

UL 1447

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Electric Lawn Mowers

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UL Standard for Safety for Electric Lawn Mowers, UL 1447

Fourth Edition, Dated May 31, 2006

Summary of Topics

This new edition of ANSI/UL 1447 includes editorial revisions consisting of wording clarifications, updated references, and renumbering of the standard.

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

Future Effective Dates	References
May 31, 2007	Paragraph 1.4

The requirements are substantially in accordance with UL's Proposal(s) on this subject dated November 11, 2005 and March 10, 2006.

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.

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://ulstandardsinfo.net/ulforeword.html>

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

Page	Date
1-106.....	May 31, 2006
SA1-SA18	May 31, 2006
A1-A2	May 31, 2006
SR1-SR2	May 31, 2006



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ANSI/UL 1447-2006

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UL 1447

Standard for Electric Lawn Mowers

First Edition – May, 1977
Second Edition – September, 1988
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Fourth Edition

May 31, 2006

The most recent designation of ANSI/UL 1447 as an American National Standard (ANSI) occurred on May 17, 2006.

This ANSI/UL Standard for Safety, which consists of the Fourth edition 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. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

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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PART 1 – ALL LAWN MOWERS

INTRODUCTION

1 Scope

1.1 These requirements cover cord-connected electrically operated lawn mowers rated 250 volts or less to be employed in accordance with the National Electrical Code, ANSI/NFPA 70. These requirements also cover battery-operated lawn mowers.

1.2 These requirements do not cover equipment for use in hazardous locations as defined in the National Electrical Code, ANSI/NFPA 70.

1.3 These requirements do not cover sulky-type lawn mowers, garden tractors or their attachments, flail mowers, sickle-bar mowers, or lawn mowers intended for commercial use.

1.4 In addition to the requirements in this standard, a lawn mower shall comply with the Safety Specification for Consumer Turf-Care Equipment – Walk-Behind Mowers and Ride-On Machines with Mowers, ANSI B71.1, and with the Safety Standard for Walk-Behind Power Lawn Mowers, 16 CFR 1205.

1.4 effective May 31, 2007

1.5 In the text, a requirement that applies only to a rotary or other type of lawn mower is identified by a specific reference in that requirement to the specific lawn mower involved. Absence of the specific reference, or use of the term lawn mower, indicates that the requirement applies to all of the lawn mowers covered in this standard.

2 Components

2.1 Except as indicated in this clause, a component of a product covered by this standard shall comply with the requirements for that component. See the Standards for Components appendix for a list of standards covering components generally used in the products covered by this standard.

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

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

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

2.4 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 Units of Measurement

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

4 Undated References

4.1 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.

5 Glossary

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

5.2 ACCESSIBLE PART – A part located so that it can be contacted by a person, either directly or by means of a probe or tool, or so that it is not recessed the required distance behind an opening. See Section 7, Accessibility of Live Parts.

5.3 BASIC INSULATION – The insulation applied to live parts to provide basic protection against electric shock.

5.4 BLADE – Any rigid or semi-rigid device or means that is intended to cut grass during mowing operations and includes all blades of a multi-blade mower.

5.5 BLADE-TIP CIRCLE – The path described by the outermost point of the blade as it moves about its axis.

5.6 CATCHER ASSEMBLY – A part or combination of parts on a lawn mower that provides a means of collecting grass clippings and debris.

5.7 CUTTING HEIGHT – The vertical distance between the blade-tip circle and the supporting surface of a lawn mower.

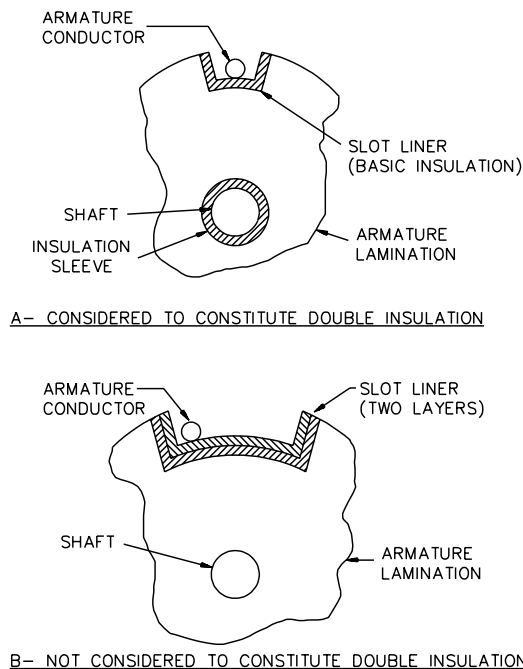
5.8 CUTTING WIDTH – For a single-blade mower, the diameter of the blade-tip circle. For a multi-blade mower, the width of a composite of all blade-tip circles measured perpendicular to the forward direction of the mower.

5.9 DEAD-MAN CONTROL – An operator control designed so that it will automatically interrupt power when the actuating force supplied by the operator is removed.

5.10 DEFORM – Any visible alteration of shape or dimension of a body caused by stresses induced by external forces.

5.11 DOUBLE INSULATION – An insulation system comprised of both basic insulation and supplementary insulation, with the two insulation systems physically separated and arranged so that they are not simultaneously subjected to the same deteriorating influences – temperature, contaminants, and the like – to the same degree. See Figure 5.1.

Figure 5.1
Examples illustrating 5.11



S0723A

5.12 ENCLOSURE – That portion of the lawn mower that:

- a) Renders inaccessible all or any part that may otherwise present a risk of electric shock or injury to persons; or
- b) Reduces the propagation of flame that may be initiated by electrical disturbances occurring within.

5.13 GUARD – A part or an assembly provided for shielding an area that would otherwise introduce a risk of electric shock or injury to persons.

5.14 LEAKAGE CURRENT – All current or currents, including capacitively-coupled currents, that may be conveyed between exposed conductive surfaces of a lawn mower and ground or other exposed conductive surfaces of the lawn mower.

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

5.16 MAXIMUM OPERATING SPEED – The maximum revolutions per minute (rpm) obtainable by the motor under the conditions of the particular test where the term is used. For a cord-connected mower, it is the speed attained when the mower is energized from a 120V, (or 240V if applicable), 60Hz supply source with any blade speed controls set at maximum. For a battery-powered mower it is the speed attained after the battery has been fully charged in accordance with the mower manufacturer's instructions.

