



UL 60974-1

STANDARD FOR SAFETY

Arc Welding Equipment; Part 1:
Welding Power Sources

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UL Standard for Safety for Arc Welding Equipment; Part 1: Welding Power Sources, UL 60974-1

First Edition, Dated March 17, 2005

Summary of Topics

Revision pages have been issued to delete the ANSI approval information from the title page.

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Standard for Arc Welding Equipment; Part 1: Welding Power Sources

First Edition

March 17, 2005

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Preface (UL)

This UL Standard is based on IEC Publication 60974-1: Second edition – Arc Welding Equipment; Part 1: Welding Power Sources, as revised by Amendment 1. IEC publication 60974-1 is copyrighted by the IEC.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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NATIONAL DIFFERENCES

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60974-1, Arc Welding Equipment; Part 1: Welding Power Sources copyright 1998 as amended in 2000, are indicated by notations (differences) and are presented in bold text.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are national differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ARC WELDING EQUIPMENT – Part 1: Welding power sources

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60974-1 has been prepared by IEC technical committee 26: Electric welding, and by ISO technical committee 44: Welding and allied processes.

This second edition cancels and replaces the first edition published in 1989 and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
26/153/FDIS	26/156/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This amendment has been prepared by IEC technical committee 26: Electric welding.

The text of this amendment is based on the following documents:

FDIS	Report on voting
26/181/FDIS	26/197/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2004. At this date, the publication will be:

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

Annexes C, E, I and J form an integral part of this standard.

Annexes A, B, D, F, G, H and K are for information only.

DV.1 DE Addition:

Words in SMALL ROMAN CAPITALS in the text are defined in clause 3.

DV.2 DE Addition:

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

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ARC WELDING EQUIPMENT – Part 1: Welding power sources

1 Scope

This part of IEC 60974 is applicable to power sources for arc welding and allied processes designed for INDUSTRIAL AND PROFESSIONAL USE, and supplied by a voltage not exceeding that specified in table 1 of IEC 60038, or driven by mechanical means.

This standard is not applicable to welding power sources for manual metal arc welding with limited duty operation which are designed mainly for use by laymen.

This part of IEC 60974 specifies safety requirements for construction and performance requirements of welding power sources and PLASMA CUTTING SYSTEMS.

NOTE 1 – Typical allied processes are electric arc cutting and arc spraying.

NOTE 2 – This standard does not include electromagnetic compatibility (EMC) requirements.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60974. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60974 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60038:1983,
IEC standard voltages

IEC 60050(151):1978,
International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices

IEC 60050(851):1991,
International Electrotechnical Vocabulary (IEV) – Chapter 851: Electric welding

IEC 60051-2:1984,
Direct acting indicating analogue electrical measuring instruments and their accessories – Part 2: Special requirements for ammeters and voltmeters

IEC 60068-2-63:1991,
Environmental testing – Part 2: Test methods – Test Eg: Impact, spring hammer

IEC 60085:1984,
Thermal evaluation and classification of electrical insulation

IEC 60112:1979,
Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions

IEC 60204-1:1992,
Electrical equipment of industrial machines – Part 1: General requirements

IEC 60309-1:1988,
Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements

IEC 60417:1973,
Graphical symbols for use on equipment. Index, survey and compilation of the single sheets

IEC 60445:1988,
Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system

IEC 60529:1989,
Degrees of protection provided by enclosures (IP Code)

IEC 60536:1976,
Classification of electrical and electronic equipment with regard to protection against electric shock

IEC 60664-1:1992,
Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests

IEC 60664-3:1992,
Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating to achieve insulation coordination of printed board assemblies

IEC 60905:1987,
Loading guide for dry-type power transformers

IEC 60974-7:1999,
Arc welding equipment – Part 7: Torches

IEC 60974-12:1992,
Arc welding equipment – Part 12: Coupling devices for welding cables

IEC 61558 (all parts),
Safety of power transformers, power supply units and similar

ISO 7000:1989,
Graphical symbols for use on equipments – Index and synopsis. Bilingual edition

2DV.1 D2 Modification of 2 by deleting the following text:

