in the field	
	Inch	(mm)
Uncoated sheet steel	0.032	(0.81)
Galvanized sheet steel	0.034	(0.86)
Sheet aluminum	0.045	(1.14)
Sheet copper or brass	0.045	(1.14)

6.3 Enclosures of polymeric materials

6.3.1 Polymeric material used for the enclosure of a cord-connected tool that requires operator attendance while work is being done shall comply with the requirements in 6.3.3 and 61.1 and with the requirements for Polymeric Materials, Section 63 or 64, whichever is applicable.

6.3.2 Polymeric material used for the enclosure of a tool that is intended for permanent connection to the power supply or a tool that may be operated unattended shall comply with:

- a) The requirement in 6.3.3 and 61.1 and with the requirements for Polymeric Materials, Section 63 or 64, whichever is applicable; and
- b) Any additional examination and test needed to evaluate the material for use in the application.

6.3.3 A polymeric material used for the enclosure of a tool shall be resistant to thermal degradation at the maximum temperature to which it is exposed during its normal use.

6.3.4 With reference to 6.3.3, a polymeric material is considered to be resistant to thermal degradation at the temperatures to which it will be exposed if:

- a) The material has a temperature index, based on historical data or a long-term thermal aging program, more than the maximum temperature to which it is exposed during its normal use;
- b) The maximum temperature to which the material is exposed during normal use does not exceed 65°C (149°F); or
- c) The maximum temperature to which the material is exposed during normal use does not exceed 95°C (203°F), and the material complies with the requirement for Polymeric Enclosures Following Oven Conditioning, Section 62.

7 Accessibility of Live Parts

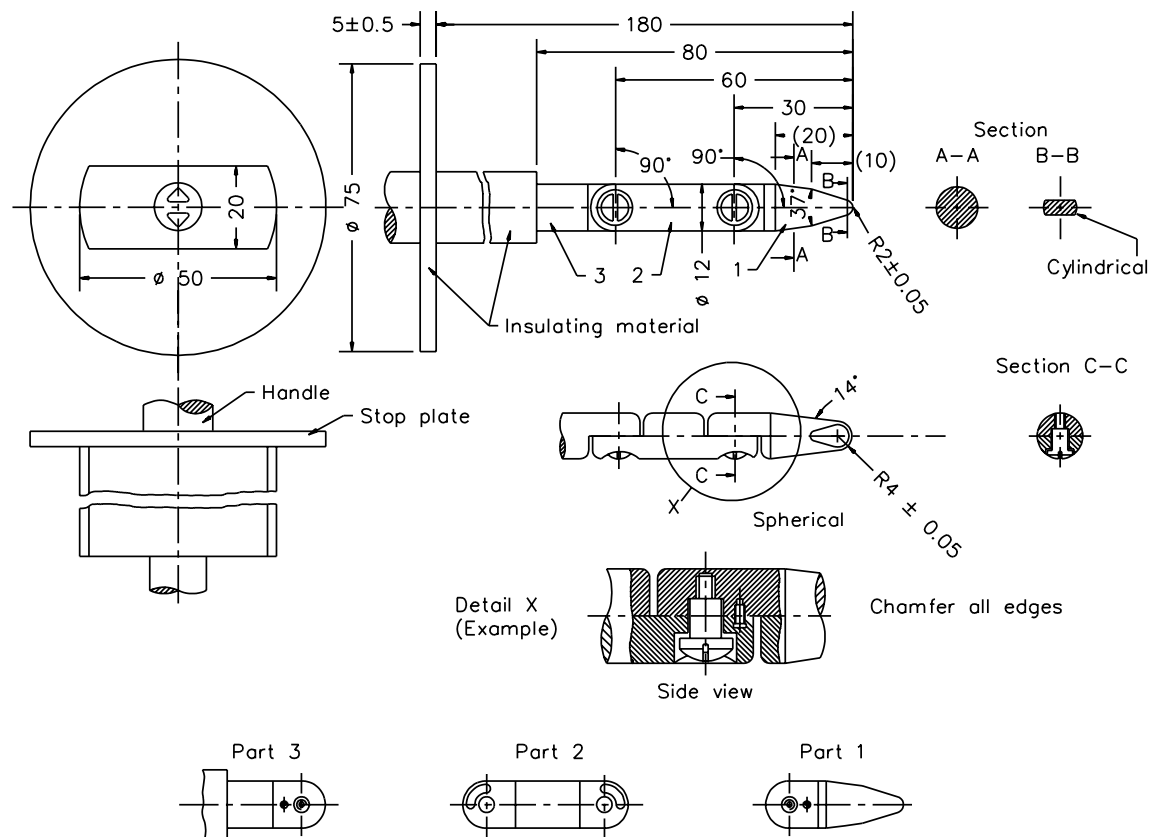
7.1 An electrical part of a tool shall be located or enclosed so that the likelihood of unintentional contact with an uninsulated live part will be reduced. Insulated brush caps do not require additional enclosure.

7.2 With reference to the requirement in 7.1, the enclosure of a tool shall have no openings, other than those required for normal use of the tool, which will permit the finger probe, illustrated in Figure 7.1, to contact any uninsulated live part or film-coated wire when applied in any direction.

7.2 effective August 5, 1999

Figure 7.1
IEC articulate probe

Figure 7.1 effective August 5, 1999



SA1788A

Linear dimensions in millimeters

Tolerances on dimensions without specific tolerance:

on angles: $+0'$, $-10'$

on linear dimensions:

up to 25 mm: $+0$ mm, -0.05 over 25 mm: ± 0.2 mm

Material of finger: for example heat-treated steel

Both joints of this finger may be bent through an angle of 90° , with a 0 to $+10^\circ$ tolerance, but in one and the same direction only.

Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to 90° . For this reason dimensions and tolerances of these details are not given in the drawing. The actual design must ensure a 90° bending angle with a 0 to $+10^\circ$ tolerance.

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7.3 In a double-insulated tool, a test pin as illustrated in Figure 7.2, when inserted point first into an opening in an enclosure housing, shall not contact any parts separated from live parts by basic insulation only.

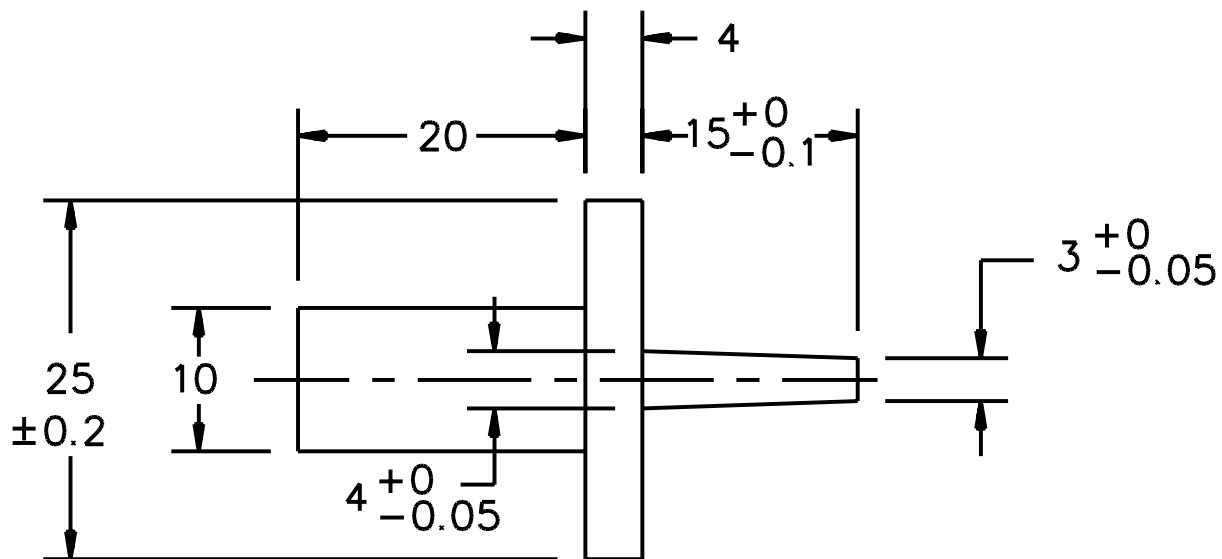
7.3 effective August 5, 1999

7.4 During the examination of a tool in connection with the requirement in 7.2 and 7.3, a part of the outer enclosure that is intended to be removed without the use of a tool by the user – to permit the attachment of an accessory, to allow access to means for making an operating adjustment, or for a similar reason – is to be disregarded; that is, such a part is not considered to reduce the risk of electric shock.

7.5 If removal of a guard or a cover is necessary for mounting a motor shipped detached from a tool, the guard or cover shall be constructed so that it cannot be replaced improperly.

Figure 7.2
Test pin

Figure 7.2 effective August 5, 1999



S2962

Dimensions in millimeters

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8 Exclusion of Foreign Matter

8.1 The enclosure of a tool, a control unit, or an auxiliary component, such as a rheostat or a rectifier, that is not integral with the tool shall exclude foreign matter, including abrasive or electrically conductive particles, that is likely to be present during operation and that may:

- a) Adversely affect electrical insulation – for example, by build-up of a leakage path over an insulating surface; or
- b) Otherwise result in a risk of fire or electric shock.

8.2 All uninsulated live parts and film-coated wire in a grinder shall be completely enclosed.

Exception: The following are acceptable for a grinder with provision for grounding:

- a) An opening in a horizontal bottom surface of a bench grinder;*
- b) An opening in a vertical skirt of a bench grinder entirely below an opening specified in (a) above;*
- c) An opening in a vertical skirt of a bench grinder below an opening in a curved bottom surface; and*
- d) An opening in the enclosure of a grinder other than a bench grinder if protection equivalent to that for a bench grinder is provided.*

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9 Mechanical Assembly

9.1 A tool assembled by the manufacturer or in accordance with the manufacturer's specifications, shall not be adversely affected by the vibration during its intended operation.

9.2 A brush cap shall be tightly threaded or otherwise designed and secured to reduce the likelihood of unexpected loosening.

9.2 revised June 30, 1998

9.3 A switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or a similar component shall be mounted securely, and shall be prevented from turning or shifting. See 9.4.

Exception No. 1: The requirement that a switch be deterred from turning or shifting may be waived 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 the normal operation of the switch.*
- b) Means for mounting the switch make it unlikely that operation of the switch will loosen it.*
- c) The spacings are not reduced below the minimum acceptable values if the switch rotates.*
- d) Normal operation of the switch is by mechanical means rather than by direct contact by persons.*

Exception No. 2: A lampholder of a type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be deterred from turning if rotation cannot reduce spacings below the minimum acceptable values.

9.4 The means for preventing the turning mentioned in 9.3 is to consist of more than friction between surfaces – for example, a properly applied lock washer is acceptable as means to deter turning of a small stem-mounted switch or other device having a single-hole mounting means.