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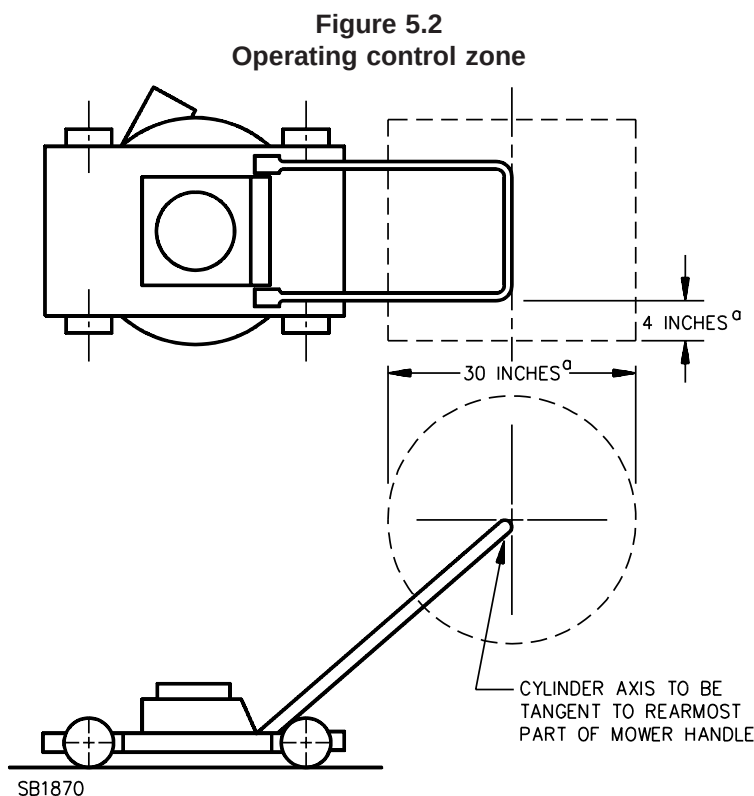
5.17 MINOR DIMENSION OF AN OPENING – The diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening with a force of 5 pounds (22.2 N).

5.18 MOTOR – A power-producing machine that converts electrical energy into mechanical energy.

5.19 NORMAL STARTING MEANS – The primary mechanism intended to be actuated by the operator to start a mower's motor.

5.20 OPERATING CONTROL ZONE – The space enclosed by a cylinder with a radius of 15 inches (380 mm) having a horizontal axis that is:

- a) Perpendicular to the fore-aft centerline of the mower; and
- b) Tangent to the rearmost part of the mower handle, extending 4 inches (102 mm) beyond the outermost portion of each side of the handle. See Figure 5.2.



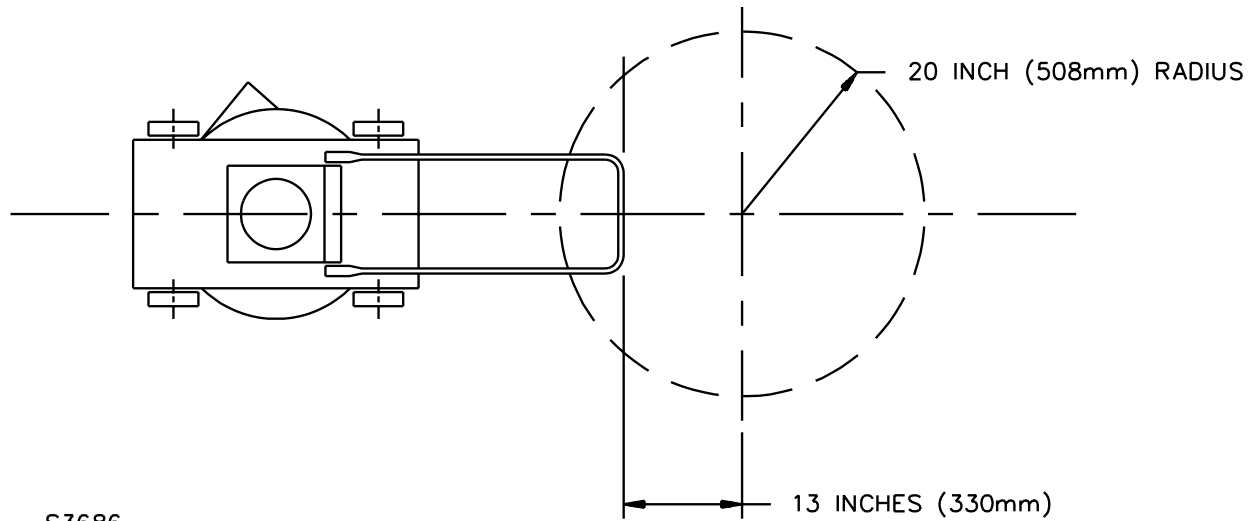
5.21 OPERATOR CONTROL – Any device necessary for operating a lawn mower including a drive-engaging control, a movable-guide control, a drive-speed changing control, and a deflector control.

5.22 OPERATOR ZONE – The space enclosed by a cylinder, from ground to 6 feet (1.63 m) above ground, with a radius of 20 inches (508 mm), having a vertical axis that is:

- a) Located 13 inches (330 mm) behind the handle assembly when adjusted to the most unfavorable position; and

b) Centered on the fore-aft centerline of the cutting width. See Figure 5.3.

Figure 5.3
Operator zone



S3686

5.23 REEL-TYPE MOWER – A lawn mower that cuts grass by rotating one or more helically formed blades about a horizontal axis to provide a shearing action with a stationary cutter bar or bed knife.

5.24 REINFORCED INSULATION – An improved basic insulation with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against electric shock as double insulation. It may consist of one or more layers of insulating material. It is acceptable in place of double insulation only in accordance with the Exception to 70.1.

5.25 ROTARY MOWER – A lawn mower in which one or more cutting blades rotate in essentially a horizontal plane about at least one vertical axis.

5.26 SUPPLEMENTARY INSULATION – An independent insulation provided in addition to the basic insulation to protect against electric shock in case of mechanical rupture or electrical breakdown of the basic insulation. An enclosure of insulating material may form a part or the whole of the supplementary insulation.

5.27 SWING-OVER HANDLE – A handle that pivots from one end of a lawn mower to the other about a horizontal axis to allow reversing the direction of travel of the lawn mower without turning the lawn mower around.

5.28 WALK-BEHIND LAWN MOWER – A grass-cutting machine that:

- a) Is either pushed or self-propelled;
- b) Has a minimum cutting width of 12 inches (305 mm);

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- c) Employs a motor as the power source; and
- d) Is controlled by an operator walking behind the mower.

CONSTRUCTION

6 Frame and Enclosure

6.1 General

6.1.1 The frame and enclosure of a lawn mower shall be formed and assembled so that it has the strength and rigidity necessary to resist the abuses to which is subjected, without introducing a 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 defects.

6.1.2 Among the factors taken into consideration when a frame or enclosure is investigated are its:

- a) Mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;
- d) Combustibility and resistance to ignition from electrical sources;
- e) Resistance to corrosion;
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use; and
- g) Dielectric properties, insulation resistance, and resistance to arc tracking.

6.1.3 Materials that are exposed to oil, acids, solvents, reagents, cleaning agents, or ozone as part of the use or application of the lawn mower shall not be adversely affected by these environments as determined by appropriate tests.

6.1.4 An edge, a projection, a corner, or the like of an enclosure, a frame, a guard, a handle, or the like shall be smooth and well-rounded, and not sufficiently sharp to constitute a risk of injury to persons in normal use and maintenance of a lawn mower.

6.1.5 If breakage or deformation of an enclosure, a frame, a guard, or the like, results in a risk of injury to persons, the material of the part shall have the properties required to meet the expected loading conditions without breakage or deformation.

