

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Arc welding equipment –  
Part 9: Installation and use**

**Matériel de soudage à l'arc –  
Partie 9: Installation et utilisation**

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## ARC WELDING EQUIPMENT –

### Part 9: Installation and use

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International Standard IEC 60974-9 has been prepared by IEC technical committee 26: Electric welding.

This standard cancels and replaces IEC/TS 62081, published in 1999. This first edition constitutes a technical revision. The following major differences with respect to IEC/TS 62081:1999 are to be noted:

- 4.3.3 Welding cables: now dimensions are recommended.
- 5 Electromagnetic compatibility (EMC): this is completely new.
- 6 Electromagnetic fields (EMF) : this is completely new.
- 7.3 Inspection and maintenance of the welding installation: there is now a differentiation between periodical and routine inspection.

This bilingual version, published in 2010-03, corresponds to the English version.

The text of this part of IEC 60974 is based on the following documents:

FDIS	Report on voting
26/404/FDIS	26/405/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.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all the parts of the IEC 60974 series, under the general title *Arc welding equipment*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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# ARC WELDING EQUIPMENT –

## Part 9: Installation and use

### 1 Scope

This part of IEC 60974 is applicable to the installation and use of equipment for arc welding and allied processes designed in accordance with safety requirements of IEC 60974-1, IEC 60974-6 or equivalent.

This part of IEC 60974 is applicable for the guidance of instructors, operators, welders, managers, and supervisors in the safe installation and use of equipment for arc welding and allied processes and the safe performance of welding and cutting operations.

National and local regulations take precedence over this part of IEC 60974.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60245-6, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 6: Arc welding electrode cables*

IEC/TR 60755, *General requirements for residual current operated protective devices*

IEC 60974-1:2005, *Arc welding equipment – Part 1: Welding power sources*

IEC 60974-4, *Arc welding equipment – Part 4: In-service inspection and testing*

IEC 60974-6, *Arc welding equipment – Part 6: Limited duty manual metal arc welding power sources*

IEC 60974-10, *Arc welding equipment – Part 10: Electromagnetic compatibility (EMC) requirements*

IEC 60974-11, *Arc welding equipment – Part 11: Electrode holders*

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

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### welding circuit

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 arc may be established between two electrodes. In such a case, the workpiece is not necessarily a part of the welding circuit.

[IEC 60974-1:2005, 3.11]

### 3.2

#### **extraneous conductive part**

conductive part not forming part of the electrical installation and liable to introduce an electric potential, generally the earth potential

NOTE Electrical installation includes the welding circuit.

### 3.3

#### **workpiece**

metal piece or pieces on which welding or allied processes are performed

### 3.4

#### **protective clothing and accessories**

protective clothing and accessories (e.g. gloves, hand shields, head masks and filter lenses) used in order to diminish electric shock risks and the effects of fume and spatter and to protect the skin and eyes against arc radiation

### 3.5

#### **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 (for example 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 of unavoidable or accidental contact by the operator;
- c) in wet, 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 increased hazard have been insulated.

[IEC 60974-1:2005, 3.46]

### 3.6

#### **industrial and professional use**

use intended only for experts or instructed persons

[IEC 60974-1:2005, 3.2]

### 3.7

#### **expert**

#### **competent person**

#### **skilled person**

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.

[IEC 60974-1:2005, 3.3]

**3.8**  
**wire feeder**

equipment that delivers filler wire to the arc or weld zone which includes the wire-feed control and means to apply motion to the filler wire and may also include the filler wire supply

[IEC 60974-5:2007, 3.11]

**3.9**  
**auxiliary power output**

circuit of a welding power source designed to provide electrical power to auxiliary equipment

**4 Installation**

**4.1 General**

Welding equipment used in arc welding installations shall be intended for the purpose and shall be built in accordance with IEC 60974-1, IEC 60974-4, IEC 60974-6, IEC 60974-10, IEC 60974-11 and IEC 60974-12 (see Clause 2), as given on the rating plate.

Electromagnetic compatibility (EMC) requirements shall be taken into consideration during installation, see Clause 5.