9.5 If a motor shipped detached from a tool is intended to be installed in the field according to the instructions provided with the tool, proper alignment shall be provided for by location and size of the mounting hardware. If a motor is intended to be used on a belt-driven tool, the necessary pulleys for field installation shall be provided with the tool. See 72.1.4.

9.6 With reference to the requirement in 9.5, adjustment means may be provided to allow for belt tensioning and alignment.

10 Protection Against Corrosion

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

Exception No. 1: A surface of sheet steel or a cast-iron part in an enclosure if the oxidation of the iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable need not comply with this requirement. The thickness of the metal and the temperature are also factors.

Exception No. 2: Bearings, laminations, and minor parts of iron or steel, such as washers, screws, and the like, need not comply with this requirement.

11 Power Supply Connections – Permanently Connected Tools

11.1 General

11.1.1 A tool intended for permanent connection to the power-supply circuit shall have provision for the connection of a wiring system.

11.2 Wiring compartments

11.2.1 The location of a wiring compartment in which connections to the supply circuit are intended to be made shall be such that these connections can be readily inspected after the tool is installed as intended.

11.2.2 A wiring compartment intended for connection of a wiring system shall be attached to the tool so as to be prevented from turning with respect thereto.

11.2.3 A wiring compartment and any other space intended to enclose wires shall be free of any sharp edge, burr, fin, moving part, or the like, that could damage the conductor insulation.

11.3 Wiring terminals and leads

11.3.1 A field-wiring terminal is considered to be a terminal to which a wire may be connected in the field, unless the wire is provided as part of the tool and a pressure wire connector, a soldered loop, a crimped eyelet, or other means of making the connection is factory-assembled to the wire.

11.3.2 A permanently connected tool shall be provided with field-wiring terminals for the connection of conductors having an ampacity suitable for the tool, or it shall be provided with field-connection leads for such connection.

11.3.3 A field-wiring terminal shall be provided with a pressure wire connector, firmly bolted or held by a screw.

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

11.3.4 A wire-binding screw shall not be smaller than No. 10 (5.3 mm²).

Exception: A No. 8 screw may be used at a field-wiring terminal intended only for the connection of a No. 14 AWG (2.1 mm²) conductor.

11.3.5 A field-wiring terminal shall be prevented from turning.

11.3.6 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.05 inch (1.27 mm) thick. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

Exception: A plate equal to or greater than 0.03 inch (0.76 mm) thick may be used if the tapped threads have acceptable mechanical strength.

11.3.7 Upturned lugs or a cupped washer shall be capable of retaining a conductor corresponding in size to that mentioned in 11.3.2 under the head of the screw or washer.

11.3.8 The free length of a field-connection lead inside an outlet box or a wiring compartment shall be 6 inches (152 mm) or more.

11.4 Grounded power-supply conductor

11.4.1 A permanently connected tool rated 125 volts or 125/250 volts, 3-wire, or less employing a lampholder of the Edison screw-shell type, a single-pole switch, or a single-pole overcurrent-protective device other than an automatic control without a marked off position shall have one field-wiring terminal or field-connection lead that is identified for the connection of the grounded conductor of the supply circuit. The terminal or lead intended to be grounded shall be electrically connected to screw shells of lampholders and not to a switch or overcurrent-protective device of the single-pole type, other than an automatic control without a marked off position.

Exception: A double insulated tool complying with the requirements in Sections 78 – 82 need not comply with this requirement.

11.4.2 A field-wiring terminal intended for connection of a grounded supply conductor shall:

- a) Be made of or plated with metal substantially white in color and be readily distinguishable from the other terminals; or
- b) Be clearly identified in some other manner, such as on a wiring diagram permanently attached to the tool.

11.4.3 A lead intended for field-connection of a grounded supply conductor shall be finished to show a white or natural grey color, and shall be readily distinguishable from the other lead or leads.

11.5 Equipment-grounding conductor

11.5.1 A field-wiring terminal or field-connection lead for an equipment-grounding conductor shall be provided.

Exception: A double insulated tool complying with the requirements in Sections 78 – 82 need not comply with this requirement.

11.5.2 The surface of a lead intended for field-connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

11.5.3 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked "G," "GR," "GND," "Ground," "Grounding," with the symbol $\oplus$, or the like, or by a marking on a wiring diagram provided on the tool. The wire-binding screw or pressure wire connector shall be located so that it is unlikely to be removed during normal servicing of the tool.

12 Power Supply Connections – Cord-Connected Tools

12.1 Cords and plugs

12.1.1 A cord-connected tool shall be provided with 6 – 10 feet (1.8 – 3.0 m) of flexible cord, permanently attached to the tool, and with an attachment plug, which may be of the locking type, for connection to the supply circuit.

Exception: A tool may be provided with less than 6 feet (1.83 m) of permanently attached flexible cord or with a motor-attachment plug if the manufacturer:

- a) Makes an acceptable extension cord available and the tool complies with the requirements in 69.16; or*
- b) Furnishes an acceptable detachable cord set, 6 feet (1.83 m) or more in length, with the tool.*

12.1.2 The permanently attached flexible cord mentioned in the Exception to 12.1.1 shall be of such length that it is not likely to be damaged or impaired by a cutting edge, a blade, a belt, or a rotating part. The cord shall not be more than 18 inches (460 mm) long.