6.1.6 With regard to the requirement in 6.1.5, a component of a lawn mower that is exposed to impact shall withstand the ball-impact test described in Section 28, Impact Test:

- a) Without cracking that affects the functional strength of the part;
- b) Without being affected to the extent that parts presenting a risk of electric shock or injury to persons would be exposed to unintentional contact; and
- c) Without affecting the intended mechanical performance of the lawn mower.

6.1.7 A catcher assembly constructed of a woven fabric shall comply with the requirements of 64.1 and 64.2.

6.2 Metallic enclosures

6.2.1 Cast and sheet-metal portions of the enclosure shall not be thinner than specified in Table 6.1 unless the enclosure is found to be acceptable when investigated under the considerations specified in 6.1.2.

Table 6.1
Minimum acceptable thickness of metal enclosure

Metal	Minimum thickness, inch (mm)			
	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, or the like		At relatively large unreinforced flat surfaces	
Die-cast metal	3/64	(1.2)	5/64	(2.0)
Cast malleable iron	1/16	(1.6)	3/32	(2.4)
Other cast metal	3/32	(2.4)	1/8	(3.2)
Uncoated sheet steel	0.026	(0.66)	0.026	(0.66)
Galvanized sheet steel	0.029	(0.74)	0.029	(0.74)
Nonferrous sheet metal	0.036	(0.91)	0.036	(0.91)

6.3 Polymeric enclosures

6.3.1 A polymeric enclosure shall be of a material complying with the tests specified in Section 44, Polymeric Materials Other Than HB, or of a material classified HB complying with the tests specified in Section 45, Polymeric Materials Classified HB.

6.3.2 The material used as the enclosure shall be suitable for use at the maximum temperature to which it is exposed in normal use. Material exposed to temperatures in excess of 80°C (176°F) shall be investigated with respect to aging.

6.4 Handles

6.4.1 Other than as noted in 6.4.3, the handles or surfaces most likely to be grasped by the user during the normal operation of a lawn mower shall be made of or covered with an insulating material that complies with the requirements in 6.4.4, 6.4.5, the Handle Durability Test of Section 34, the Dielectric Voltage-Withstand Test of Section 79, and the second entry in Table 79.1.

6.4.2 With reference to 6.4.1, examples of surfaces that are likely to be grasped by the user during normal operation include a lever, handle, or button for a switch or other operator control. Surfaces of a guard for a switch or other operator control are also included if located where likely to be grasped. Operator-handled controls, such as wheel adjustments, collector bag releases, and the like, that are remote from the handles of the lawn mower are not included.

6.4.3 The outer surfaces of a handle or other area likely to be grasped during normal operation may be of electrically conductive material if:

a) Insulation complying with the requirements in 79.1 and the second entry in Table 79.1 is interposed between the surfaces likely to be grasped and:

- 1) The cutting member; and
- 2) Any metallic guard for the cutting member; and

b) Surfaces likely to be grasped:

- 1) Are double-insulated from live parts; or
- 2) Do not enclose electrical components and are separated from all dead metal parts that enclose electrical components by insulation complying with the requirements in 79.1 and the second entry in Table 79.1.

6.4.4 The insulating material specified in 6.4.1 shall be of a type and thickness that make it acceptable as the sole insulation between a live part and a dead metal part. If it overlies and is in intimate contact with dead metal, the insulating material shall be at least 5/64 inch (2.0 mm) thick.

Exception: The thickness of the insulating material may be less than 5/64 inch if the material is found to be acceptable when judged under the considerations specified in 6.1.2.

6.4.5 An assembly screw in an area likely to be grasped that secures a covering of insulating material to a metal enclosure and threads into a metal enclosure containing electrical components or into a metal enclosure that contacts another metal enclosure containing live parts:

- a) Shall not be accessible to the probe illustrated in Figure 7.3 when inserted to a depth of 1 inch (25.4 mm); or
- b) Shall not be recessed less than 1/8 (3.2 mm) inch behind the outer surface of the insulating material if the opening will not admit a 3/8-inch (9.5-mm) diameter rod.

6.5 Protection against corrosion

6.5.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if the corrosion of such unprotected parts introduces a risk of fire, electric shock, or injury to persons.

Exception No. 1: In certain instances in which the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast-iron parts within an enclosure may not be required to be protected against corrosion.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like need not be protected against corrosion.

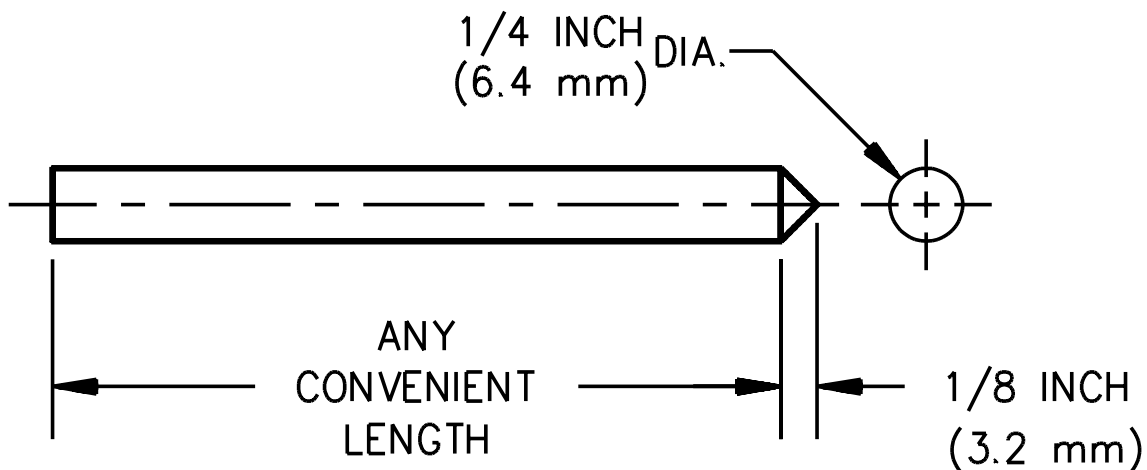
7 Accessibility of Live Parts

7.1 Electrical parts of a lawn mower shall be located or enclosed to reduce the likelihood of unintentional contact with uninsulated live parts. Insulated brush caps do not require additional enclosure.

7.2 An opening in the handle portion – the area likely to be handled during normal operation in guiding – of a lawn mower is acceptable if the probe of Figure 7.1, when inserted as far as possible into the opening:

- a) Does not enter the opening for a distance of more than 1/8 inch (3.2 mm); and
- b) Does not touch any uninsulated live part or film-coated wire.

Figure 7.1
Probe for hand-supported enclosure



PA190

7.3 With reference to the requirement in 7.1 and except as indicated in 7.2, an opening is capable of being used when:

- a) A probe as illustrated in Figure 7.2 cannot be made to touch any uninsulated live part or any film-coated wire when inserted through the opening in any possible direction using no appreciable force; and
- b) A probe as illustrated in Figure 7.3 cannot be made to touch any uninsulated live part when inserted through the opening in any possible direction using no appreciable force.

