



UL 551

Underwriters Laboratories Inc. Standard for Safety

Transformer-Type Arc-Welding Machines



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UL Standard for Safety for Transformer-Type Arc-Welding Machines, UL 551

Eighth Edition, Dated April 24, 2009

Summary of Topics

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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>.

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INTRODUCTION

1 Scope

1.1 These requirements cover limited duty welding and cutting power sources, wire feeders, torches, and electrode holders that are intended for use by a layperson in a nonindustrial setting in accordance with the National Electrical Code, NFPA 70. Products covered by these requirements include only those welding products rated 600 volts or less, and are commonly known as hobby welders.

1.1 effective July 15, 2009

1.2 These requirements do not cover motor-generator sets or rectifier- or resistance-type welding machines. These requirements do not cover industrial or professional use welders.

1.2 effective July 15, 2009

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- b) Is superseded by a requirement in this standard.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

5.1 In the following text, a requirement that applies only to a particular type of product is so identified by a specific reference in that requirement to the type or types of products involved. Absence of such specific reference or use of the term product indicates that the requirement applies to all types of products unless the context indicates otherwise.

CONSTRUCTION

6 General

6.1 An enclosure, an opening, a frame, a guard, a knob, a handle, or the like shall not be sufficiently sharp to cause a risk of injury to persons during normal maintenance or use.

Exception: A sharp edge that must be exposed to enable the product to perform its intended function.

6.2 A welding lead or electrode holder that is attached to a product shall be acceptable for the purpose.

7 Frame and Enclosure

7.1 A product shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may 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.

7.2 A product shall be provided with a case or cabinet that encloses all live parts.

Exception No. 1: A flexible supply cord or cable and welding leads need not be enclosed.

Exception No. 2: Ungrounded secondary output terminals for the connection of welding leads, tap jacks, or similar parts connected to the secondary circuit need not be enclosed if they are:

- a) Limited in voltage as specified in 27.1.1; and*
- b) Protected so as to reduce the risk of unintentional contact.*

7.3 The protection referred to in Exception No. 2 to 7.2 will usually be afforded if:

- a) Jacks are of the dead-front type,
- b) An uninsulated live part is recessed for a distance not less than half the minimum dimension of the opening behind which the live part is located,
- c) A hinged cover is provided over the terminals with smooth-edged slots or openings for the cable, or

d) In a product with a marked duty cycle more than 20 percent, an uninsulated live part, including the secondary terminals in the case of stud connections, is recessed beyond the plane of the opening.

7.4 An enclosure shall be made of cast metal, iron, steel, aluminum, copper, or brass.

Exception: Other material that has been investigated and found to be acceptable for the purpose may be used.

7.5 Among the factors to consider in determining the acceptability of an enclosure are its:

- a) Mechanical strength,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Combustibility,
- 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) Resistance to ignition from electrical sources.

For a nonmetallic enclosure, all of these factors are considered with respect to thermal aging.

7.6 The thickness of a cast-metal enclosure shall be as specified in Table 7.1.

Table 7.1
Thickness of cast-metal for enclosures

Dimensions of location of area involved	Minimum thickness, Inch (mm)	
	Cast metal other than die-cast	Die-cast metal
Area of 24 square inches (154.8 cm ²) or less and having no dimension greater than 6 inches (152.4 mm)	1/8 (3.2)	1/16 ^a (1.6)
Area greater than 24 square inches (154.8 cm ²) or having any dimension greater than 6 inches (152.4 mm)	1/8 (3.2)	3/32 (2.4)
At a threaded conduit hole	1/4 (6.4)	1/4 (6.4)
At an unthreaded conduit hole	1/8 (3.2)	1/8 (3.2)
^a The area limitation for metal 1/16 inch (1.6 mm) thick may be obtained by the provision of acceptable reinforcing ribs subdividing a larger area.		

7.7 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.053 inch (1.35 mm) if uncoated steel, not less than 0.056 inch (1.42 mm) if galvanized steel, and not less than 0.075 inch (1.91 mm) if nonferrous.

7.8 Other than as specified in 7.7, a sheet-metal enclosure shall not be thinner than specified in Table 7.2 or 7.3, as applicable.

