

Australian Standard[®]

Safety in welding and allied processes

Part 2: Electrical



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 - Australian Industry Group
 - Australian Manufacturing Workers Union
 - Electrical Regulatory Authorities Council
 - Welding Technology Institute of Australia
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Part 2: Electrical

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-019, Electrical Welding Plant, to supersede AS 1674.2—2003.

This Standard incorporates Amendment No. 1 (February 2011). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide a significant improvement in the safety of welding in hazardous environments, where, in recent years, there have been a number of deaths by electrocution.

The major changes from the 2003 edition of this Standard are as follows:

- (a) Clarifications have been made that control measures are required to remove water from category C environments.
- (b) The scope has been modified to ensure that high ripple current d.c. welding power sources are to be treated as a.c. power sources and to specifically exclude welding underwater.
- (c) A Table has been added to Section 5 detailing minimum insulation resistances for routine inspection and testing of welding power sources.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard
Safety in welding and allied processes

Part 2: Electrical

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out safety requirements for arc welding and allied processes, to reduce the possibility of electric shock and minimize associated hazards. It includes requirements for cable connections for alternating and direct current power sources, as well as requirements for hazard-reducing devices and other ancillary equipment. It also describes practices and safeguards that should be adopted by welders and provides examples of situations that present an increased risk of electric shock.

For the purposes of this Standard the term ‘direct current’ (d.c.) is considered to be a direct current with a sinusoidal ripple content of not more than 10% r.m.s. Any d.c. power source with a sinusoidal ripple content of more than 10% shall be considered as an a.c. power source (eg. a single phase unfiltered full wave rectified d.c. power source has a nominal sinusoidal ripple content of 48%).

This Standard does not cover electrical safety requirements when welding is carried out underwater.

NOTES:

- 1 Other aspects of welding safety are covered in other Standards.
- 2 Typical electrical hazards are described in Appendix A.
- 3 Some fatal electrical accidents are reported in Appendix B.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1674	Safety in welding and allied processes
1674.1	Part 1: Fire precautions
2812	Welding, brazing and cutting of metals—Glossary of terms
60529	Degrees of protection provided by enclosures (IP Code)
60974	Arc welding equipment
60974.1	Part 1: Welding power sources (IEC 60974-1, Ed.2.2 (2000) MOD)
60974.6	Part 6: Limited duty portable arc welding and allied process power sources (IEC 60974-6, Ed. 1.0 (2003) MOD)
60974.11	Part 11: Electrode holders (IEC 60974-11, Ed.2.0 (2004))
AS/NZS	
1336	Recommended practices for occupational eye protection
1337	Eye protectors for industrial applications
1338	Filters for eye protectors
1338.1	Part 1: Filters for protection against radiation generated in welding and allied operations

AS/NZS	
1995	Welding cables
2161	Occupational protective gloves
2161.4	Part 4: Protection against thermal risks (heat and fire)
2865	Safe working in a confined space
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
3100	Approval and test specification—General requirements for electrical equipment
60479	Effects of current on human beings and livestock
60479.1	Part 1: General aspects
IEC	
60974	Arc welding equipment
60974-2	Part 2: Liquid cooling systems
60974-5	Part 5: Wire feeders
60974-7	Part 7: Torches
60974-12	Part 12: Coupling devices for welding cables
WTIA	[The Welding Technology Institute of Australia]
Tech. Note 7	Technical Note No.7: Health and safety in welding
Tech. Note 22	Technical Note No.22: Welding electrical safety

1.3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 2812 and those below apply.

NOTE: Diagrams for the purpose of illustrating some definitions relating to arc welding installations are given in Figure 1.3.

1.3.1 Allied process

An electric arc process that is not used for joining, such as air arc gouging, air arc cutting, metal arc cutting, arc spraying and plasma spraying.

1.3.2 Authorized

1.3.2.1 *Authorized inspector*

A person authorized by an authority administering acts of Parliament or regulations under such acts or, in the absence of such acts and regulations, any person appointed by the Fire and Accident Underwriters' Association or the electricity supply or other authority, to inspect installations.

1.3.2.2 *Authorized person*

A person in charge of a premises or a licensed electrical contractor, electrician or other person appointed or selected by the person in charge of a premises, to perform certain duties.