IEC 60085:1984,
Thermal evaluation and classification of electrical insulation

2DV.2 D2 Modification of 2 by adding the following text:

IEC 62114
Electrical Insulation Systems (EIS) – Thermal Classification

UL 62
Flexible Cord and Fixture Wire

UL 94

Test for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 486B

Wire Connectors for Use With Aluminum Conductors

UL 489

Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

UL 498

Attachment Plugs and Receptacles

UL 551

Transformer-Type Arc-Welding Machines

UL 558

Industrial Trucks, Internal Combustion Engine-Powered

UL 969

Marking and Labeling Systems

UL 1059

Terminal Blocks

UL 1248

Engine-Generator Assemblies for Use in Recreational Vehicles

UL 1659

Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords

UL 1682

Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type

UL 2200

Stationary Engine Generator Assemblies

3 Definitions

For the purpose of this part of IEC 60974, the following definitions apply, with those in IEC 60050(151), IEC 60050(851), IEC 60204-1 and IEC 60664-1:

3.1 **ARC WELDING POWER SOURCE:** Equipment for supplying current and voltage and having the required characteristics suitable for arc welding and allied processes.

NOTE 1 – An **ARC WELDING POWER SOURCE** may also supply services to other equipment and auxiliaries e.g. auxiliary power, cooling liquid, consumable arc welding electrode and gas to shield the arc and the welding area.

NOTE 2 – In the following text, the term "welding power source" is used.

3.2 **INDUSTRIAL AND PROFESSIONAL USE:** Use intended only for **EXPERTS OR INSTRUCTED PERSONS**.

3.3 EXPERT (COMPETENT PERSON, SKILLED PERSON): A person who can judge the work assigned and recognize possible hazards on the basis of professional training, knowledge, experience and knowledge of the relevant equipment.

NOTE – Several years of practice in the relevant technical field may be taken into consideration in assessment of professional training.

3.4 INSTRUCTED PERSON: A person informed about the tasks assigned and about the possible hazards involved in neglectful behaviour.

NOTE – If necessary, the person has undergone some training.

3.5 TYPE TEST: A test of one or more devices made to a given design to check if these devices comply with the requirements of the standard concerned [IEV 851-02-09].

3.6 ROUTINE TEST: A test made on each individual device during or after manufacture to check if it complies with the requirements of the standard concerned or the criteria specified [IEV 851-02-10].

3.7 GENERAL VISUAL INSPECTION: An inspection by eye to verify that there are no apparent discrepancies with respect to provisions of the standard concerned.

3.8 DROOPING CHARACTERISTIC: An external STATIC CHARACTERISTIC of a welding power source which, in its normal welding range, is such that, as the current increases, the voltage decreases by more than 7 V/100 A.

3.9 FLAT CHARACTERISTIC: An external STATIC CHARACTERISTIC of a welding power source which, in its normal welding range, is such that, as the current increases, the voltage either decreases by less than 7 V/100 A or increases by less than 10 V/100 A.

3.10 STATIC CHARACTERISTIC: The relationship between the LOAD VOLTAGE and the WELDING CURRENT of a welding power source in a CONVENTIONAL WELDING CONDITION.

3.11 WELDING CIRCUIT: A circuit that includes all conductive material through which the WELDING CURRENT is intended to flow.

NOTE 1 – In arc welding, the arc is a part of the WELDING CIRCUIT.

NOTE 2 – In certain arc welding processes, the welding arc may be established between two electrodes. In such a case, the workpiece is not necessarily a part of the WELDING CIRCUIT.

3.12 CONTROL CIRCUIT: A circuit for the operational control of a welding power source and/or for protection of the power circuits [IEC 60204-1:1992, 3.9 modified]

3.13 WELDING CURRENT: The current delivered by a welding power source during welding.

3.14 LOAD VOLTAGE: The voltage between the output terminals when the welding power source is delivering WELDING CURRENT.

3.15 NO-LOAD VOLTAGE: The voltage, exclusive of any arc striking or arc stabilizing voltage, between the output terminals of a welding power source when the external WELDING CIRCUIT is open.