Exception: The minimum thickness of a reinforced enclosure without supporting frame may be less than specified in Tables 7.2 and 7.3 but not less than 0.020 inch (0.51 mm) for uncoated steel, 0.023 inch (0.58 mm) for coated steel, brass, aluminum, or copper if when subjected to compression and torsion forces, its strength and rigidity are shown to be not less than the corresponding properties of an enclosure of the same maximum length and width having the required thickness of metal. See Compression and Torsion Tests, Section 38.

7.9 With reference to Tables 7.2 and 7.3, a supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface. The frame also has the necessary torsional rigidity to resist the bending moments that may be applied to the surface of the enclosure when it is deflected. A structure that is as rigid as one built with a frame of angles or channels is considered to have equivalent reinforcing.

7.10 Construction considered to be without supporting frame includes:

- a) A single sheet with single formed flanges – formed edges,
- b) A single sheet that is corrugated or ribbed,
- c) An enclosure surface loosely attached to a frame – for example, with spring clips, or
- d) An enclosure surface having an unsupported edge.

Table 7.2
Thickness of sheet metal for electrical enclosures, carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^b		Minimum thickness Inch (mm)	
Maximum width, ^c Inches (cm)	Maximum length, ^d Inches (cm)	Maximum width, ^c Inches (cm)	Maximum length, ^d Inches (cm)	Uncoated	Metal coated
4.0 (10.2)	Not limited	6.25 (15.9)	Not limited	0.020 ^e (0.51)	0.023 ^e (0.58)
4.75 (12.1)	5.75 (14.6)	6.75 (17.1)	8.25 (21.0)		
6.0 (15.2)	Not limited	9.5 (24.1)	Not limited	0.026 ^e (0.66)	0.029 ^e (0.74)
7.0 (17.8)	8.75 (22.2)	10.0 (25.4)	12.5 (31.8)		
8.0 (20.3)	Not limited	12.0 (30.5)	Not limited	0.032 (0.81)	0.034 (0.86)
9.0 (22.9)	11.5 (29.2)	13.0 (33.0)	16.0 (40.6)		
12.5 (31.8)	Not limited	19.5 (49.5)	Not limited	0.042 (1.07)	0.045 (1.14)
14.0 (35.6)	18.0 (45.7)	21.0 (53.3)	25.0 (63.5)		
18.0 (45.7)	Not limited	27.0 (68.6)	Not limited	0.053 (1.35)	0.056 (1.42)
20.0 (50.8)	25.0 (63.5)	29.0 (73.7)	36.0 (91.4)		
22.0 (55.9)	Not limited	33.0 (83.8)	Not limited	0.060 (1.52)	0.063 (1.60)
25.0 (63.5)	31.0 (78.7)	35.0 (88.9)	43.0 (109.2)		
25.0 (63.5)	Not limited	39.0 (99.1)	Not limited	0.067 (1.70)	0.070 (1.78)
29.0 (73.7)	36.0 (91.4)	41.0 (104.1)	51.0 (129.5)		

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Table 7.2 Continued on Next Page

Table 7.2 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^b		Minimum thickness Inch (mm)	
Maximum width, ^c Inches (cm)	Maximum length, ^d Inches (cm)	Maximum width, ^c Inches (cm)	Maximum length, ^d Inches (cm)	Uncoated	Metal coated
33.0 (83.8)	Not limited	51.0 (129.5)	Not limited	0.080 (2.03)	0.084 (2.13)
38.0 (96.5)	47.0 (119.4)	54.0 (137.2)	66.0 (167.6)		
42.0 (106.7)	Not limited	64.0 (162.6)	Not limited	0.093 (2.36)	0.097 (2.46)
47.0 (119.4)	59.0 (149.9)	68.0 (172.7)	84.0 (213.4)		
52.0 (132.1)	Not limited	80.0 (203.2)	Not limited	0.108 (2.74)	0.111 (2.82)
60.0 (152.4)	74.0 (188.0)	84.0 (213.4)	103.0 (261.6)		
63.0 (160.0)	Not limited	97.0 (246.4)	Not limited	0.123 (3.12)	0.126 (3.20)
73.0 (185.4)	90.0 (228.6)	103.0 (261.6)	127.0 (322.6)		

^a See 7.10.
^b See 7.9.
^c The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.
^d Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.
^e Sheet steel for an enclosure intended for outdoor use – rainproof – shall not be less than 0.034 inch (0.86 mm) thick if zinc coated and not less 0.032 inch (0.81 mm) thick if uncoated.