12.1.3 The length of the cord is to be measured from where it enters the tool to the face of the attachment plug.

12.1.4 The flexible cord shall be Type S, SE, SJ, SJE, SJO, SJT, SJTO, SO, SP-3, SPE-3, SPT-3, ST, or STO.

12.1.4.1 A permanently attached flexible power-supply cord or a detached cord set provided with a tile saw shall be the outdoor use type, either junior hard-service cord (such as Type SJ) or hard-service cord (such as Type S), identified by W suffix type designation on the cord (for example, SJW).

12.1.4.1 added June 6, 1997

12.1.5 If a component having a separate supply cord is provided as part of a tool, the cord for the component being used in conjunction with the tool shall be one of the types specified in 12.1.4.

Revised 12.1.5 effective August 6, 2000

12.1.5.1 Supply connections for tools incorporating more than one electrical supply connection shall have the connections grouped and marked as specified in 70.1.8.

Added 12.1.5.1 effective August 6, 2000

12.1.6 The flexible cord shall be rated for a voltage not less than the rated voltage of the tool and shall have an ampacity not less than the current rating of the tool.

12.1.7 The attachment plug of a tool and the cord of a motor shipped detached from a tool shall be rated not less than the rated current and the rated voltage of the tool. If a tool has provision for being adapted for use on two or more different values of voltage by field alteration of internal connections, the attachment plug and any receptacle provided on the tool for the connection of the motor shall be rated not less than the voltage and current for which the tool or motor is connected when shipped from the factory. See 69.6.

12.1.8 If a tool incorporates a disconnecting means, such as a cord connector in the power-supply cord, the arrangement shall be such that no live part will be exposed under any normal condition.

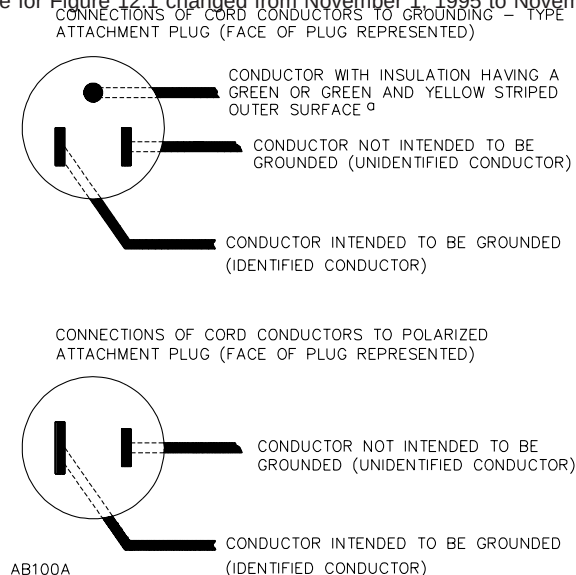
Effective date for 12.1.8 changed from November 1, 1995 to November 11, 1996

12.1.9 If a 3-wire grounding type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connections shall be as shown in Figure 12.1. See 12.1.

Effective date for 12.1.9 changed from November 1, 1995 to November 11, 1996

Figure 12.1
Connection to attachment plug

Effective date for Figure 12.1 changed from November 1, 1995 to November 11, 1996



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

12.1.10 The equipment-grounding conductor of a flexible cord:

- a) Shall be provided with insulation having an outer surface that is green with or without one or more yellow stripes;
- b) Shall be connected to the grounding member of an attachment plug of the grounding type; and
- c) Shall be conductively connected to:
 - 1) All exposed dead metal parts of the tool that may become energized; and
 - 2) All dead metal parts within the enclosure that are exposed to contact during any user servicing operation and that may become energized. User servicing as mentioned in this item and in 23.5 is considered to include operations, such as changing a blade on a table saw, adjusting a belt on a drill press, and the like.
- d) The conductor shall be secured by a closed loop connector, connector with upturned ends, or equivalent means. Lock washers or equivalent means shall be utilized to hold the conductor in place. Thread-on devices shall not be used in the ground conductor.

Revised 12.1.10 effective August 5, 1999

12.2 Strain relief

12.2.1 Strain relief shall be provided to prevent a mechanical stress on a flexible cord from being transmitted to terminals, splices, or internal wiring.

12.2.2 Means shall be provided to prevent the supply cord or interconnecting cable from being pushed into the enclosure of a tool through the cord-entry hole when such displacement results in:

- a) Subjecting the supply cord or interconnecting cable to mechanical damage;
- b) Exposing the supply cord or interconnecting cable to a temperature higher than that for which it is rated;
- c) Reducing spacings (such as to a metal strain-relief clamp) below the minimum required values; or
- d) Damaging internal connections or components.

To determine compliance, the supply cord or interconnecting cable shall be tested in accordance with Section 54A, Push Back Relief Test.

12.2.2 revised June 30, 1998

12.2.3 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, that may cause abrasion of the cord jacket or the insulation on the conductors.

12.2.4 The strain-relief means provided on a flexible cord shall comply with the requirements in Section 55.

12.2.5 The strain relief provided on a supply cord shall be independent of any rubber or thermoplastic cord guard unless the guard is molded on the cord or has been investigated and found to be acceptable for the application.

12.2.6 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, the edges of the opening shall be smoothly rounded. If it is not obvious that the edges of such an opening are smoothly rounded, the tool shall comply with the requirements in 55.1.

13 Live Parts

13.1 Metal employed for a current-carrying part shall be silver, copper, copper alloy, or other metal that has been investigated and found to be acceptable for the application.

13.2 Ordinary iron or steel, if provided with a corrosion-resistant coating, may be used for a current-carrying part:

- a) If permitted in accordance with 3.1; or
- b) Within a motor or associated governor.

The use of ordinary iron or steel, even if plated, for current-carrying parts elsewhere in a tool is not acceptable.