7.4 The opening illustrated in Figure 7.4 is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire:

- a) Less than X distance from the perimeter of the opening; and
- b) Within the volume generated by projecting the perimeter distance X normal to its plane.

X equals five times the diameter of the largest diameter rod that can be inserted through the opening, but not less than 4 inches (101 mm). In evaluating an opening, any barrier located within the volume usually is ignored unless it intersects the boundaries of the volume in a continuous, closed line.

Figure 7.2
IEC articulate probe

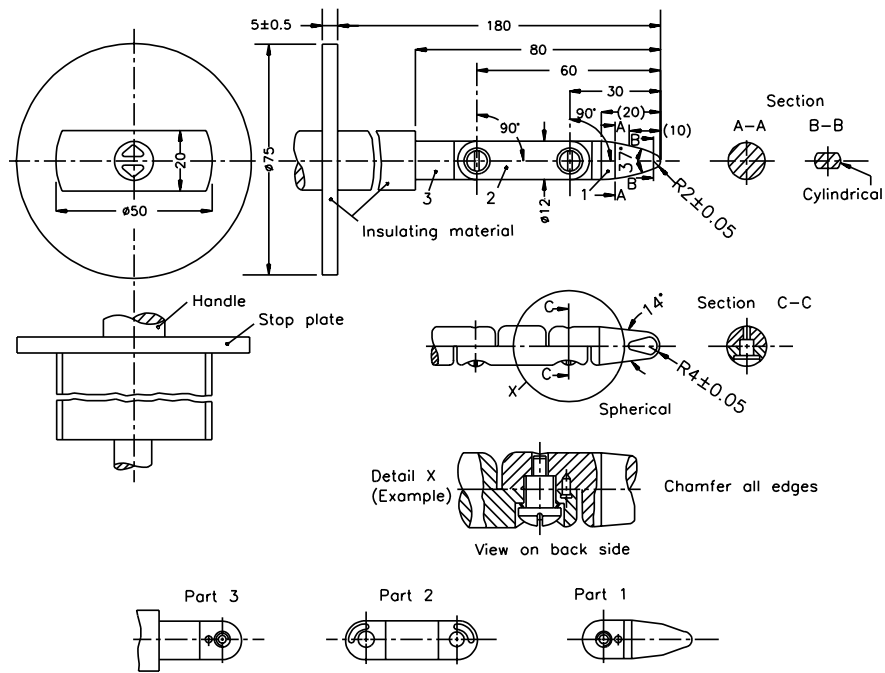
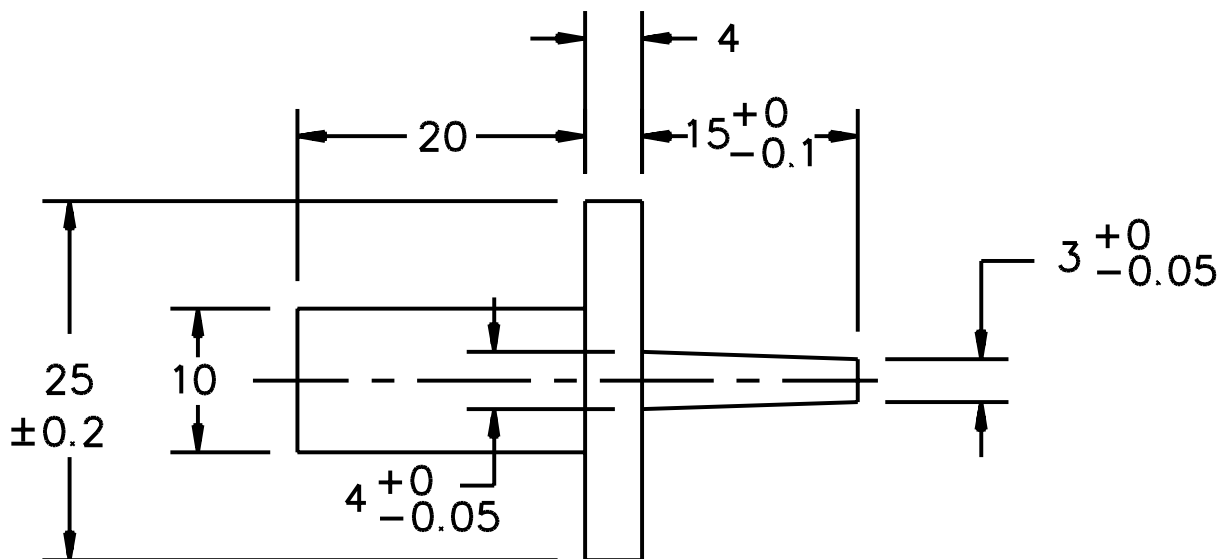


Figure 7.3
IEC test pin



S2962

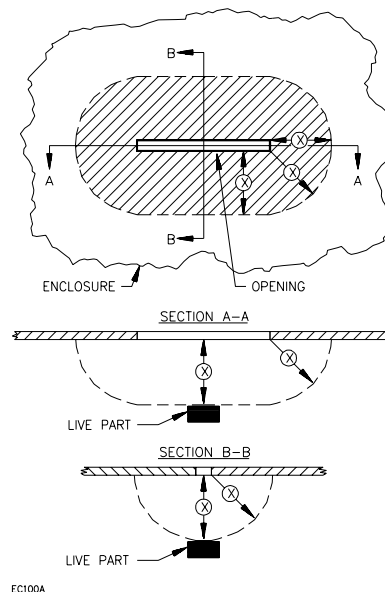
Dimensions in millimeters

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Figure 7.4
Opening in enclosure



Proportions exaggerated for clarity

7.5 During the examination of a lawn mower in connection with the requirements in 7.1, a part of the outer enclosure that may be removed without the use of tools by the user of the lawn mower, to permit the attachment of accessories, to allow access to means for making operating adjustments, or for another reason, is to be disregarded – that is, it will not be assumed that the part in question affords protection against shock unless marked in accordance with 53.4.

7.6 A latch or fastener that is intended to be opened by use of a coin or the like is considered as being able to be opened without the use of a tool.

7.7 An opening in a guard or enclosure around a moving part capable of causing injury, such as a cutting tool, a fan, a pulley, a gear, a chain, or the like, shall have a minor dimension less than 1 inch (25.4 mm).

Exception: This requirement does not apply to an opening for the cutting edges or discharge chute of a lawn mower.

7.8 The unobstructed distance from the opening to the moving part specified in 7.7 shall not be less than $8D$ minus 1.5 inches (38 mm), in which D is the minor dimension of the opening in inches (or millimeters). However, a fan is considered to be acceptably guarded if the blade cannot be contacted with the probe illustrated in Figure 7.2.

8 Accessibility of Moving Parts

8.1 Moving parts shall be guarded or enclosed to reduce the risk of injury to persons.

8.2 Among the factors to be considered when judging the acceptability of an exposed moving part are:

- a) Degree of exposure;
- b) Sharpness of the moving part;
- c) The likelihood of unintentional contact therewith;
- d) The speed of the moving part; and
- e) The likelihood that fingers, arms, or feet would be exposed to a risk of injury to persons by the moving part or that clothing would be caught by the part.