The requirements of national and local regulations shall be taken into consideration during installation, including grounding or protective earth connections, fuses, supply disconnecting device, type of supply circuit, etc.

Read the manufacturers' instruction manual before installing the equipment. Full use shall be made of the technical information relevant to the welding equipment.

Specific advice may be obtained from the welding equipment manufacturer if necessary.

**4.2 Supply circuit**

**4.2.1 Selection of supply cables**

Supply cables for welding equipment and their overload protection, if not provided by the manufacturer, shall be selected in accordance with the information given in the manufacturers' instruction manual.

Supply cables shall be placed, so that they cannot be damaged in use. If that cannot be achieved, a sensitive residual current circuit breaker, capable of operating at a leakage current not exceeding 30 mA in accordance with IEC/TR 60755 shall be used to reduce the risk of electric shock.

**4.2.2 Supply disconnecting device**

The installer shall ensure that a supply disconnecting device is fitted at the point of supply.

NOTE A plug may be used as supply disconnecting device in accordance with national or local regulation.

**4.2.3 Emergency stopping device**

When an emergency stopping device is required by national regulation (e.g. automatic welding equipment), it shall conform to relevant IEC standard.

For welding in an environment with increased hazard of electric shock, see 7.10.

### 4.3 Welding circuit

#### 4.3.1 Isolation from the input supply

The welding circuit and circuits electrically connected to the welding circuit shall be electrically isolated from the mains supply.

Verification shall be carried out by an expert.

#### 4.3.2 Summation of no-load voltages

If more than one welding power source is in use at the same time, their no-load voltages can be cumulative and could create an increased hazard of electric shock. Welding power sources shall be installed so as to minimize this risk. Guidance is given in 7.9.

NOTE 1 In the case of two welding transformers connected to the same lines, the resulting output voltage may be the sum of both no-load voltages. This can be avoided by using a suitable input or output connection (see 7.9).

NOTE 2 Where more than one welding power source is installed, individual welding power sources with their separate controls and connections should be clearly identified to show which items belong to any one welding circuit.

#### 4.3.3 Welding cables

Welding cables shall comply with IEC 60245-6. Copper conductor welding cables shall be selected in accordance with duty cycle and national regulations or, when not existing, current rating given in Table 1. Where long cable runs are involved, it may be necessary to choose the cable size on the basis of voltage drop, see Annex B.

**Table 1 – Current ratings for copper welding cables**

Nominal cross-sectional area mm <sup>2</sup>	Current ratings for specified duty cycle at an ambient temperature of 25 °C <sup>a</sup>						
	100 %	85 %	80 %	60 %	35 %	20 %	8 %
	A	A	A	A	A	A	A
10	100	100	100	101	106	118	158
16	135	136	136	139	150	174	243
25	180	182	183	190	213	254	366
35	225	229	231	243	279	338	497
50	285	293	296	316	371	457	681
70	355	367	373	403	482	602	908
95	430	448	456	498	606	765	1 164
120	500	524	534	587	721	917	1 404
150	580	610	622	689	853	1 090	1 676
185	665	702	717	797	995	1 277	1 971

<sup>a</sup> For higher ambient temperatures, a correction factor shall be applied:  
0,96 (30 °C) ; 0,91 (35 °C) ; 0,87 (40 °C) ; 0,82 (45 °C).

#### 4.3.4 Connection between the welding power source and the workpiece

When the welding current does not flow entirely in the welding circuit, stray currents, which are components of the welding current, occur. These can cause damage and may be eliminated by the following means:

- a) the electrical connection between the welding power source and the workpieces shall be made as direct as practicable by means of an insulated return cable having an adequate current carrying capacity;
- b) extraneous conductive parts, such as metal rails, pipes and frames shall not be used as part of the welding circuit, unless they constitute the workpiece itself;
- c) the return clamp shall be as near as practicable to the welding arc;

NOTE 1 When the return clamp is removed, it should be electrically isolated from parts connected to earth, e.g. metallic enclosures with protective earth connection (class I), metal floors, building services.