13.3 An uninsulated live part shall be secured to the surface on which it is mounted, and supporting insulating materials shall be secured in place, so that it will be prevented from turning or shifting in position, if such motion may result in a reduction of spacings below the minimum acceptable values. A brush-holder connector shall be secured independently of the brush.

13.4 Friction between surfaces is not acceptable as a means to prevent turning or shifting of an uninsulated live part, but a properly applied lock washer may be used.

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14 Internal Wiring

14.1 The wiring and connections between parts of a tool shall be protected or enclosed.

Exception: Flexible cord as specified in 12.1.4 and used for external interconnection between components where flexibility is essential need not be protected or enclosed; however, Type SP and SPT cord shall not be used if it will be subjected to extreme flexing, such as the cord supplying the motor of a radial-arm saw.

14.2 Internal wiring exposed through an opening in the enclosure of a tool is considered to be protected as required by 14.1 if, when judged as though it were film-coated wire, the wiring complies with the conditions specified in 7.2. Internal wiring not so protected shall be secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

14.3 Among the factors to be considered when judging internal wiring shall be:

- a) The temperature and voltage to which the wiring may be subjected;
- b) Exposure to oil, grease, or other substances that may have a deleterious effect; and
- c) Other conditions of service to which it may be subjected.

14.4 Thermoplastic-insulated wire and neoprene-insulated wire employed for internal wiring shall be standard building wire or appliance wiring material. The thickness of insulation shall be 0.030 inch (0.76 mm) or more.

Exception: The nominal thickness of the insulation may be less than 0.030 inch, but shall not be less than 1/64 inch (0.4 mm) if the wire is also provided with a braid not less than 1/64 inch thick.

14.5 Type AF and Type CF wire shall not be used for internal wiring.

14.6 Rubber-insulated wire employed for internal wiring shall be provided with a braid, and the wall thickness of the insulation shall not be less than 1/32 inch (0.8 mm).

Exception: A braid need not be provided for appliance-wiring material having heat-resistant rubber insulation, of other than a silicone type, 3/64 inch (1.2 mm) or more thick.

Effective date for 14.6 changed from November 1, 1995 to November 11, 1996

14.7 Appliance-wiring material having cross-linked synthetic polymer, polytetrafluorethylene, or fluorinated ethylene propylene insulation 0.015 inch (0.38 mm) or more thick is acceptable for internal wiring.

14.8 Insulating tubing employed in place of wire insulation shall be suitable for the application and shall have a wall thickness not less than 1/32 inch (0.8 mm).

14.9 Wiring shall be protected from sharp edges, including screw threads, burrs, moving parts, and other agencies that may abrade the insulation on a conductor. See 55.3 and 55.4.

14.10 A hole through which insulated wires pass in a sheet-metal wall within the overall enclosure of a tool shall be provided with a smooth, rounded bushing, or shall have a smooth, rounded surface upon which the wires may bear, to prevent abrasion of the insulation. See 55.3 and 55.4. If a flexible cord is used for external interconnection as mentioned in 14.1, the construction shall comply with the requirements in 12.2.1 – 12.2.6 and the Strain Relief Test, Section 54, unless the cord will be protected from stress and motion.

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

14.12 All splices and connections shall be mechanically secure and shall provide reliable electrical contact. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in a risk of fire or electric shock.

14.13 In a tool in which excessive vibration is likely to occur, the requirement in 14.12 necessitates the use of lock washers or other means to prevent wire-binding screws and nuts from becoming loosened.

14.14 An open-end spade lug is not acceptable unless additional means, such as upturned ends on the lug, bosses, shoulders, and the like, are provided to hold the lug in place should the wire-binding screw or nut become slightly loosened.

14.15 A wire-binding screw shall thread into metal.

14.16 A splice shall be provided with insulation equivalent to that on the wires involved if permanence of spacings between the splice and other metal parts may not be maintained.

14.17 The thickness of insulation on a splice shall be 1/32 inch (0.8 mm) or more. In determining whether splice insulation consisting of coated-fabric, thermoplastic, or other tubing is acceptable, consideration shall be given to such factors as its dielectric properties, heat- and moisture-resistant characteristics, and the like. Thermoplastic tape wrapped over a sharp edge is not acceptable. An insulated splicing device is acceptable within the limits of its voltage and temperature range.

14.18 Stranded internal wiring shall be connected at a wire-binding screw so that loose strands of wire will not reduce spacings below the values identified in Spacings, Section 22. This may be accomplished by use of pressure wire connectors, crimped eyelets, soldering all strands of the wire together, or equivalent means.

14.19 A quick connect, an eyelet, a wire connector, or other means that does not require positioning to prevent reduction of spacings below the minimum acceptable values shall be provided to make necessary electrical connections, such as to:

- a) Electrically connect a motor shipped detached from the tool;
- b) Reconnect a multiple-voltage motor for a different voltage;
- c) Reconnect a motor shipped detached from a tool, which can rotate in either direction, for rotation in the opposite direction; or
- d) Reposition a switch mounted integrally with a motor shipped detached from a tool to comply with the requirement in 31.5.

14.20 Internal wiring shall not be disturbed in mounting a motor shipped detached from the tool.

14.21 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method acceptable for the combination of metals involved at the connection point.

14.22 With reference to 14.21, a wire binding screw or a pressure wire connector used as a terminating device shall be acceptable for use with aluminum under the conditions involved – for example, temperature, heat cycling, vibration, and the like.

