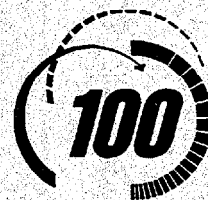


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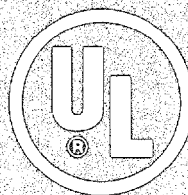
UL 551

ISBN 1-55989-503-9

Transformer-Type Arc-Welding Machines



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January 10, 1994

Standard for

Transformer-Type Arc-Welding Machines

UL 551, Seventh Edition

Accompanying this transmittal notice is a copy of the Seventh edition of UL 551.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

As indicated on the title page, 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 ANSI/UL 551-1993.

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

JANUARY 10, 1994



1

UL 551

Standard for

Transformer-Type Arc-Welding Machines

First Edition – September, 1937

Second Edition – October, 1952

Third Edition – April, 1972

Fourth Edition – July, 1977

Fifth Edition – May, 1981

Sixth Edition – January, 1987

Seventh Edition**January 10, 1994**

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated January 10, 1994. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

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

Approved as ANSI C33.2-1972, April 24, 1972

Approved as ANSI/UL 551-1977, January 25, 1977

Approved as ANSI/UL 551-1980, July 28, 1980

Approved as ANSI/UL 551-1986, September 19, 1986

Approved as ANSI/UL 551-1993, October 7, 1993

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

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(1 – 01/10/94 – 01/10/94)

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FOREWORD

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

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

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

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

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

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

INTRODUCTION

1 Scope

1.1 These requirements cover arc-welding machines of the transformer type rated 600 volts or less, to be used in accordance with the National Electrical Code, NFPA 70.

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

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the standard was developed, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this standard.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

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

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

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

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

3 Units of Measurement

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

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	Maximum length, ^d	Maximum width, ^c	Maximum length, ^d	Uncoated	Metal coated
Inches (cm)	Inches (cm)	Inches (cm)	Inches (cm)		
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)		
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.
^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 No. 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 No. 12 AWG (3.3 mm²) for a screen having larger openings.

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 natural gray color, and shall be readily distinguishable from the other leads.

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.