Table 7.3
Thickness of sheet metal for electrical enclosures, aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^b		Minimum thickness Inches (mm)
Maximum width ^c Inches (cm)	Maximum length ^d Inches (cm)	Maximum width ^c Inches (cm)	Maximum length ^d Inches (cm)	
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.5 (24.1)	0.023 ^e (0.58)
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)	0.029 (0.74)
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)	0.036 (0.91)
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)	0.045 (1.14)
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)	0.058 (1.47)
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	
20.0 (50.8)	25.0 (63.5)	45.0 (114.3)	55.0 (139.7)	0.075 (1.91)
25.0 (63.5)	Not limited	60.0 (152.4)	Not limited	
29.0 (73.7)	36.0 (91.4)	64.0 (162.6)	78.0 (198.1)	0.095 (2.41)
37.0 (94.0)	Not limited	87.0 (221.0)	Not limited	
42.0 (106.7)	53.0 (134.6)	93.0 (236.2)	114.0 (289.6)	0.122 (3.10)
52.0 (132.1)	Not limited	123.0 (312.4)	Not limited	
60.0 (152.4)	74.0 (188.0)	130.0 (330.2)	160.0 (406.4)	0.153 (3.89)

^a See 7.10.
^b See 7.9.
^c The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

Table 7.3 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^b		Minimum thickness Inches (mm)
Maximum width ^c Inches (cm)	Maximum length ^d Inches (cm)	Maximum width ^c Inches (cm)	Maximum length ^d Inches (cm)	
^d Not limited applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.				
^e Sheet copper, brass, or aluminum for an enclosure intended for outdoor use – rainproof – shall not be less than 0.029 inch thick.				

7.11 The bottom of a product shall be solid or shall be provided with screening or wire mesh.

7.12 The wires of a screen shall not be less than 16 AWG (1.3 mm²) for a screen having openings that are 1/2 square inch (3.2 cm²) or less in area, and shall not be less than 12 AWG (3.3 mm²) for a screen having larger openings.

7.12 revised June 23, 2011

7.13 Sheet steel employed for expanded-metal mesh and perforated sheet steel having mesh openings or perforations:

a) One-half square inch (3.2 cm²) or less in area shall not be less than 0.043 inch (1.1 mm) thick – 0.046 inch (1.2 mm) if zinc-coated; and

b) More than 1/2 square inch in area shall not be less than 0.081 inch (2.06 mm) thick – 0.084 inch (2.13 mm) if zinc-coated.

8 Accessibility of Live Parts

8.1 An opening in an enclosure through which an uninsulated live part of the primary circuit is accessible shall be of such size or shape that it will not permit passage of a rod having the diameter specified in Table 8.1.

Table 8.1
Test rods for openings

Distance from current-carrying part to opening, inches (mm)	Diameter of test rod that will not pass through opening
1.5 or less (38.1)	1/3 of distance from current-carrying part to opening
1.6 – 4 (40.6 – 101.6)	33/64 inch (13.1 mm)
4.1 – 6 (104.1 – 152.4)	49/64 inch (19.5 mm)
Over 6 (152.4)	49/64 ^a inch (19.5 mm)
^a No limit is specified for openings in the bottom wall of an enclosure that are not directly below a transformer or a reactor.	

9 Protection Against Corrosion

9.1 Iron and steel parts shall be protected against corrosion by painting, enameling, galvanizing, plating, or other equivalent means such as a plastic coating that has been investigated and found to be acceptable for the purpose.

Exception: Bearings and other parts where protection is impracticable.

10 Supply Connections

10.1 General

10.1.1 A product with a duty cycle rating:

- a) Of more than 20 percent shall be equipped with a power supply cord or provision for connection to a wiring system; and
- b) Of 20 percent shall be equipped with a power supply cord.

Exception: A product that does not have wheels, casters, or other means for mobility may have provision for connection to a wiring system in lieu of a power supply cord.