1.3.3 Conductor

1.3.3.1 *Electrode conductor*

Fixed wiring between a machine electrode or work terminal and the corresponding output terminal.

1.3.3.2 *Work (or return) conductor*

Fixed wiring between a machine work or return terminal and the corresponding output terminal.

1.3.4 Control lead

A lead that connects the power source to ancillary devices, for control or regulating purposes, but is not part of the welding circuit.

1.3.5 Distribution box

A multi-operator arrangement of connections, sockets or terminals that is enclosed in a box or covered space, dividing a welding circuit into two or more branches that are suitable for use by two or more welders.

1.3.6 Environment

1.3.6.1 Category A environment (see Clause 2.2(a))

An environment where—

- (a) the risk of an electric shock or electrocution by arc welding is low;
- (b) normal work practice is used; and
- (c) it is not possible for a welder or any other worker to be in contact with the workpiece, in the event of being in contact with a live part of the welding circuit.

1.3.6.2 Category B environment (see Clause 2.2(b))

An environment where there is a significant risk of the welder contacting the workpiece or other parts of the welding circuit.

NOTE: Such an environment may be found where the ambient temperature is less than 32°C and—

- (a) freedom from movement is restricted, so that an operator is forced to perform welding in a cramped position (e.g., kneeling, sitting, lying), with physical contact with conductive parts (e.g., the workpiece); or
- (b) there is a high risk of accidental or unavoidable contact by the operator with conductive elements, which may or may not be in a confined space as defined in AS/NZS 2865.

1.3.6.3 Category C environment (see Clause 2.2(c))

An environment where the risk of an electric shock or electrocution by arc welding is greatly increased due to low body impedance of the welder and a significant risk of the welder contacting the workpiece or other parts of the welding circuit.

NOTE: Low body impedance is likely in the presence of water, moisture or heat, particularly where the ambient temperature is above 32°C. In wet, moist or hot locations, humidity or perspiration considerably reduces the skin resistance of human bodies and the insulating properties of personal protective equipment accessories and clothing.

1.3.7 FCAW

Flux-cored arc welding.

1.3.8 GMAW

Gas metal-arc welding.

1.3.9 GTAW

Gas tungsten-arc welding.

1.3.10 Hazard-reducing device (HRD)

A device designed to reduce the hazard of electric shocks from a welding circuit.

1.3.11 Licensed electrical worker

A person who holds an appropriate licence or approval to carry out electrical work in accordance with AS/NZS 3000.

1.3.12 Mains installation (electrical)

Wiring systems, switchgear, control gear, accessories, appliances, luminaires and fittings associated with wiring situated on any premises to which electricity is supplied or is to be supplied through any one service to a consumer.

1.3.13 MMAW

Manual metal-arc welding.

1.3.14 Observer

A person whose sole responsibility is to monitor the welder(s) activity, and who is capable of responding appropriately in an emergency.

1.3.15 Open-circuit voltage (OCV) or no-load voltage

The voltage between output terminals of a power source, while it is switched on, but not delivering any current.

1.3.16 Output lead (or cable)

1.3.16.1 Electrode lead (or cable)

A lead between an electrode holder or torch and an electrode output terminal of an electrode conductor, distribution box, choke or power source.

1.3.16.2 Work (or return) lead (or cable)

A lead between work and a return or work output terminal of a return conductor, distribution box or power source.

NOTE: The term 'earth lead' is often incorrectly used to refer to a return lead or a work lead.

1.3.17 Power source (also known as welding machine)

A device that supplies welding current and output characteristics that are suitable for arc welding or allied processes.

1.3.18 SAW

Submerged arc welding.

1.3.19 Shall

Indicates that a statement is mandatory.

1.3.20 Should

Indicates a recommendation.

1.3.21 Terminal

1.3.21.1 Power source terminal

A terminal of a welding or cutting power source, for the connection of conductors or leads of a welding circuit (see Figure 1.1).

1.3.21.2 Output terminal

A terminal in a welding circuit to which an output lead is connected.

1.3.22 Voltage-reducing device (VRD)

A type of hazard-reducing device (either internally or externally fitted to a welding power source) that is designed to automatically reduce the open-circuit voltage to a safer level.

1.3.23 Welder

A person who performs welding (including tack welding) or cutting operations.

NOTE: The term 'welder' is often used incorrectly to refer to a welding power source.