14.23 A tool which employs a splicing device (wire nut) of the thread-on or setscrew type (other than in terminal blocks) shall be additionally secured by wrapping the wires and the connector with friction tape or by other equivalent means. Thread-on devices shall not be used to connect a ground lead.

Exception No. 1: This requirement does not apply to double-insulated tools.

Exception No. 2: Tape need not be additionally applied to machine-applied wire nuts, or to wire nuts located in a confined area where the wire nut is not capable of backing off.

Added 14.23 effective August 5, 1999

15 Interconnecting Cords

15.1 Other than as mentioned in 15.4, a motor intended to be installed in the field shall be provided with a length of flexible cord and an attachment plug for connection to a supply receptacle installed as a part of the tool.

15.2 Flexible cord as mentioned in 15.1 shall be one of the types specified in 12.1.4; however, Type SP or SPT cord shall not be used if it will be subjected to extreme flexing, such as the cord supplying the motor of a radial-arm saw. For a grounded tool, the flexible cord shall include an equipment-grounding conductor, and this conductor shall be bonded to all dead metal enclosures of electrical parts of a motor assembly and shall connect through the receptacle to the grounding system of the tool.

15.3 Other than mentioned in this paragraph, the length of flexible cord shall not be excessive and the cord shall be routed directly from the motor to the receptacle. Routing hardware may be provided if a longer length is required and it becomes necessary to secure the cord to prevent possible damage in using or moving the tool.

15.4 A motor shipped detached from a tool may be provided with a 6 – 10-foot (1.83 – 3.05-m) cord terminating in an attachment plug for connection to the power supply if, when the motor is installed in accordance with the manufacturer's instructions, the tool complies with the requirements in this standard.

16 Insulating Material

16.1 Material for mounting an uninsulated live part shall be phenolic composition, cold-molded composition, or other material that has been investigated and found acceptable for the application.

16.2 Vulcanized fiber may be used for an insulating bushing, a washer, a separator, a brush-holder liner, and a barrier, but not as the sole support for an uninsulated live part where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock. Thermoplastic material may be employed for the sole support of an uninsulated live part only if it has been investigated and found to have mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric strength, resistance to arc tracking, and other properties needed for the application.

16.3 A molded part shall be constructed so that it will have the mechanical strength and rigidity needed to withstand stresses of normal use. A brush cap shall be protected, by recessing or other means, from mechanical damage that may occur during normal use unless it has the strength necessary to withstand the abuses to which it is likely to be subjected.

17 Motors

17.1 The motor of a tool shall drive the maximum normal load of the tool without introducing a risk of fire, electric shock, or injury to persons.

17.2 A motor winding shall resist the absorption of moisture, and shall be formed and assembled in a workmanlike manner.

17.3 A brush-holder assembly shall be constructed so that when a brush is worn out – no longer capable of performing its function – the brush, spring and other parts of the assembly will be retained to the degree necessary to prevent:

- a) An accessible dead metal part from becoming energized; and
- b) A live part from becoming accessible.

17.4 A motor that is shipped detached from a tool and intended for installation in the tool by the user shall be investigated with the tool.

18 Switches and Controls

18.1 A switch or other control device shall have a voltage rating and an ampacity not less than the corresponding values of the load that it controls.

18.2 A motor controller – a switch or other device for starting and stopping the motor – shall be provided on a tool. The motor controller may be on a motor shipped detached from a tool.

Exception: A motor controller need not be provided on a permanently connected tool if all three of the following conditions are met:

- a) The instruction manual specifies the correct motor controller for use with a particular motor, and the motor controller is available from the manufacturer;*
- b) The instruction manual contains instructions for mounting the motor controller in accordance with 31.3 – 31.6; and*
- c) The motor controller is provided with a locking means that complies with the requirements in 31.7 and 31.8.*

Effective date for 18.2 changed from November 1, 1995 to November 11, 1996

18.3 A single-pole switch employed in a tool having a nominal rating of 125 volts or less shall be connected in the conductor not intended to be grounded. A double-pole switch shall be employed in a tool having a nominal rating more than 125 volts.

Exception: A single-pole switch may be employed in a tool having a nominal rating more than 125 volts if it switches the control circuit of a motor controller. The motor controller shall open all ungrounded supply conductors.

18.4 A tool shall not employ a through-cord switch.

18.5 A trigger provided on a miter saw to manually actuate the lower blade guard so as to prevent interference with the cutting operation shall be such that the manual release of the trigger automatically returns the lower blade guard to its original position.

19 Lampholders

19.1 If a tool is intended to be connected to the grounded conductor of a supply circuit, a lampholder of the tool shall be wired so that the screw shell will be connected to that conductor.

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19.2 An Edison-base lampholder employed in a tool having a nominal rating more than 125 volts shall be connected on the load side of the on-off switch of the tool.

19.3 An Edison-base lampholder employed in a double-insulated tool shall be connected such that the screw shell is connected to the neutral side of the line.

20 Overcurrent-Protective Devices

20.1 An overcurrent- or thermal-protective device shall be suitable for the application, considering the rating of the branch circuit to which the tool will be properly connected.