- d) the welding circuit shall not be earthed unless required by national or local regulations (see 4.3.5);
- e) connection of the return cable to the workpiece shall be ensured by the use of devices having suitable means for cable connection, a fastening system not liable to come loose accidentally, and good electrical contact. Magnetic devices only present a good electrical contact if the contact surfaces of the magnetic device and the contact area of the workpiece are sufficiently large, even, conductive and clean (e.g. free from rust and primer) and if the contact area of the workpiece is magnetic;

NOTE 2 If workpieces are on a welding bench or a work-handling device, the return cable may be connected to the bench or device.

- f) connection devices for non-stationary flexible welding cables in the welding circuit shall:
  - 1) have an adequate covering of insulating material to prevent inadvertent contact with live parts, when connected, with the exception of the return clamp at the workpiece itself;
  - 2) be suitable for the sizes of cables used and the welding current;
  - 3) be effectively connected to the welding cables and in good electrical contact with them.

Both the welding cable and the connection device shall be used within their specified current rating. The connection device shall not be fitted with a cable smaller in diameter than specified by the manufacturer of the connection device.

When coupling devices are used, they shall comply with IEC 60974-12.

#### 4.3.5 Earthing of the workpiece

The welding circuit should not be earthed, since it can increase the risk of stray welding currents (see 4.3.3). Earthing of the welding circuit can also increase the area of metal through which a person in contact with the welding circuit (e.g. the welding electrode) could receive a shock.

NOTE 1 There are workpieces which have an inherent connection to earth, e.g. steel structures, ships, pipelines etc. When these are welded, the possibility of stray currents is increased.

NOTE 2 In some cases, the workpiece may be in permanent contact with earth, e.g. with protection class I equipment which itself has protective conductors connected to earth. Such a workpiece is considered to be inherently connected to earth.

An assessment of the welding circuit and the welding area shall be made to ensure that stray welding current will not flow through any object connected to earth and not intended or capable of carrying the welding current (e.g. protective earth connection).

If electrical hand-tools are used, which may come into contact with the workpiece, then those tools shall be class II equipment (i.e. with double or reinforced insulation without protective earth connection).

If earthing is required by national or local regulations, the earth connection shall be made by a separate dedicated cable or conductor with a rating of at least that of the return cable and connected directly to the workpiece.

Precautions shall be taken to insulate the operator from earth as well as from the workpiece (see 7.7.2).

NOTE 3 Where external radio frequency suppression networks are connected to the welding circuit, an expert should assess whether the welding circuit can still be regarded as insulated from earth.

NOTE 4 External radio frequency suppression networks could consist of a number of different components e.g. LCR filters (inductance/capacitance/resistance).

#### **4.3.6 Location of gas cylinders**

Care shall be taken to prevent gas cylinders in the vicinity of the workpiece becoming part of the welding circuit.

### **5 Electromagnetic compatibility (EMC)**

#### **5.1 General**

The user is responsible for installing and using the arc welding equipment in accordance with the manufacturer's instructions. If electromagnetic disturbances are detected, then it shall be the responsibility of the user of the arc welding equipment to resolve the situation with the technical assistance of the manufacturer.

#### **5.2 Assessment of area**

Before installing arc welding equipment, the user shall make an assessment of potential electromagnetic interferences in the surrounding area. The following shall be taken into account:

- a) other supply cables, control cables, signalling and telephone cables, above, below and adjacent to the arc welding equipment;
- b) radio and television transmitters and receivers;
- c) computer and other control equipment;
- d) safety critical equipment, for example guarding of industrial equipment;
- e) the health of the people around, for example the use of pacemakers and hearing aids;
- f) equipment used for calibration or measurement;
- g) the immunity of other equipment in the environment. The user shall ensure that other equipment being used in the environment is compatible. This may require additional protection measures;
- h) the time of day that welding or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

#### **5.3 Methods of reducing emissions**

##### **5.3.1 Public supply system**

The arc welding equipment shall be connected to the public supply system in accordance with the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the supply system. Consideration shall be given to shielding the supply cable of permanently installed arc welding equipment, in metallic conduit or equivalent. Shielding shall be electrically continuous throughout its length. The shielding shall be connected to the welding power source so that good electrical contact is maintained between the conduit and the welding power source enclosure.