1.3.24 Welding

The making of a joint between parts, by means of heat or pressure or both, in such a way that there is continuity in the nature of the material of the parts.

NOTE: A filler material may or may not be used.

1.3.25 Welding circuit (also known as output circuit)

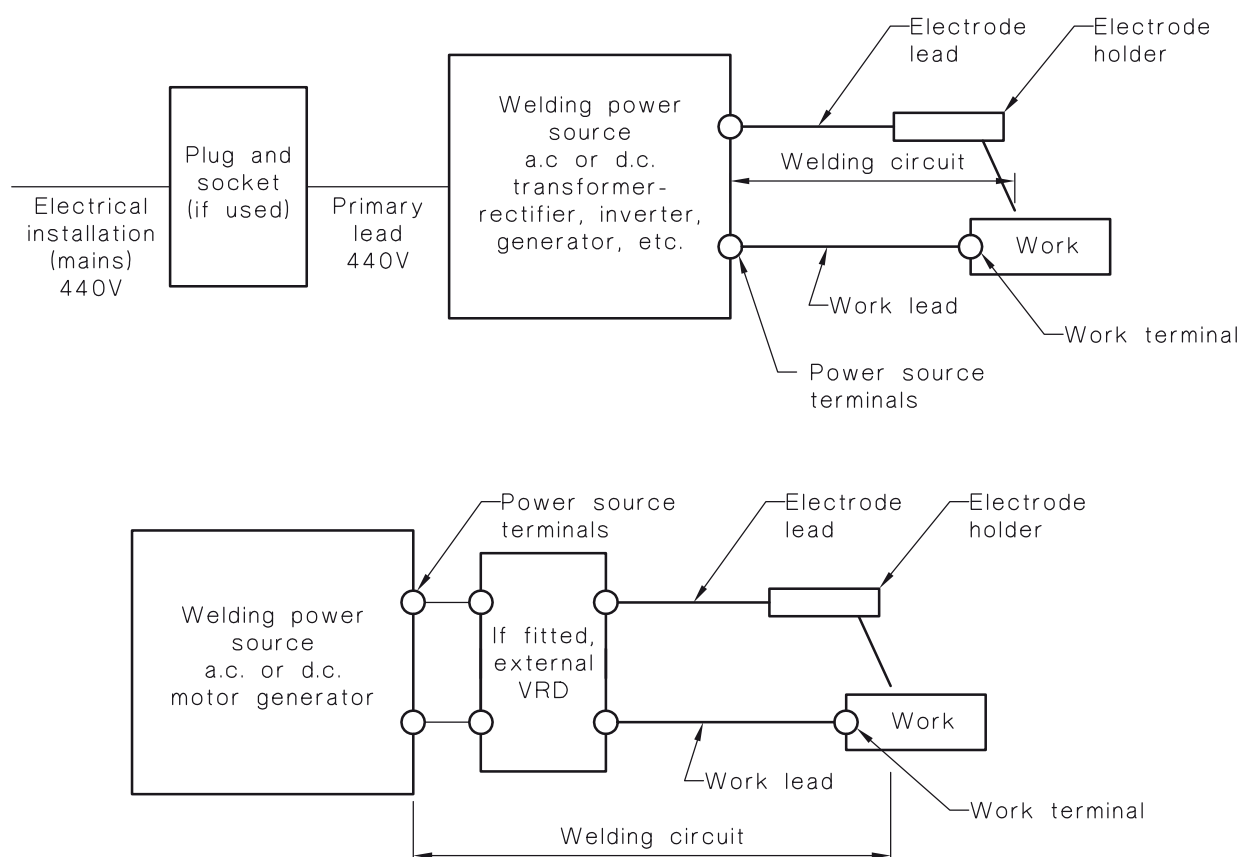
A circuit that includes the conductive material through which a welding current is intended to flow.

NOTES:

- 1 An arc is part of a welding circuit.
- 2 In certain welding processes, an arc may be established between two electrodes. In such a case, the workpiece is not necessarily part of the welding circuit.

1.3.26 Welding current

Current delivered by a power source during welding.



NOTE: These diagrams are for purposes of illustration and do not embrace all the possible combination of circumstances.