20.2 A thermal- or overcurrent-protective device shall not open during normal use of the tool.

20.3 If the handle of a circuit breaker is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the on position.

Effective date for 20.3 changed from November 1, 1995 to November 11, 1996

21 Capacitors

21.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across the line – such as a capacitor for radio-interference elimination or power-factor correction – shall be housed within an enclosure or container that will protect the plates against mechanical damage, and that will prevent the emission of flame or molten material resulting from breakdown of the capacitor. The construction shall comply with one of the following:

- a) The capacitor container or enclosure shall be of sheet steel not less than 0.02 inch (0.51 mm) thick or shall be constructed to afford equivalent protection;
- b) A capacitor having a sheet-steel container or enclosure thinner than 0.02 inch or of other suitable material shall be mounted in an enclosure that houses other parts of the appliance and that is acceptable for the enclosure of live parts;
- c) The individual container or enclosure of an electrolytic capacitor with means for venting shall be such as to provide protection against mechanical damage only, and no minimum enclosure thickness is specified; or
- d) The individual container or enclosure of an electrolytic capacitor not provided with means for venting and with an opening more than 1/16 inch (1.6 mm) wide between the capacitor enclosure and the motor shall comply with the requirements in 58.1, and no minimum enclosure thickness is specified.

22 Spacings

22.1 The following spacing shall not be less than the minimum acceptable value specified in Table 22.1 (see 11.3.1):

- a) Between field-wiring terminals of opposite polarity; and
- b) Between a field-wiring terminal and a dead metal part or an uninsulated live part not always of the same polarity.

Exception: Spacings complying with 22.3 need not comply with this requirement.

Table 22.1
Minimum acceptable spacings at field-wiring terminals

Potential involved, volts	Minimum spacing, Inch (mm) ^a					
	Between field-wiring terminals of opposite polarity, through air or over surface			Between a field-wiring terminal and a dead metal part or an uninsulated live part not always of the same polarity		
				Over surface		Through air
250 or less	1/4	(6.4)		1/4	(6.4)	1/4 (6.4)
More than 250	1/2	(12.7)		1/2	(12.7)	3/8 (9.5)

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

22.2 At other than field-wiring terminals, the following spacings shall not be less than the minimum acceptable value specified in Table 22.2:

- a) Between uninsulated parts of opposite polarity; and
- b) Between an uninsulated live part and a dead metal part.

If an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that the spacing will not be reduced below the minimum acceptable value. See 22.6 and Figure 22.1.

Exception: Spacings complying with 22.3 need not comply with this requirement.

Table 22.2
Minimum acceptable spacings at other than field-wiring terminals

Potential involved, volts	Minimum spacing, Inch (mm)							
	Tool employing a motor having a diameter of 7 inches (178 mm) or less ^a				Tool employing a motor having a diameter more than 7 inches (178 mm) through 11 inches (279 mm) ^a			
					Over surface		Through air	
0 – 125	3/32	(2.4)	3/32	(2.4)	1/4	(6.4) ^b	1/8	(3.2) ^b
126 – 250	3/32	(2.4)	3/32	(2.4)	1/4	(6.4) ^b	1/4	(6.4) ^b
251 – 600	1/2	(12.7) ^b	3/8	(9.5) ^b	1/2	(12.7) ^b	3/8	(9.5) ^b

^a This is the diameter, measured in the plane of a lamination, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and the like, used solely for motor mounting, cooling, assembly, or connection.

^b A spacing of not less than 3/32 inch (2.4 mm), over surface and through air, is acceptable between film-coated wire, rigidly supported and held in place on a coil, and dead metal parts.

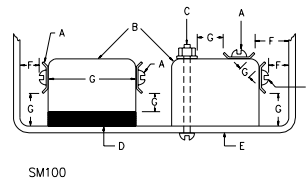
22.3 The minimum acceptable spacings specified in Tables 22.1 and 22.2 do not apply to the inherent spacings of a component of a tool, such as a snap switch; such spacings shall be judged on the basis of the requirements for the component. See Figure 22.1.

22.4 The spacings in a motor shall comply with the spacing requirements in the Standard for Electric Motors, UL 1004.

22.5 In applying Table 22.2 to a tool employing two or more motors of different sizes, the spacings shall be judged on the basis of the size of the largest motor in the tool.

Figure 22.1
Component spacings

Figure 22.1 revised June 30, 1998



- A. Uninsulated live parts of a component.
- B. Insulating material of a component.
- C. Mounting screw of a component.
- D. Dead metal part of a component.
- E. Dead metal part of the product.
- F. Spacings to which the requirements of this standard apply unless specifically noted otherwise.
- G. Spacings to which the requirements of the component standard apply.

22.6 At a terminal screw and a stud to which connection is made in the field by a wire connector, eyelet, and the like, as described in 11.3.1, and at support springs of brushes, the spacings shall not be less than the values specified in Table 22.2 when such a connector, eyelet, and the like, is in the position that results in minimum spacings between parts of opposite polarity and to dead metal.

22.6 revised March 7, 1997

22.7 An insulating liner or barrier of vulcanized fiber or similar material employed where a spacing would otherwise be less than the minimum acceptable value shall not be less than 1/32 inch (0.8 mm) thick, and shall be located or of such material so that it will not be adversely affected by arcing.

Exception: Vulcanized fiber equal to or greater than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

22.8 Film-coated wire is regarded as an uninsulated live part when spacings are being considered.

23 Grounding

23.1 The power-supply cord of a tool that is not double insulated shall include an equipment-grounding conductor. A tool operating at potentials of not more than 150 volts to ground may be provided with a system of double insulation complying with the requirements for Double-Insulated Tools, Sections 78 – 82, in lieu of grounding.

23.2 The grounding member of the attachment plug mentioned in 12.1.10(b) shall be fixed in position with respect to the plug.

23.3 With reference to the requirements in 12.1.10(c), the connection shall be made by a screw or other means not likely to be removed during any servicing not involving the power-supply cord. Solder alone shall not be used for making this connection.