10.1.2 A product rated 125 volts, or 125/250 volts, 3 wire or less and employing:

- a) A lamp- or element-holder of the Edison-screw-shell type, or
- b) A single-pole circuit breaker or switch

shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The terminal or lead intended to be connected to a grounded conductor of the supply circuit shall be the one that is connected to the screw shells of lamp- or element-holders and to which are connected no single-pole switches other than an automatic control without a marked off position.

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

10.1.4 A lead intended to be connected to a grounded power-supply conductor shall be finished to show a white or gray color, and shall be readily distinguishable from the other leads.

10.1.4 revised June 23, 2011

10.2 Cords and plugs

10.2.1 A product that is intended for connection to the supply circuit by means of a flexible cord in accordance with 10.1.1 shall be provided with a flexible cord as specified in 10.2.2 or 10.2.3 that is not less than 6 feet (1.8 m) long and that is terminated in an attachment plug. The attachment plug shall be an armored plug, a solid molded-rubber plug, or the equivalent, that is acceptable for hard service.

Exception No. 1: For a product having ratings above 250 volts only, the flexible cord need not be terminated in an attachment plug if the markings described in 43.24, 44.2, and 44.3 are provided.

Exception No. 2: For a product having ratings above and below 250 volts, the flexible cord need not be terminated in an attachment plug if the product is wired for voltages above 250 volts when shipped, and the markings described in 43.24, 44.2, and 44.3 are provided.

10.2.2 A product having a primary input rating of 12 kVA or less shall be provided with Type S, SO, ST, STO, SJ, SJO, SJT, SJTO, or SPT-3 cord.

10.2.3 A product having a primary input rating of more than 12 kVA shall be provided with Type S, SO, ST, or STO cord.

10.2.4 The flexible cord shall be of a size and ampacity as specified in Table 10.1, with the ampacity determined by the following formula:

$$I_r \geq \sqrt{I_a^2 d + I_b^2 (1 - d)}$$

in which:

I_r is the ampacity of the cord;

I_a is the rated input current corresponding to the rated load output;

I_b is the input current with product idling – energized but with no output load; and

d is the rated duty cycle expressed as a fraction of total time.

Table 10.1
Ampacities of cords

Conductor size, AWG (mm ²)		Ampacity ^a
18	(0.82)	10
16	(1.3)	13
14	(2.1)	18
12	(3.3)	25
10	(5.3)	30
8	(8.4)	40
6	(13.3)	55
4	(21.2)	70
2	(33.6)	95

^a The ampacities are applicable only when 2 conductors are current carrying. A conductor used for equipment grounding and a neutral conductor are not considered to be current-carrying conductors.

10.2.5 The rating of an attachment plug terminating the supply cord shall not be less than the primary rating of the product.

Exception: For a product that is provided with a switch or circuit breaker that complies with the requirement in 22.2, the current rating of the plug may not be less than 75 percent of the primary current rating of the product. See 43.5.

10.3 Strain relief, bushings, and entrance holes

10.3.1 A hole, a knockout, or a fitting shall be provided in a product intended for connection to a permanent wiring system.

10.3.2 The diameter of a knockout and the width of the flat surface surrounding the knockout shall be as specified in Table 10.2.

Table 10.2
Diameter of knockout and width of surrounding flat surface

Size of supply conductor, AWG (mm ²)	Trade size of conduit, inches	Knockout diameter, inches (mm) ^a		Minimum width of flat surface surrounding knockout, inch (mm)	
14 – 8 (2.1 – 8.4)	1/2	0.875	(22.22)	0.133	(3.38)
6 (13.3)	3/4	1.109	(28.17)	0.156	(3.96)
4 – 2 (21.2 – 33.6)	1	1.375	(34.93)	0.198	(5.03)
1 – 0 (42.4)	1-1/4	1.734	(44.04)	0.274	(6.96)

^a A plus tolerance of 0.031 inch (0.79 mm) and a minus tolerance of 0.015 inch (0.38 mm) apply to the knockout diameter. The diameter is not to be measured at points where a tab may remain after removal of the knockout.

10.3.3 A product having a power-supply cord shall be provided with strain relief and bushings as described in 10.3.4 – 10.3.7.