FIGURE 1.3 ILLUSTRATION OF SOME ARC WELDING TERMS

SECTION 2 RISK ASSESSMENT AND PERSONAL SAFETY

2.1 GENERAL

Parts of welding circuits, including workpieces and current return paths, have to be considered electrically alive. Consequently, welders shall follow the precautions and requirements in this Section, to minimize the risk of current passing through their body.

Before use, equipment shall be examined for soundness and proper maintenance in accordance with Section 5.

2.2 CLASSIFICATION OF WELDING ENVIRONMENT

Before welding commences, the work area shall be assessed and the welding environment classified for risk of electric shock in accordance with Clause 1.3.6. Also the following apply:

- (a) Category A environment (see Clause 1.3.6.1) In Category A environments, considerable effort is required to insulate the welder and others from the workpiece, such as bench-top welding where the workpiece is small and there is a low risk of the welder becoming part of the circuit; or where both the welder and any assistants are prevented from being in contact with conductive parts. For repetitive operations, such an environment is usually limited to carefully designed workstations, as well as welder training and welding procedure qualification test bays.

NOTE: AS 60974.1 and AS 60974.6 classify a Category A environment as 'an environment without increased hazard of electric shock'.

- (b) Category B environment (see Clause 1.3.6.2) Category B environments include general fabrication activities, large workpieces, steel building structures, inside pressure vessels, processing tanks, storage tanks, conductive confined spaces and onboard ships.

NOTES:

- 1 AS 60974.1 and AS 60974.6 classify Category B environments as 'environment with increased hazard of electric shock'.
- 2 When the weather is hot, when high preheat temperature is employed or when the vessel is exposed to the sun, many Category B environments become Category C environments.

- (c) Category C environment (see Clause 1.3.6.3) Category C environments include, but are not limited to, coffer dams, trenches, underground mines, in rain, partially submerged areas, splash zones (see also Appendix B).

NOTE: It may be possible to derate Category B and Category C environments, where effective control measures are taken to reduce or eliminate the risk (e.g., airconditioning, special insulating clothing).

2.3 CONTROL MEASURES

2.3.1 Category A environments

For welding in Category A environments (defined by Clause 1.3.6.1), Clause 2.2(a) and the following apply:

- (a) The electrode and workpiece shall be regarded as electrically live.
NOTE: The welder should take care to avoid contact with them.
- (b) Welding gloves shall be sound, dry and used on both hands while welding or changing electrodes.

- (c) Welders should wear appropriate dry fireproof clothing that covers the legs and arms, and footwear should be rubber soled and not have bare steel toecaps.
- (d) Leather cushions, wooden duckboards or other means shall be used to insulate the welder from damp concrete floors and any exposed parts of the workpiece.
- (e) Leads and equipment shall be inspected for damage. Damaged equipment and leads shall not be used, but removed from service for repair or discarded.

NOTE: A system of tagging for defective equipment is recommended.

- (f) While tacking two pieces together, the arc shall be struck on the piece connected to the return lead.

NOTE: Trying to tack weld on an unconnected piece will expose any person holding a piece not connected to the return lead to the risk of electric shock.

- (g) The work area shall be kept tidy and free from tangled leads, discarded cut-offs and electrode stubs.
- (h) The electrode holder or gun shall not be placed on the workpiece, where it may short circuit.

NOTE: An insulated container should be provided.

- (i) The power shall be turned off and MMAW electrodes and stub ends removed from the electrode holder, before the welder leaves the work area and whenever the leads have to be moved.

NOTE: Further detailed advice may be obtained from WTIA Tech. Notes 7 and 22.

2.3.2 Category B environments

While welding in Category B environments (see Clause 1.3.6.2), Clauses 2.2(b) and 2.3.1 and the following apply:

- (a) Where practicable, care shall be taken to convert to a Category A environment.
NOTE: Insulating cushions, sheets, blankets, duckboards and other suitable protection should be used to insulate the welder, if practical.
- (b) The open-circuit voltage in a Category B environment shall not exceed 113 V d.c. peak or 68 V a.c. peak and 48 V a.c. r.m.s.

The open circuit voltage shall be measured, to ensure it is within the specified limits. If necessary, the power source shall be fitted with a hazard-reduction device complying with Clause 3.2.7, in order to comply with this requirement.

NOTE: Power sources complying with AS 60974.1 should have been marked with the letter S in a square on the compliance plate, to indicate its safety in such an environment (see Table 3.2.2). Many a.c. MMAW power sources, particularly older machines, do not meet this requirement and should not be used in a Category B environment.