9 Mechanical Assembly

9.1 General

9.1.1 A lawn mower shall be assembled so that it is unlikely to create a risk of fire, electric shock, or injury to persons due to vibration during normal operation.

9.1.2 If various functional attachments are available for use with a lawn mower, each attachment shall be considered individually.

9.1.3 Some guards provided over moving parts are required to be self-restoring. Other features of guards that shall be considered include:

- a) Removability without the use of tools;
- b) Removability for servicing and likelihood of replacement;
- c) Strength and rigidity;
- d) Completeness; and
- e) Introduction of an additional risk of injury such as a pinch point and the necessity for additional handling because of a need for servicing, such as cleaning, unjamming, and the like.

9.1.4 The enclosure or guard of a rotating member and a discharge guide or deflector shall be complete and shall have such strength as to contain and deflect:

- a) Parts that because of breakage or other reasons become loose or separated from a rotating part; and
- b) Foreign objects that are struck and propelled by a rotating member.

9.1.5 If a guard must be moved in order to install a catcher assembly, it shall be hinged or otherwise affixed to a lawn mower so that it automatically assumes its intended position when the catcher assembly is removed.

Exception: The hinged guard is not required to be used when a safety interlock is incorporated and when the interlock is suitable for 10,000 cycles at normal load.

9.1.6 A switch, a lampholder, an attachment-plug receptacle, a plug connector, or other component that is handled by the user shall be mounted securely and shall be prevented from turning by means other than friction between surfaces.

Exception No. 1: The requirement that a switch be prevented from turning may be waived if all four of the following conditions are met:

- a) The switch is of a plunger, slide, 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 of mounting the switch makes it unlikely that operation of the switch will loosen the switch.*
- c) 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 the 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 prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.

9.1.7 With reference to the requirements in 9.1.6, a lock washer, properly applied, is acceptable as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

9.1.8 An adhesive that is used to secure a part which if dislodged would result in 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.

9.1.9 The requirement in 9.1.8 also applies to an adhesive used to secure a conductive part that when loosened or dislodged:

- a) Energizes an accessible dead metal part;
- b) Makes a live part accessible;
- c) Reduces spacings below the minimum acceptable values; or
- d) Short-circuits live parts.

9.1.10 A lawn mower shall be so constructed that user-maintenance can be accomplished without the likelihood of:

- a) Pinching leads;
- b) Reducing spacings to values less than those indicated in Table 21.1;
- c) Mislocating or damaging the means for accomplishing strain relief; and
- d) Mislocating or damaging a guard or other similar device.

9.1.11 User-maintenance is considered to consist of inspection of or replacement of motor brushes or fuses and other service that is recommended in the instruction manual to be performed by the user. It does not include maintenance that the instruction manual recommends be done by authorized service personnel.

9.1.12 Compliance with the requirements in 9.1.10 is to be accomplished by routing of wires, provision of wire channels, provision of locating wells for components, use of barriers, use of restraints, securing of components, and other means.

9.1.13 Routing as mentioned in 9.1.10 is acceptable if the construction is such that after the wire has been put into the intended position prior to reassembling the lawn mower so that the reassembly procedure will not result in the wire contacting a moving part or being pinched. This does not mean that the wire must be of such length or so clamped that it cannot reach the pinch point or the moving part.

9.1.14 A lawn mower employing a soft rubber, neoprene, or polyvinyl chloride pressure pad to hold down or maintain permanent position of an electrical part, such as a motor, to provide for intended functioning of the lawn mower shall be tested in accordance with 39.2. If the pressure pad is exposed to grease, it shall also be tested in accordance with 39.3.

Exception: The test is not required if a risk of fire or electric shock does not result from deterioration of the pad as determined by the test in 39.1.

9.2 Lawn mowers shipped partially disassembled

9.2.1 A lawn mower shall be completely assembled before shipped from the factory.

Exception: A lawn mower may be shipped from the factory partially disassembled to facilitate packaging if:

- a) All parts for assembly that are necessary for the operation of the lawn mower are provided in one carton;*
- b) Proper assembly can be readily accomplished without introducing a risk of fire, electric shock, or injury to persons;*
- c) Clear and detailed assembly instructions are provided;*
- d) Internal electrical connections that must be made in field are made by plug and receptacle connections only and do not require rearrangement of components or wiring; and*
- e) The lawn mower is marked in accordance with 53.8, if a required guard is shipped from the factory detached.*

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10 Handles

10.1 A lawn mower shall have a handle or handles that permit grasping the lawn mower with both hands.

10.2 The handle of a lawn mower shall be attached to the product so that the handle will not become unintentionally uncoupled during operation.

10.3 A positive stop or latch shall be provided for the handle in its intended operating position or positions. The stop or latch shall not be subject to unintentional disengagement during intended operation of the lawn mower and shall not allow the center of the handle grips to come closer than 17 inches (432 mm) horizontally behind the closest path of the mower blade or blades unless the blades are manually disengaged.

10.4 A swing-over handle shall comply with the requirements in 10.3 with the handle in either operating position.

11 Rotating Parts

11.1 A rotating part shall be formed and assembled so that it has the strength and rigidity necessary to reduce the risk of its release or loosening in a manner that may cause injury to persons.

11.2 Except as noted in 11.3, a user-removable rotating part, such as a blade, shall be assembled so that the direction of rotation tends to tighten the means used to hold the rotating part in place. Dynamic braking of the lawn mower shall not loosen a retaining means during tests conducted on the dynamic braking device.

11.3 A lawn mower employing a removable rotating part not intended to be removed by the user shall be secured as specified in 11.2 by a keyed nut, a jam nut, a nut locked in place with a pin, or other positive means.

11.4 The means of fastening the cutting members to the body of a multi-piece blade or disc shall be such that the fastening means will not become worn to a condition that introduces a risk of injury to persons before the cutting members are worn beyond any usefulness.

12 Supply Connections

12.1 Power-supply cord

12.1.1 A lawn mower shall be provided with a power-supply cord that cannot be damaged or impaired by any cutting edges, blades, belts, or rotating parts on the lawn mower.

Exception: A lawn mower may employ a motor attachment plug for connecting an extension cord.

12.1.2 A power-supply cord shall be 8 – 18 inches (200 – 460 mm) long.

12.2 Cord set

12.2.1 A lawn mower intended for use with a cord set shall not be provided with terminal pins that accommodate a standard appliance plug.

12.3 Flexible cord

12.3.1 A flexible power supply cord provided with a lawn mower shall be Type SW, SOW, STW, STOW, SJOW, SJTW, or SJTOW.

12.3.2 The flexible cord used in a cord set provided with, or made available for use with, a lawn mower shall be one of the types specified in 12.3.1.

12.3.3 A flexible cord shall be acceptable for use at a voltage not less than the rated voltage of the lawn mower, and shall have an ampacity not less than the current rating of the lawn mower.