### 5.3.2 Maintenance of arc welding equipment

The arc welding equipment shall be routinely maintained in accordance with IEC 60974-4 and the manufacturer's instructions. All access and service doors and covers shall be closed and properly fastened when the arc welding equipment is in operation. The arc welding equipment shall not be modified in any way, except for those changes and adjustments covered in the manufacturer's instructions. In particular, the spark gaps of arc striking and stabilising devices shall be adjusted and maintained in accordance with the manufacturer's instructions.

### 5.3.3 Welding cables

The welding cables shall be kept as short as possible and shall be positioned as close as possible to each other, running at or close to the floor level. The welding cables shall never be coiled.

### 5.3.4 Equipotential bonding

Bonding of all metallic objects in the surrounding area should be considered for the purpose of reducing emissions. However, metallic objects bonded to the workpiece will increase the risk that the operator could receive an electric shock by touching these metallic objects and the electrode at the same time. The operator shall be insulated from all such bonded metallic objects.

### 5.3.5 Earthing of the workpiece

Where the workpiece is not bonded to earth for electrical safety, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitance, selected in accordance with national and local regulations.

### 5.3.6 Screening and shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire welding area may be considered for special applications.

## 6 Electromagnetic fields (EMF)

Electric current flowing through any conductor causes localized electric and magnetic fields (EMF). All welders should use the following procedures in order to minimize the risk associated with exposure to EMF from the welding circuit:

- route the welding cables together – secure them with tape when possible;
- place your torso and head as far away as possible from the welding circuit;
- never coil welding cables around your body;
- do not place your body between welding cables. Keep both welding cables on the same side of your body;
- connect the return cable to the workpiece as close as possible to the area being welded;
- do not work next to, sit or lean on the welding power source;
- do not weld whilst carrying the welding power source or wire feeder.

EMF may also interfere with medical implants, e.g. pacemakers. Protective measures for persons with medical implants shall be taken. For example, access restrictions for passers-by



or individual risk-evaluations for welders. Risk assessment and recommendation for users of medical implants shall be made by a medical expert.

## 7 Use

### 7.1 General requirements

User shall ensure that arc welding equipment and accessories conform to the relevant parts of IEC 60974, see Clause 2, as given on the rating plate. Before welding equipment is put into service, the user shall read and understand the instructions provided by the manufacturer, national or local regulation, trade association and occupational recommendations, national health and safety recommendations.

Consideration shall be given to the environment in which the welding equipment is used as additional precautions may need to be taken e.g. increased hazard of electric shock; confined spaces; flammable area, asphyxiation (see Annex A).

### 7.2 Connection between several welding power sources

If welding power sources are to be connected in parallel or in series, this shall be carried out by an expert and in accordance with the manufacturers' recommendations. The equipment shall be approved for arc welding operations only after a check has been carried out to ensure that the permissible no-load voltage cannot be exceeded.

When one welding power source connected in parallel or series is taken out of service, that power source shall be disconnected from the mains supply and from the welding circuit, so as to prevent any hazards that might be caused by feed-back voltages.

### 7.3 Inspection and maintenance of the welding installation

#### 7.3.1 Periodical inspection

On installation, and periodically thereafter, an expert nominated for the task shall check that the welding equipment has been correctly selected and connected for the work to be carried out in accordance with IEC 60974-4 and the manufacturer's instructions and that all connections are clean and tight and the welding equipment is in good condition.

In addition, all protective earthing shall be checked for effectiveness. Any defects found shall be repaired.

#### 7.3.2 Routine inspection

The operator shall be instructed to check all external connections daily and each time a reconnection is made. Particular attention shall be paid to the installation of supply and welding cables, electrode holders and coupling devices. Any defects found shall be reported, and faulty equipment shall not be used until it has been repaired.

The return clamp shall be connected directly to the workpiece as close as practicable to the point of welding or to the welding bench on which the workpiece is situated or to the work-handling device.

For plasma cutting the no-load voltages are higher than with welding. This shall be considered during inspection and maintenance procedures. Particular attention shall be paid to the water cooling equipment to ensure that any leaks do not affect the insulation.