3.16 CONVENTIONAL VALUE: A standardized value that is used as a measure of a parameter for the purposes of comparison, calibration, testing etc.

NOTE – CONVENTIONAL VALUES do not necessarily apply during the actual welding process.

3.17 CONVENTIONAL WELDING CONDITION: A condition of the welding power source in the energized and thermally stabilized state defined by a CONVENTIONAL WELDING CURRENT driven by the corresponding CONVENTIONAL LOAD VOLTAGE through a CONVENTIONAL LOAD at RATED SUPPLY VOLTAGE and frequency or speed of rotation.

3.18 CONVENTIONAL LOAD: A practically non-inductive constant resistive load having a power factor not less than 0,99.

3.19 CONVENTIONAL WELDING CURRENT (I_2): The current delivered by a welding power source to a CONVENTIONAL LOAD at the corresponding CONVENTIONAL LOAD VOLTAGE.

NOTE – The values of I_2 are given as r.m.s. values for a.c. and arithmetic mean values for d.c.

3.20 CONVENTIONAL LOAD VOLTAGE (U_2): The LOAD VOLTAGE of a welding power source having a specified linear relationship to the CONVENTIONAL WELDING CURRENT.

NOTE 1 – The values for U_2 are given as r.m.s. values for a.c. and arithmetic mean values for d.c.

NOTE 2 – The specified linear relationship varies in accordance with the process (see 11.2).

3.21 RATED VALUE: An assigned value, generally by the manufacturer, for a specified operating condition of a component, device or equipment.

3.22 RATING: The set of RATED VALUES and operating conditions.

3.23 RATED OUTPUT: The RATED VALUES of the output of a welding power source.

3.24 RATED MAXIMUM WELDING CURRENT (I_{2max}): The maximum value of the CONVENTIONAL WELDING CURRENT that can be obtained at the CONVENTIONAL WELDING CONDITION from a welding power source at its maximum setting.

3.25 RATED MINIMUM WELDING CURRENT (I_{2min}): The minimum value of the CONVENTIONAL WELDING CURRENT that can be obtained at the CONVENTIONAL WELDING CONDITION from a welding power source at its minimum setting.

3.26 RATED NO-LOAD VOLTAGE (U_0): The NO-LOAD VOLTAGE, measured in accordance with 11.1, at RATED SUPPLY VOLTAGE and frequency or RATED NO-LOAD SPEED of rotation.

NOTE – If a welding power source is fitted with a HAZARD REDUCING DEVICE, this is the voltage measured before the HAZARD REDUCING DEVICE has performed its function.

3.27 RATED REDUCED NO-LOAD VOLTAGE (U_r): The NO-LOAD VOLTAGE of a welding power source, fitted with a VOLTAGE REDUCING DEVICE, measured in accordance with 11.1 immediately after the device acts to effect a reduction in the voltage.

3.28 RATED SWITCHED NO-LOAD VOLTAGE (U_S): The d.c. NO-LOAD VOLTAGE of a welding power source, fitted with an A.C. TO D.C. SWITCHING DEVICE.

3.29 RATED SUPPLY VOLTAGE (U_1): The r.m.s. value of an input voltage for which the welding power source is designed.

3.30 RATED SUPPLY CURRENT (I_1): The r.m.s. value of an input current to the welding power source at a rated CONVENTIONAL WELDING CONDITION.

3.31 RATED NO-LOAD SUPPLY CURRENT (I_0): The input current to the welding power source at RATED NO-LOAD VOLTAGE.

3.32 RATED MAXIMUM SUPPLY CURRENT (I_{1max}): The maximum value of the RATED SUPPLY CURRENT.

3.33 MAXIMUM EFFECTIVE SUPPLY CURRENT (I_{1eff}): The maximum value of the effective input current, calculated from the RATED SUPPLY CURRENT (I_1), the corresponding DUTY CYCLE (DUTY FACTOR) (X) and the supply current at no-load (I_0) by the formula:

$$I_{1eff} = \sqrt{I_1^2 \times X + I_0^2 \times (1 - X)}$$

3.34 RATED LOAD SPEED (n): The speed of rotation of a rotating welding power source when operating at RATED MAXIMUM WELDING CURRENT.