- (c) Whenever the welder works without an observer, the open circuit voltage shall not exceed 35 V d.c. peak or 35 V a.c. peak and 25 V a.c. r.m.s. (i.e., the same as in Item 2.3.3(e) for a Category C environment).

NOTE: The use of a HRD may be required.

- (d) Where the environment is a confined space, the provisions of AS/NZS 2865 shall also apply, which specifies requirements for access to the space, egress from the space in an emergency, avoiding asphyxiation and avoiding entanglement or entrapment. Where access to the space is restricted, an observer, as described in Clause 1.3.14, shall be required.

NOTES:

- 1 These control measures should be included in the hot work permit described in AS 1674.1.
- 2 Further detailed advice may be obtained from WTIA Tech. Notes 7 and 22.

2.3.3 Category C environments

For welding in Category C environments (defined by Clause 1.3.6.3), Clauses 2.2(c) 2.3.2 and the following apply:

- (a) Where it is determined that the welder or welding equipment can become wet from rain, splashing, partial submersion or other external sources, then adequate control measures shall be implemented before welding commences.
- (b) Every effort shall be made to make the environment as cool as possible to minimize perspiration.
- (c) An observer shall be appointed to monitor the welder. The observer or a third person working close by shall be trained in rescue and emergency procedures. The observer may monitor more than one welder, provided that the welders being monitored can be observed at the same time.
- (d) Maintenance of welding equipment shall not be undertaken in this environment.
- (e) The voltage between the electrode holder and the workpiece while an arc is not present shall not exceed 35 V d.c. peak or 35 V a.c. peak and 25 V a.c. r.m.s.

NOTES:

- 1 The use of covers to protect from water exposure (e.g., rain or a dripping roof), air-conditioning and frequent changes of clothing (particularly cotton glove liners) should minimize the risk.
- 2 Most equipment for GMAW, FCAW and GTAW complies with this requirement, because the current is switched with a trigger switch.
- 3 For MMAW or similar processes, such as carbon-arc gouging, the power source may require an additional hazard-reducing device.
- 4 Further detailed advice may be obtained from WTIA Tech. Notes 7 and 22.

2.4 PARTICULAR HAZARDS WITH PLASMA-ARC PROCESSES

Plasma-arc processes can produce fumes, gases, noise, radiation and heat, and explosion when cutting aluminium, which can present greater hazards than typical arc welding processes.

Plasma-arc cutting equipment presents a greater risk of electric shock than arc welding equipment, due to the higher voltages.

NOTE: Reference should be made to the supplier's recommendations for guidance on protection from these potential hazards.

SECTION 3 EQUIPMENT

3.1 HELMETS, HANDSHIELDS, GOGGLES, FACE MASKS AND GLOVES

Helmets, hand shields, goggles and face masks shall be designed so that no injury to the wearer can arise through conduction of electricity through the material, and any metal parts which might touch the head or face shall be electrically insulated.

NOTE: Helmets, hand shields, goggles and facemasks should comply with AS/NZS 1336, AS/NZS 1337 or AS/NZS 1338.1. Gloves should comply with AS/NZS 2161.4.

3.2 POWER SOURCES

3.2.1 General

In addition to the requirements specified herein, power sources shall comply with the relevant requirements of AS 60974.1, AS/NZS 3100 and AS 60974.6.

3.2.2 Degree of protection

The power source shall have a degree of protection that suits the environment in which it is to be used.

NOTES:

- 1 Box 22 on the rating plate of power sources should show the degree of protection in accordance with AS 60974.1.
- 2 Table 3.2.2 shows a typical rating plate.
- 3 Power sources rated with an IP21 degree of protection, as designated by AS 60529, are for indoor use only.
- 4 Power sources rated with a minimum of IP23 degree of protection, as designated by AS 60529, may be used outdoors.
- 5 The design and testing of power sources for use in Category B and Category C environments should be agreed between the manufacturer and the purchaser. Examples of such conditions include high humidity, unusually corrosive fumes, steam, excessive oil vapour, abnormal vibration, abnormal shock, excessive dust, severe weather conditions, unusual coastal conditions, shipboard conditions, vermin infestation and atmospheres conducive to the growth of fungus.