12.4 Attachment plug

12.4.1 An attachment plug shall be rated for use at a current not less than the rated current, and at the rated voltage of the lawn mower. If the lawn mower is adaptable for use on two or more different values of voltage by field-alteration of internal connections, the attachment plug provided with the lawn mower shall be rated for the voltage for which the lawn mower is connected when shipped from the factory. See 50.3.

12.4.2 The attachment plug shall be of the polarized- or 3-prong grounding-type.

12.4.3 A 3- to 2-wire grounding adapter shall not be provided with a lawn mower.

12.4.4 An attachment plug may be of the locking type.

12.4.5 Means shall be provided to support the attachment plug of a lawn mower so that the cord connector of the extension cord will not touch the ground when the handle is in a normal operating position.

12.4.6 An attachment plug on a lawn mower supply cord shall be constructed so that, when inserted in an extension cord connector – cord connector body – the blades will not be energized until they are inaccessible to contact by persons. See Section 35, Attachment Plug Test.

12.5 Strain relief

12.5.1 Strain relief shall be provided so that a stress on a flexible cord is not transmitted to terminals, splices, or internal wiring in the lawn mower or in a fitting, such as an attachment plug, or an appliance plug.

12.5.2 A metal strain-relief clamp or band without auxiliary protection is acceptable with a power-supply cord, unless it is judged that the design of the clamp may damage the cord insulation.

12.5.3 Means shall be provided to prevent the supply cord from being pushed into the enclosure of a lawn mower through the cord-entry hole when such displacement results in:

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

To determine compliance, the supply cord shall be tested in accordance with Section 37, Push-Back Relief Test.

12.6 Bushings

12.6.1 The edges of the entry hole for the power-supply cord, including the cord-entry hole in a bushing, shall be smooth and free from burrs, fins, and sharp edges. Unless an insulating bushing of a material that has been found acceptable for the application is provided, the hole in the metal in which the bushing is mounted shall be smooth and free from burrs, fins, and sharp edges.

13 Live Parts

13.1 A current-carrying part shall be made of aluminum, silver, copper, a copper alloy, or other material acceptable for the purpose.

13.2 Plated iron or steel may be used for a current-carrying part:

- a) Within a motor or associated governor; or
- b) If permitted in accordance with 2.1.

Unplated or unpainted iron or steel is not acceptable. The foregoing restriction does not apply to stainless steel.

13.3 An uninsulated live part and its support shall be secured to the base or mounting surface so that it is prevented from turning or shifting in position if such motion results in a reduction of spacings below the minimum acceptable values.

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13.4 Friction between surfaces is not acceptable as the sole means to prevent the turning of a live part but a properly applied lock washer or a factory-assembled press-fit is acceptable for this purpose.

14 Internal Wiring

14.1 General

14.1.1 The wiring and connections between parts of a lawn mower shall be adequately protected or enclosed.

Exception: A suitable length of flexible cord may be employed for external connections if flexibility is essential. See 14.1.2 and 14.1.4.

14.1.2 A flexible cord used for external interconnection as specified in the Exception to 14.1.1 shall be one of the types of cord specified in 12.3.1 or the equivalent, and shall be provided with suitable bushings and strain relief in accordance with the requirements in 12.4.6 – 12.5.3 and Section 36, Strain Relief Test, unless the construction is such that the cord will be protected from stress and motion.

14.1.3 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of the lawn mower.

14.1.4 With reference to exposure of internal wiring through openings in the enclosure of a lawn mower, the protection of the wiring required in 14.1.1 is considered to exist if, when judged as if it were film-coated wire, the wiring would be acceptable in accordance with 7.2 and 7.3. No wiring is to be located where it can be contacted by the user.

14.1.5 Internal wiring shall not be located near a hole in the appliance where it can be damaged by a screw, nail, or other device intended to support the lawn mower.

14.1.6 Wiring inside a lawn mower that might otherwise be subjected to mechanical damage shall be in armored cable, conduit, or electrical metallic tubing or shall be otherwise protected.

14.1.7 Wiring shall be protected from sharp edges including screw threads, burrs, fins, moving parts, and other agencies that might cause abrasion of the insulation on conductors.

14.1.8 Insulated internal wiring shall be suitable for the particular application, when considered with respect to:

- a) The temperature and voltage to which the wiring is likely to be subjected;
- b) Exposure to oil, grease, or other substances likely to have a deleterious effect on the insulation;
- c) Exposure to moisture; and
- d) Other conditions of services to which it is subjected.

14.1.9 Thermoplastic-insulated wire and neoprene-insulated wire employed for internal wiring shall be standard building wire or suitable appliance wiring material, and shall comply with Table 14.1.

Table 14.1
Characteristics of internal wiring

Insulation	Nominal thickness of insulation, inch (mm)	Nominal thickness of braid or jacket, inch
Thermoplastic or neoprene rubber	1/32 or 0.030 (0.76)	Not required
	1/64 or 0.015 (0.38)	1/64 or 0.015
	1/32 or 0.030 (0.76)	1/64 or 0.015 ^a
^a For heat-resistant rubber, other than a silicone type, the insulation thickness shall not be less than 3/64 inch (0.018 mm) and no braid is required.		

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

14.1.11 Insulating tubing employed in place of wire insulation shall be suitable for the application as specified in 14.1.8 and shall have a nominal wall thickness of at least 1/32 inch (0.8 mm).

14.2 Splices and connections

14.2.1 All splices and connections shall be mechanically secure and shall provide adequate and reliable electrical continuity. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection results in a risk of fire or electric shock. Consideration shall be given to vibration and the like when judging the suitability of electrical connections.

14.2.2 An open-end spade lug is not acceptable unless additional means, such as upturned lugs or the like, is provided to hold the lug in place should the wire-binding screw or nut become loosened. An ordinary open-end spade lug with a lock washer is not acceptable.

14.2.3 A splice shall be adequately insulated if permanence of spacings between the splice and other metal parts is not ensured.

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

14.2.5 The means of connecting stranded internal wiring shall be such that loose strands of wire will be prevented from contacting live parts of opposite polarity and dead metal parts.

14.2.6 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 suitable for the combination of metals involved at the connection point.

14.2.7 A wire-binding screw, a pressure wire connector, or the like, used as the terminating device specified in 14.2.6 shall be suitable for use with aluminum under the conditions involved including such factors as temperature, heat cycling, and vibration.