3.35 RATED NO-LOAD SPEED (n_0): The speed of rotation of a rotating welding power source when the external WELDING CIRCUIT is open.

NOTE – If an engine is fitted with a device to reduce the speed when not welding, n_0 will be measured before the speed reduction device has operated.

3.36 RATED IDLE SPEED (n_i): The reduced no-load speed of an engine driven welding power source.

3.37 DUTY CYCLE; DUTY FACTOR (X): The ratio for a given time interval of the on-load duration to the total time.

NOTE 1 – This ratio, lying between 0 and 1, may be expressed as a percentage.

NOTE 2 – For the purpose of this standard, the time period of one complete cycle is 10 min. For example, in the case of a 60% duty cycle (duty factor), load is applied continuously for 6 min followed by a no-load period of 4 min.

3.38 CLEARANCE: The shortest distance in air between two conductive parts [IEC 60664-1:1992, 1.3.2].

3.39 CREEPAGE DISTANCE: The shortest distance along the surface of the insulating material between two conductive parts [IEV 151-03-37].

3.40 POLLUTION DEGREE: A numeral characterizing the expected pollution of the MICRO-ENVIRONMENT [IEC 60664-1:1992, 1.3.13].

NOTE – For the purpose of evaluating creepage distances and clearances, the following four POLLUTION DEGREES in the MICRO-ENVIRONMENT are established in 2.5.1 of IEC 60664-1.

a) POLLUTION DEGREE 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.

b) POLLUTION DEGREE 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.

c) POLLUTION DEGREE 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation is to be expected.

d) POLLUTION DEGREE 4: The pollution generates persistent conductivity caused by conductive dust or by rain or snow.

3.41 MICRO-ENVIRONMENT: The immediate environment of the insulation which particularly influences the dimensioning of the CREEPAGE DISTANCES [IEC 60664-1:1992, 1.3.12.2].

3.42 MATERIAL GROUP: Materials are separated into four groups by their comparative tracking index (CTI) values, as follows:

MATERIAL GROUP I	$600 \leq \text{CTI}$
MATERIAL GROUP II	$400 \leq \text{CTI} < 600$
MATERIAL GROUP IIIA	$175 \leq \text{CTI} < 400$
MATERIAL GROUP IIIB	$100 \leq \text{CTI} < 175$

The CTI values above refer to values in accordance with IEC 60112.

NOTE – For inorganic insulating materials, e.g. glass or ceramics, which do not track, creepage distances need not be greater than their associated clearance for the purpose of insulation co-ordination.

3.43 TEMPERATURE RISE: The difference between the temperature of a part of a welding power source and that of the ambient air.

3.44 THERMAL EQUILIBRIUM: The state reached when the observed TEMPERATURE RISE of any part of the welding power source does not exceed 2 K/h.

3.45 THERMAL PROTECTION: A system intended to ensure the protection of a part, and hence the whole, of a welding power source against excessive temperatures resulting from certain conditions of thermal overload.

It is capable of being reset (either manually or automatically) when the temperature falls to the reset value.

3.46 ENVIRONMENTS WITH INCREASED HAZARD OF ELECTRIC SHOCK: Environments where the hazard of electric shock by arc welding is increased in relation to normal arc welding conditions.

NOTE 1 – Such environments are found for example

a) in locations in which freedom of movement is restricted, so that the operator is forced to perform the welding in a cramped (e.g. kneeling, sitting, lying) position with physical contact with conductive parts;

b) in locations which are fully or partially limited by conductive elements, and in which there is a high risk or unavoidable or accidental contact by the operator;

c) in wet or damp or hot locations where humidity or perspiration considerably reduces the skin resistance of the human body and the insulating properties of accessories.

NOTE 2 – ENVIRONMENTS WITH INCREASED HAZARD OF ELECTRIC SHOCK are not meant to include places where electrically conductive parts in the near vicinity of the operator which can cause the increased hazard have been insulated.