23.4 The screw mentioned in 23.3 shall be of corrosion-resistant metal or shall be protected against corrosion. A lock washer or other means shall be employed to prevent the screw from being loosened by vibration. This screw shall have a slotted, hexagonal, green-colored head.

Exception: Screws that are clearly marked or are inaccessible need not have a slotted, hexagonal, green-colored head.

23.5 In a permanently connected tool, all exposed dead metal parts that may become energized, and all dead metal parts within the enclosure that are exposed to contact during any user servicing operation and that may become energized shall be conductively connected to:

- a) The point of the enclosure at which the supply circuit is intended to be connected; and
- b) The equipment-grounding field-wiring terminal or field-connection lead.

23.6 With reference to the requirements in 12.1.10 and 23.5, the following dead metal parts are not considered likely to become energized:

- a) A small metal part, such as an adhesive-attached foil marking, a screw, a handle, and the like, that is:
 - 1) On the exterior of the enclosure and separated from all electrical components by grounded metal; or
 - 2) Electrically isolated from all electrical components.
- b) A panel or a cover that is isolated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 1/32 inch (0.8 mm) thick and reliably secured in place.
- c) A panel or a cover that does not enclose an uninsulated live part and is electrically isolated from other electrical components.
- d) A core and an assembly screw of a relay, a solenoid, and the like.

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23.7 Unless the dead metal parts described in 12.1.10 and 23.5 are bonded together by mechanical fasteners, a individual bonding conductor or strap shall be used for this purpose.

23.8 The bonding conductor shall be silver, copper, copper alloy, or other metal that has been investigated and found to be acceptable for use as an electrical conductor, and shall be protected against corrosion unless inherently resistant thereto. An individual bonding conductor or strap shall be installed so that it is unlikely to be damaged.

23.9 Bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connection, brazing, or welding. A bonding connection shall reliably penetrate a nonconductive coating, such as paint. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material unless the construction has been shown to be acceptable by an investigation that includes tests, such as overload, short-circuit, and aging.

23.10 The size of an individual conductor or strap employed to bond an electrical enclosure or motor frame shall not be less than the applicable size indicated in Table 250-95 of the National Electrical Code, ANSI/NFPA 70-1996. The applicable size is to be determined by the rating of the branch-circuit overcurrent device to which the tool is intended to be connected.

Exception No. 1: A smaller conductor may be used provided it complies with the Bonding Overload Test, Section 59.

Exception No. 2: A bonding conductor to a motor need not be larger than the motor-circuit conductors.

23.10 revised June 30, 1998

23.11 If more than one rating of a branch-circuit overcurrent device is involved, the size of the bonding conductor shall be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor.

23.12 With reference to the requirement in 23.11, if a motor may be individually protected by a branch-circuit overcurrent device smaller than the overcurrent devices protecting the overall equipment, the size of a bonding conductor for that motor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the motor.

23.13 The grounding means of a resilient mount of a motor, including a series motor, shall comply with the requirements for those features in the Standard for Electric Motors, UL 1004.

PROTECTION AGAINST INJURY TO PERSONS

ALL TOOLS

24 General

24.1 Sections 24 – 44 contain requirements for tools covered by this standard the operation of which may involve a risk of injury to persons.

24.2 During examination of a tool with respect to a risk of injury to persons, the general requirements for materials, enclosure, guards, and the like, shall be applied, along with specific requirements for that tool. The requirements in Sections 25 – 44 apply to tools of common constructions; specific features of tools that are not contemplated herein will be considered. A specific requirement pertaining to a particular tool takes precedence over a corresponding requirement specified in the general section.

24.3 The material of an enclosure, a frame, a guard, or the like, breakage or deterioration of which may result in a risk of injury to persons, shall have such properties as to meet the demand of expected conditions of normal use.

25 Attachments and Accessories

25.1 Operation of a tool with an accessory or an attachment (see 1.2, 1.5, and 2.2) shall not result in a risk of injury to persons. See Sections 73 – 77 for specific requirements for accessories and attachments. The tool with the accessory or attachment installed shall comply with the applicable requirements in Sections 26 – 44.

Effective date for 25.1 changed from November 1, 1995 to November 11, 1996

26 Temperatures

26.1 When tested as described in 26.2, a temperature on a surface of a tool that may be contacted by the user, other than the cutting tool, shall not be more than the maximum acceptable value specified in Table 26.1.

Table 26.1
Maximum acceptable surface temperature

Location	Composition of surface			
	Metal		Nonmetallic	
	°C	°F	°C	°F
Handle, lever, or knob likely to be grasped	50	122	60	140
Accessible surface in a work area	60	140	85	185
Surface subject to casual contact	70	158	95	203

26.2 With reference to 26.1, surface temperatures of a bench grinder, a table saw, or a radial-arm saw are to be measured after 30 minutes of operation as described in Table 49.1, with the tool at room temperature at the beginning of the test. Surface temperatures of all other tools are to be measured during the normal temperature test. For all tools, if the test is conducted at a room temperature other than 25°C (77°F), the results are to be corrected to that temperature.

26.3 A lamp shall be provided with a shade or be recessed within the tool enclosure.

27 Rotating Members

27.1 A tool employing a user-removable rotating part, such as a blade or a grinding wheel, shall be constructed so that the direction of rotation tends to tighten the nut that secures the rotating part in place.

27.2 A removable rotating part not intended to be removed by the user shall be:

- Secured as described in 27.1; or
- Secured by a keyed nut, a jam nut, a nut locked in place with a pin, or other positive means.