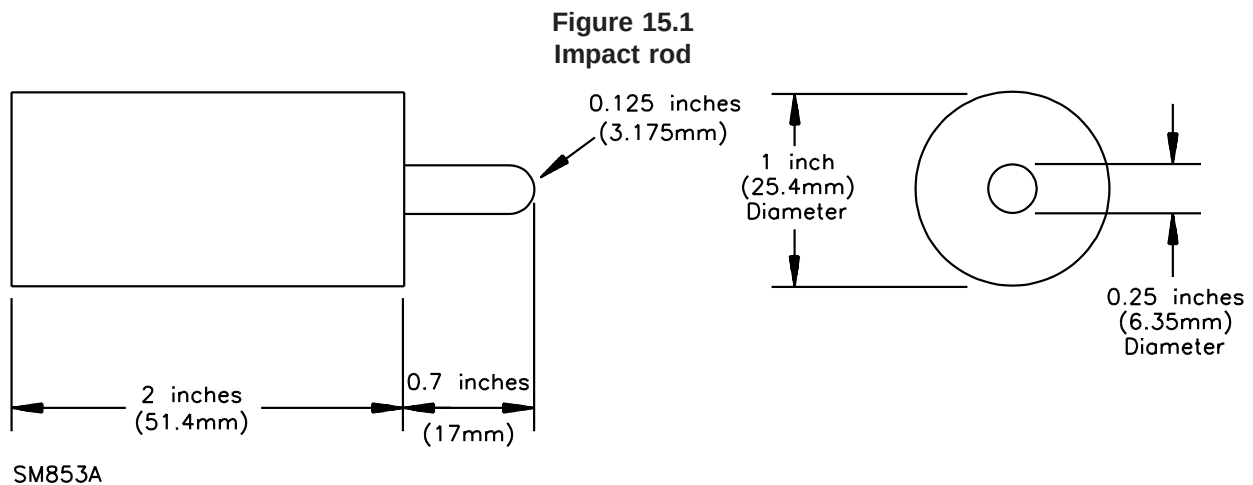
15 Electrical Insulation

15.1 Insulating washers, bushings, and the like, and bases or supports for the mounting of live parts shall be made of a moisture-resistant material such as glazed porcelain, phenolic, cold-molded composition, or other material suitable for the particular application, that will not be adversely affected by the temperatures to which they will be subjected under conditions of use.

15.2 Ordinary vulcanized fiber that is used for insulating bushings, washers, separators, and barriers, shall not be used as the sole support for uninsulated live parts if shrinkage, current leakage, or warpage introduces a risk of fire or electric shock. Thermoplastic materials may be employed if investigated and found to have physical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric strength, and other properties suitable for the application. All these properties shall be considered with respect to the effects of thermal aging.

15.3 A molded part shall have mechanical strength and rigidity to withstand stresses of normal service. A brush cap shall be protected by recessing or other means from mechanical damage that occurs during normal use, unless the cap has the strength necessary to withstand the abuses to which it is subjected.

15.4 A brush cap of a lawn mower is to withstand an impact of 1 foot-pound (1.36 J) without cracking, breaking, or exposing live parts. The impact is to be applied through the hardened steel rod shown in Figure 15.1 with a diameter of 1/4 inch (6.4 mm), held in contact with the brush cap by any convenient means.



16 Motors

16.1 A motor shall be acceptable for the particular application, and shall be capable of handling the maximum normal load of the lawn mower as described in 27.4 – 27.6 without introducing risks of fire, electric shock, or injury to persons.

16.2 A motor winding shall resist the absorption of moisture.

16.3 With reference to the requirement in 16.2, film-coated wire is not required to be additionally treated to prevent absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be impregnated or otherwise treated to resist moisture absorption.

16.4 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 shall 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 Switches and Controls

17.1 A switch or other control device shall be provided in a lawn mower to control the motor. The switch or other control device shall have a voltage and current rating not less than the corresponding values of the load that it controls.

17.2 A lawn mower shall not employ a through-cord switch.

17.3 A single-pole switch in a lawn mower employing a polarized attachment plug shall be connected in the conductor not intended to be grounded.

17.4 A device that automatically starts a lawn mower, such as a timer, an automatically-reset overload-protective device, or the like, shall not be employed unless it can be demonstrated that automatic starting does not result in a risk of injury to persons.

17.5 All operator controls shall be operable from the location assumed by an operator when operating the product. This is not intended to apply to a fixed adjustment, such as the adjustment of wheel-height on a lawn mower.

17.6 An electric lawn mower shall be provided with a momentary-contact switch or a dead-man control for disengaging the propelling drive and the blades so that the lawn mower cannot propel itself when it is unattended and so that the blades will not operate unless the operator actuates the control. No means for locking the switch in the "on" position shall be provided.

17.7 A switch shall be located or protected so that it is unlikely to be subjected to unintentional operation during intended use.

17.8 A switch shall be located or guarded so that a lawn mower cannot be energized by:

- a) Placing the lawn mower in any at-rest position against a flat or contoured surface that is encountered in use; or
- b) Actuating the switch by irregular surfaces across which the lawn mower is moved.

17.9 A switch shall operate by finger pressure with the lawn mower held in the intended manner.

18 Lampholders

18.1 A lampholder shall be designed or installed so that uninsulated live parts other than the lamp contacts are not exposed to contact by persons removing or replacing lamps in normal service.

18.2 The screw shell of a lampholder shall be connected to the conductor of the flexible cord intended to be grounded, whether or not it is actually grounded.

19 Capacitors

19.1 A capacitor provided as a part of a capacitor motor, and a capacitor connected across the line, such as a capacitor for radio-interference suppression, shall be housed within a suitable enclosure or container that protects the plates against mechanical damage and that reduces the risk of the emission of flame or molten material resulting from breakdown or malfunction of the capacitor. The enclosure shall be made of metal providing strength and protection not less than that of sheet steel having a thickness of 0.020 inch (0.51 mm).

Exception No. 1: The enclosure of a capacitor may be made of sheet steel having a lesser thickness or of a material other than metal if the capacitor is mounted in an enclosure that:

- a) Houses other parts of the lawn mower; and*
- b) Is acceptable for the enclosure of live parts.*

Exception No. 2: The individual enclosure of an electrolytic capacitor with means for venting shall provide protection against mechanical damage only, and the requirement for minimum enclosure thickness does not apply. The individual enclosure of an electrolytic capacitor not provided with means for venting and with an opening (gap) more than 1/16 inch (1.6 mm) wide need not comply with the requirement for enclosure thickness if it complies with the test requirements specified in Section 41, Capacitor Test.

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

20 Printed-Wiring Boards

20.1 A printed-wiring board included as part of the circuitry of a lawn mower shall comply with requirements in the Standard for Printed-Wiring Boards, UL 796. The printed-wiring board shall have a flammability rating of V-1 or better as determined by an evaluation to the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: A printed-wiring board positioned inside an enclosure or compartment having a 5V rating in accordance with UL 94 is not prohibited from having a flame rating of HB.

21 Spacings

21.1 The spacing between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part that is exposed to contact by persons or that is grounded shall not be less than the value specified in Table 21.1 for alternating-current circuits. 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 minimum acceptable spacing will be maintained in all possible positions of the movable part.

Exception No. 1: Inherent spacings of a component of the lawn mower, such as a snap switch, are judged on the basis of the requirements for the component in question.

Exception No. 2: For a repulsion motor, a repulsion-induction motor, or a repulsion-start induction motor, the spacing requirements do not apply to the commutator, the brush assembly, or the jumpers that short-circuit the brushes. Any uninsulated conductor of the rotor circuit is regarded as a dead metal part with respect to the stator circuit, and the appropriate spacing is required between uninsulated stator and rotor conductors.

21.2 In applying Table 21.1 to a lawn mower incorporating two or more motors of different sizes, the spacings inside each motor shall be judged on the basis of the size of that motor, and the spacings elsewhere in the lawn mower shall be judged on the basis of the size of the largest motor in the lawn mower.

21.3 If an isolated dead metal part is interposed between or in close proximity to (a), (b), or (c), then the spacing between the isolated dead metal part and (a), (b), or (c) shall be at least 3/64 inch (1.2 mm):

- a) Live parts of opposite polarity; or
- b) A live part and an exposed dead metal part; or
- c) A live part and a dead metal part that may be grounded.

The sum of the spacing between the isolated dead metal part and each of the other two parts shall not be less than that specified in Table 21.1. See Figure 21.1.

Table 21.1
Minimum acceptable spacings

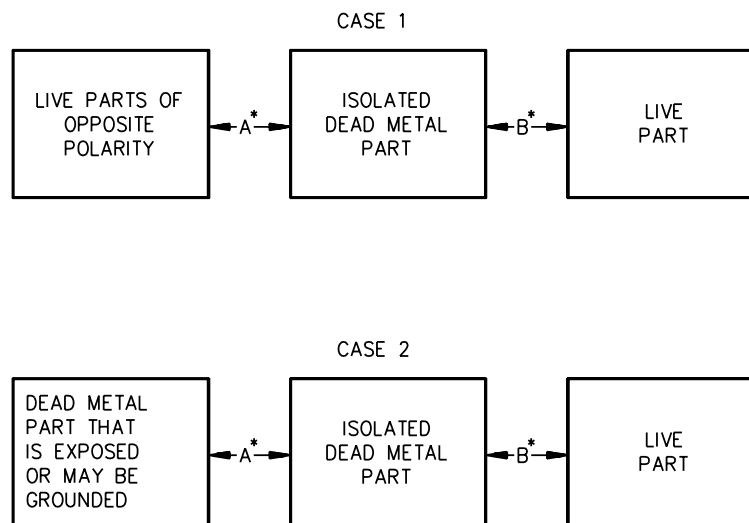
Potential involved volts	Parts involved	Minimum spacings, inch (mm)			
		Motor diameter ^a 7 inches (180 mm) or less		Motor diameter ^a more than 7 inches	
		Over surface	Through air	Over surface	Through air
0 – 125	Between commutator bars or collector rings of a motor and the motor shaft and laminations	3/32 (2.4)	3/32 (2.4)	3/16 ^b (4.8)	1/8 ^b (3.2)
	Elsewhere in the appliance	3/32 (2.4)	3/32 (2.4)	1/4 ^{b,c} (6.4)	1/8 ^{b,c} (3.2)
126 – 250	Between the commutator or collector rings of a motor	3/32 (2.4)	3/32 (2.4)	3/16 ^b (4.8)	3/16 ^b (4.8)
	Elsewhere in the appliance	3/32 (2.4)	3/32 (2.4)	1/4 ^{b,c} (6.4)	1/4 ^{b,c} (6.4)

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

^b Spacings not less than 3/32 inch are acceptable throughout a universal motor.

^c Film-coated wire is considered to be an uninsulated live part. However, a spacing not less than 3/32 inch (over surface and through air) between film-coated wire, that is rigidly supported and held in place on a coil, and a dead metal part is acceptable in a lawn mower.

Figure 21.1
Spacings for isolated dead metal parts



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*Spacing A and spacing B shall each be at least 3/64 inch (1.2 mm); and spacing A plus spacing B shall not be less than indicated in Table 21.1.

21.4 Primary-circuit spacings apply in all secondary circuits supplied by a transformer winding of 200 volt-amperes or a higher capacity – maximum available power – at a potential greater than 100 volts. The spacings in all other secondary circuits are to be judged on the basis of the dielectric voltage-withstand test described in 30.1.

21.5 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 be of such material so that it is not adversely affected by arcing.

Exception: Vulcanized fiber not less 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 minimum acceptable through-air spacing.

21.6 An insulating liner or barrier of a material other than that mentioned in 21.5 may be used if, upon investigation, the material is found to be acceptable for the particular application.

21.7 The spacings between an enclosure of polymeric material classified HB and:

- a) A nonarcing bare live part, such as a bus bar, a connecting strap, a terminal, or similar part, shall not be less than 1/32 inch (0.8 mm).
- b) An arcing part, such as a commutator, unenclosed switch contacts, and similar parts, shall not be less than 1/2 inch (12.7 mm) except as indicated in 45.7.1.

The spacing specified is to be measured from the source of the arc.

22 Grounding

22.1 The flexible cord of a lawn mower shall include an equipment-grounding conductor.

22.2 An equipment-grounding conductor of a flexible cord:

- a) Shall be green with or without one or more yellow stripes;
- b) Shall be connected to the grounding member of a suitable attachment plug of the grounding type; and
- c) Shall be conductively connected to:
 - 1) All exposed dead metal parts of the lawn mower; and
 - 2) All dead metal parts within the enclosure that are exposed to contact during any user servicing and that are likely to become energized.

The grounding conductor shall be connected by means of a screw or other reliable means not likely to be removed during any servicing operation not involving the power supply cord; solder alone shall not be used for securing this conductor.

22.3 The screw mentioned in 22.2(c) shall be of corrosion-resistant metal or shall be acceptably protected against corrosion. A lock washer or other suitable means shall be employed to prevent the screw from being loosened by vibration. This screw shall have a slotted, hexagonal, green-colored head.

22.4 With reference to the requirement in 22.2(c), 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 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 cover that does not enclose uninsulated live parts and is electrically isolated from other electrical components.
- d) Cores and assembly screws of relays, solenoids, and the like.

PERFORMANCE

23 General

23.1 The performance of a lawn mower shall be investigated by subjecting the requisite number of samples to all the applicable tests as described in Sections 24 – 41. Insofar as practicable, the tests shall be conducted in the order in which they are presented. Samples employed for leakage-current tests shall be tested for leakage prior to employing the samples for other tests.

24 Leakage Current Test

24.1 The leakage current of a lawn mower rated for a nominal 120-volt supply when tested in accordance with 24.2 – 24.6 shall not be more than 0.5 milliamperes.

24.2 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered suitable for protection against shock as defined in 7.1 – 7.6. Surfaces are considered to be simultaneously accessible if they can be contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are not considered to involve a risk of electric shock.

24.3 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 10 by 20 centimeters in contact with the surface. If the surface is less than 10 by 20 centimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the lawn mower.

24.4 The measurement circuit for leakage current is to be as illustrated in Figure 24.1. The measurement instrument is defined in (a) – (d). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

- a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.
- b) The meter is to indicate 1.11 times the average of the full-wave rectified composite wave form of voltage across the resistor or current through the resistor.
- c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response, ratio of indicated to actual value of current, that is equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 milliampere the measurement is to have an error of not more than 5 percent at 60 hertz.
- d) Unless the meter is being used to measure leakage from one part of an appliance to another, the meter is to be connected between the accessible parts and the grounded supply conductor.